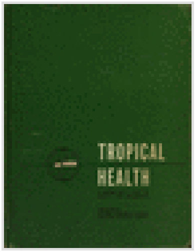

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TROPICAL HEALTH

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FOREWORD

A study of the needs and resources for research in the broad field of tropical health was undertaken by the Division of Medical Sciences, National Academy of Sciences—National Research Council in 1959 and was completed early in 1962.

Dr. Willard H. Wright, who served as the director of this study, has outlined the history of the conception, the purpose, the design and the conduct of this study in the introductory chapter of this report. The Division acknowledges the dedicated and enlightened conduct of the study by Dr. Wright and his staff, the wholehearted cooperation of a host of consultants and the wise guidance provided by the Advisory Committee under the able chairmanship of Dr. Albert B. Sabin.

Those readers who are concerned primarily with an evaluation of the impact of disease on the welfare of the peoples of the tropical areas of the world may find their chief interest in the comprehensive survey of the regional distribution of the "major diseases" of the tropics. The medical scientist, on the other hand, will probably devote his primary attention to the section of the report that constitutes a symposium of opinion of some ninety experts in many countries on the scientific and medical problems that are clamant for solution. Those who bear responsibility for the development of policy in this field and for the planning of programs should find much of value in the survey of available resources for research and control in the tropical regions. Finally, the attention of all readers is directed to the cumulative argument for the need for a considerable expansion of research in the field and to the specific recommendations of the Advisory Committee for the promotion of a larger and more effective national effort.

Anticipating inevitable delays in the publication of a document as bulky as this is, a summary report bereft of the major part of the statistical detail was prepared and given limited circulation a few months ago. The full report that is now presented should be found to be much more useful as a source reference.

The Division is grateful to the Office of the Surgeon General, U. S. Army, the National Institutes of Health, U. S. Public Health Service, and to the Rockefeller Foundation for generous financial support that has made possible the conduct of this study.

R. KEITH CANNAN
Chairman, Division of Medical Sciences
National Academy of Sciences—
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PREFACE

The main objectives of the survey, whose results are presented in the following pages, were to evaluate the medical and hygienic problems of importance in the future development of the tropics and to determine the research needs as a basis for recommendations regarding the future activities of the United States in this field.

In this connection it may be well to keep in mind that the tropics include an area which encompasses most of Latin America, almost all of Africa, the Middle East and Near East, most of Asia and the Pacific Islands—an area with approximately half of the world's population. When the contiguous areas, in which similar medical and hygienic problems prevail, are included, one must consider the needs of almost two billion people—about two-thirds of the world population. We are dealing here with regions, some of which are already overcrowded to the bursting point while others are still a relative wilderness, which under appropriate conditions could provide a haven for expanding world populations. It is also important to remember that the tropics and contiguous areas include most of the economically underdeveloped regions, which are now in great ferment seeking new ways of life. There are here hundreds of millions of people, who live in poverty and despair with, in many instances, an average life expectancy of only 35 years—people who are less and less willing to spend their short lives dreaming about the rewards of the hereafter, but who instead are seeking more and more a better life here and now. However, as was recently emphasized by Dr. George Harrar of the Rockefeller Foundation, this is usually a population that is struggling for survival without the knowledge or tools to improve its way of life, a population burdened by illiteracy, infectious and parasitic diseases, and inadequate nutrition (Industry and Tropical Health, IV, 79-83, 1961).

The tropical areas, which in general can now barely feed their own populations, could under appropriate conditions become the source of abundant food supplies so badly needed by the undernourished millions of people in the world. The tropics—an important source of vital raw materials—could with proper development become also one of the most important potential outlets for the products of the more highly industrialized nations of the world. The challenge of the tropics is not only a humanitarian one concerned with the fact that hundreds of millions of people living there are badly in need of help, but also that the continued well-being of the United States and other highly developed and industrialized nations, is to a large extent dependent on the future development of the people and resources in these hitherto dormant territories. The strong nations may well ponder the possibility that they may not long remain strong, unless they not merely help the weak nations but help them to become strong. In fact, the very peace of the world may depend on whether the strong nations of the world, regardless of their political or economic systems, can unite in fighting their real common enemy—which is the hunger, misery, disease, poverty and despair of the restless hundreds of millions of people now living in the tropics and in the other economically depressed, contiguous regions of the world.

No science or technology—be it of medicine, hygiene, nutrition, climatology, agronomy, or any other—can by itself be expected to bring about the desired developments in the tropics, but it may also be said that without the help of science and technology the economists and statesmen can hope for little if any progress. It was Stacy May, the economist on our Advisory Committee, who stated: "In a true sense it may be said that tropical medicine is the midwife of economic progress in the underdeveloped areas of the world. Where mass diseases are brought under control, productivity tends to increase —through increasing the percentage of adult workers as a proportion of the total population, through augmenting their strength and ambition to work, and in many cases by actually making possible the opening of new or the reclaiming of abandoned land previously untenable because of the prevalence of disease." (Amer. J. Trop. Med. & Hyg., *3*:412-421, 1954.)

Dr. May's statement in part also answers those economists who fear that "premature" improvements in public health may do more harm than good by increasing the total population beyond the means of the economy to support it. In this connection, another member of the Advisory Committee, Dr. Thomas H. Weller, recently wrote: " . . . Programs of tropical health must develop concurrently with efforts designed to improve the educational, economic and social status of underprivileged man, and . . . each element must be in phase with, and not disruptive of the indigenous economy." (New England J. Med., *264*:911-914, 1961.) Dr. George Rosen, professor of health education at Columbia University School of Public Health and Administrative Medicine, recently also indicated that "the importance of economic, social, and political factors in determining the health status of a people renders it imperative to take a comprehensive approach. In many undeveloped parts of the world, health aims cannot be attained without improvement of agriculture, development of industry, creation of competent administrative service, and a rise in the educational status of the population. In short, the undeveloped areas of the world confront the 20th century on a global scale with the same kind of problem that the sanitary reformers faced on a national scale about a hundred years ago. Just as Edwin Chadwick, Southwood Smith, and the other sanitary reformers recognized that no community can continue to sustain indefinitely large social losses due to preventable ill health and advance economically, so today men realize that aid must be given to the underprivileged members of the international community in social and economic terms if they are to deal successfully with their health problems." (Amer. J. Public Health, *51*:1013-1017, 1961.)

The medical and hygienic problems of the tropics consist largely of the same infectious diseases, that only recently were the chief causes of illness and death in the highly industrialized and economically advanced countries of the temperate zone, plus the special pestilences that plague both man and his domestic animals in specific zones of the tropics. The staff and advisory committee concerned with the present survey, were not unaware of the fact that tremendous progress in tropical health could be achieved by the mere application of knowledge already in existence—if only poverty and lack of education were not in the way. It was also realized, however, that in almost all the important diseases of the tropics as well as in the field of nutrition, there were also gross deficiencies in our knowledge which called for systematic research or development or both. Part VII of the present report which deals with the "Research Needs in Medical and Hygienic Problems of the Tropics" is based on suggestions received from an international group of 89 individuals, each of whom was endowed with long experience and extensive knowledge in the field of his special competence. This section on research needs is, in my own opinion, the most important part of this survey, because it clearly indicates the new knowledge that is needed and provides a basic blueprint for the important research activities that need to be pursued on an international scale for many years to come—as an aid to the solution of the disease and hygienic problems that are fundamental to the future development of the tropics and the greater well-being of the people that inhabit them. It may be helpful here to call attention to several particularly significant statements in this section.

Dr. William W. Frye, in the part on *bacillary dysentery* stressed especially the need for "the development of pilot or demonstration control programs which should be directed toward *the transformation of knowledge acquired in research to life-saving and disease-preventing programs*."

Dr. James A. Doull pointed out that of the 10 to 12 million *leprosy* cases in the world, about 80 per cent are in the tropics, and that "in relation to the needs and the sums spent for treatment and institutional care, the expenditures for leprosy research are almost insignificant."

Dr. Oliver R. McCoy, dealing with the *spirochaetal diseases* (syphilis and yaws), listed many problems for investigation, which included "development of new drugs, especially antibiotics, with the aim of discovering inexpensive, long-acting drugs without allergic hazards" as well as "the possibility of immunization in animals and in man."

In his summary of the *trachoma* problem, Dr. James A. Doull called attention to the fact that this disease affects an estimated 400,000,000 people in the world, and that it is "the greatest single cause of serious loss of vision and of blindness." He also concluded that "several well staffed and fully equipped centers strategically located throughout the world are needed for a proper study of this important disease" and pointed to the need for "safe and effective chemotherapy at low cost, requiring days instead of weeks or months, as at present, and otherwise suitable for mass campaigns in underdeveloped countries."

In his summary on the research needs in *malaria*, Dr. Paul F. Russell pointed to the conclusion that "the ideal antimalarial, containing the virtues of causal prophylaxis, suppression, rapid and complete curative action, sporontocidal effect, inability to create parasite resistance, absence of toxic effects, palatability and low cost, is still waiting to be discovered."

Dr. George M. Saunders, in summarizing the suggestions for research on *nutritional diseases*, stated: "It seems obvious that in attempting to identify areas where research is to be recommended, one cannot isolate one or more nutritional disorders for separate studies without regard to all environmental and host factors which influence their occurrence. The economy of an area, the ratio of producing hands to consuming mouths, the availability of essential nutrients and the knowledge of their proper use and the direct and indirect effects of infectious diseases on nutrition are all important and interrelated factors."

In the era which has just passed the great colonial powers supported extensive programs of research in large institutes of tropical medicine and hygiene as an aid to the development and exploitation of the areas under their control—and many important discoveries of benefit to all mankind resulted from this effort. During World War II, impelled by the needs of its Armed Forces, the United States for the first time became a great center for the investigation of urgent problems in tropical disease, hygiene, climatology and nutrition. Colonialism is now rapidly passing into history, and the future of the tropics is becoming more and more the concern of the people who inhabit them and of the united nations of the world who have taken upon themselves the responsibility of dealing with the problems that are the concern of all mankind.

In the years that followed World War II, research activities on problems of importance to tropical health rapidly diminished in the United States, and at the time the present survey was contemplated and finally initiated they were limited in scope and neither planned nor coordinated to achieve specific objectives—despite the fact that year after year the United States was spending increasingly larger amounts of money for the support and development of health projects in the tropics and contiguous areas. More recently, and particularly since the passage of the International Health Research Act of 1960, there has been a considerable increase in the international research activities of the United States which include also research on various problems of tropical health. In considering the adequacy of the present activities of the United States in research on tropical health, the Committee recognized that several departments of the Federal Government, through their own agencies as well as through support of universities at home and abroad, were engaged in research or training in tropical health in conformity with particular missions defined for them by specific legislation. Under present authorization, most of the international health research activities are directed toward the acquisition of knowledge of importance to the health of the people of the United States. The Advisory Committee agreed that: "It is an inescapable fact that history, having brought the United States to a position of leadership in the world, has imposed on it a responsibility to support the efforts of other peoples to improve their health and welfare. This derives not merely from the deep moral and humanitarian purposes of our nation but is also dictated by justifiable self-interest. The Committee finds, however, that the agencies of government that have the means to pursue these objectives in the field of tropical health are unnecessarily constrained by ambiguity of authority. If the United States is to make its proper contribution to the international effort in tropical health, these constraints should be removed. *Specifically there is need to establish authority to support research on problems that are important as problems of the tropics and not because their solutions may contribute indirectly to the health of the people residing in the United States.*"

After reviewing the current research activities in tropical health of government agencies, universities, private foundations, and industrial corporations, it was realized that, although these represented a "considerable and expanding effort," "they fall far short of meeting recognized needs [as set forth in Part VII of this Report], and that the goals of the greater physical and economic well-being of the indigenous populations of tropical regions call for a great expansion of research activity. The Committee believes that the United States can make its due contribution to the international effort most effectively and economically by fostering more coordination of research activities and that this may best be accomplished by the establishment of what might be known as a 'National Program for Research in Tropical Health.' The objective should be to assure that the research problems set forth in the body of this Report, and others that will be recognized from time to time, will be vigorously pursued wherever the best opportunities for their solution may exist."

The Advisory Committee visualized an organization whose function it would be to provide the necessary leadership and continuity of effort needed for the achievement of the objectives set forth above. This organization would not seek funds to support any research programs of its own, but would exert its influence to assure that existing programs would be strengthened and expanded particularly in those fields that for various reasons are currently receiving little or no attention. The "coordination" to be provided by the proposed organization would not be by central control or direction, but rather by bringing together those who are active, investigatively and administratively, in the field of tropical health so that the planning and programming of their activities may be facilitated and improved not only by a fuller knowledge of the work already in progress elsewhere, but of the research needs that are being neglected and of the opportunities that may exist or should be created for carrying them out. By fostering an increased interest in the problems of tropical health among American scientists, this organization may stimulate active participation of competent individuals to pursue necessary studies in neglected areas as well as the training of additional personnel for research in this field both at home and abroad.

In considering how the proposed organization might best fulfill its mission, the Advisory Committee expressed the belief "that the National Academy of Sciences—National Research Council is well qualified to organize and provide these services by reason of its unique national status derived from its charter, by its close association with the scientific and professional societies and with the medical institutions of the country, by its international affiliations, by its long record of national service, by its ability to assemble authoritative advisory groups in the pure and applied sciences and by the qualifications of its staff."

The future development of the tropics for the benefit of the people who inhabit them, as well as for the benefit of all mankind, requires not only the application of existing knowledge but also the acquisition of much new knowledge concerning many of the medical and hygienic problems set forth in the body of this Report. It is hoped that the research needs delineated in this Report and the recommendation for the establishment of a National Program for Research in Tropical Health will help the United States to make its proper contribution to the international effort in this field.

In considering the problems of the future development of the tropics, I am not unaware of the fact that even the limited application of existing medical and hygienic knowledge for the control of the mass-killing bacterial, parasitic and viral diseases has been largely responsible for the most phenomenal increase in population in the past fifteen years in many of the economically depressed areas of the tropics, and that further expansion of public health activities will result in a still greater lowering of death rates and, therefore, also in a still greater rate of population increase—unless adequate fertility control can counteract the growing success in death control. Competent analysts have indicated that the extraordinary increase in population, which is greatest in the economically most depressed areas, threatens to nullify all efforts to improve the living standards of the people, whose misery and despair constitutes the greatest threat to world stability and peace. Accordingly there are many who believe that the continued acquisition and application of knowledge designed to prolong life and to eliminate the miseries and handicaps of disease, without comparable concurrent activities directed at fertility control, will in effect, before long, result in the even greater miseries of hunger, poverty and war, and thereby create the greatest potential threat to human survival in all parts of the world.

Since it is inconceivable that any government would, in the present era of world-wide communications, attempt to withhold from its people the attainable benefits of medical science, and of the economic improvement that science and technology can bring—or if it did, that it would long endure—it follows that the acquisition and application of knowledge for adequate fertility control must be an essential corollary of all those activities that result in greater human survival. Current methods of fertility control can achieve much when energetically applied by an aroused and educated population, as has been shown in Japan in the past fifteen years, but they are impractical for the hundreds of millions of uneducated and poverty-stricken people who want it and need it the most. There is an urgent need for expanding research on all aspects of the population problem, and medical science can help by discovering the new knowledge that could make fertility control at least as practically applicable and successful as death control. The United States is now spending a relatively minute amount of effort and money for research on fertility control, and yet it is more important to the future well-being of the world than the new knowledge we need about heart disease and cancer. Dr. Ernest Stebbins, dean of the School of Hygiene and Public Health, Johns Hopkins University, put it this way: "Increasing population is the number one public health problem in many parts of the world. . . . Failure to attack this problem vigorously and immediately will mean increased suffering for millions of people and perhaps even world disaster. . . . It would seem logical to attack this problem with the same intensity and enthusiasm as we attacked the problem of malaria. It is imperative that public health resources be made available for research for improved contraceptive methods, and that this be given a higher priority in the public health program."

Thus, although the problem of fertility control was not in the purview of the present survey, it is one which cannot be ignored in a judicious appraisal of the needs and opportunities for research in tropical health.

ALBERT B. SABIN
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Chapter 1

Introduction

Willard H. Wright

Background of the survey

The present project had its inception in discussions in the American Society of Tropical Medicine and Hygiene in 1953 and 1954. In January of the latter year, Dr. Frederick J. Brady, the president of the Society at that time, appointed an *ad hoc* committee to consider methods and means for the implementation of such a survey.

At the time in question, the interest in tropical medicine, inspired of necessity during World War II, had flagged considerably and military operations in Korea had done little in the way of reviving such interest. The teaching of tropical medicine courses in the medical schools of the United States was steadily declining. Training programs had been discontinued. Both public and private funds for research in the field were being materially curtailed. At the same time, the United States was assuming responsibilities for health projects in tropical areas through its aid programs without having available for the most part professional personnel with adequate training and experience in the disciplines embraced within the field. It was the view of President Brady and members of the Council of the above-mentioned Society that this country could ill afford to remain oblivious to the relative importance of tropical medicine in relation to its internal economy, its dependence on the tropics for many of its strategic materials, and its obligations under expanding assistance programs to countries within the tropical sphere.

The *ad hoc* committee under the chairmanship of Dr. Albert B. Sabin functioned for a number of years and was responsible for enlisting the aid of various agencies and, in turn, the National Academy of Sciences—National Research Council. In 1958, Dr. R. Keith Cannan, Chairman, Division of Medical Sciences, Academy-Research Council, was instrumental in securing the necessary funds for the implementation of the study. Support has been provided by the National Institutes of Health, the U. S. Army Research and Development Command, and The Rockefeller Foundation, and appreciation is accorded these organizations for financial aid.

A meeting of Dr. Sabin's committee was held in Miami, Florida, during the November 1958 meetings of the above-mentioned Society. This meeting was attended by representatives of the Academy-Research Council and by other individuals interested in research and international health problems. Careful consideration was given to plans for the survey and tentative objectives were approved by the group. It was believed that the work could be completed within two years and the finances were, therefore, tailored to fit this schedule. As it turned out, this estimate was too conservative and failed to give full weight to the magnitude of the task.

The survey got under way on 1 January 1959. The first three months were devoted to securing a small staff, in becoming familiar with sources of material and in making necessary contacts with organizations and individuals active in the international health and tropical medicine fields. It soon became evident that the required sources of material were lacking in many instances and considerable time had to be devoted in the first half year of the work to compiling this basic information. It became necessary to prepare a list of hospitals, clinics and environmental sanitation installations in the tropics; to assemble a roster of medical missions; to ascertain which American business firms were involved in medical care and preventive medicine in that part of the world; and to compile a world list of medical and veterinary institutions conducting research in tropical medicine, as well as a list of medical and veterinary schools in the same category. Other similar tasks included gathering information on government and private agencies, both domestic and foreign, supporting grant-in-aid and fellowship programs in tropical medicine, as well as teaching and training programs in the field. Collection of pertinent data could not be undertaken until such lists were available.

As some momentum was gained, it became clear that informal advisory aid would be insufficient to achieve the goals of the survey, and in January 1960 an Advisory Committee was appointed by the President of the Academy-Research Council. This Committee has held several meetings and has functioned effectively also on an interim basis by providing consultative services on many aspects of the project. The Committee members have given unstintingly of their time and counsel and have been most helpful in guiding the course of the work and in arriving at many decisions concerning the treatment of the assembled data.

Scope and latitude of the survey

The original recommendations of the *ad hoc* committee concerning the scope and latitude of the survey were adopted for the most part by the Advisory Committee of the Academy-Research Council.

The main objective of the survey was "to determine the role to be played by the United States in future research and development on problems related to human and veterinary medicine, hygiene, nutrition and climatic influences in the tropics." To accomplish this task, the following suggestions were submitted:

> "Collect the best factual information on the present status of diseases of human beings and animals of foremost economic importance in various tropical regions.
>
> "List the most important human and animal diseases which at present cannot be controlled because (a) the means of control are available but methods are too costly for practical purposes, or (b) insufficient knowledge is available to permit control.
>
> "Analyze the hygienic, climatic and nutritional conditions which are responsible for low productivity of peoples currently inhabiting various tropical regions, as well as those which would constitute the greatest hindrance to the movement of new populations into those areas, when and if such migration should become economically necessary and politically feasible.
>
> "Evaluate research and development work on these problems that is presently in progress in (a) research institutes of governmental and private agencies of other nations, and in (b) various private and public institutions in the United States.
>
> "Gather information on the specific problems of interest to American industry, commerce and government in various tropical regions."

Following the collection of information on the above-mentioned questions, it was expected that the staff of the project would be in a position to make pertinent recommendations concerning the health needs in the tropics and the resources essential to meet these needs.

The recommended coverage was incorporated into the plan of the survey. It was early realized, however, that an adequate evaluation of public health problems in the tropics could not be made without some recourse to information concerning control programs, environmental sanitation, facilities for medical care, medical and paramedical personnel and financial support being devoted to health in this part of the world. Early in the course of the study, therefore, it was decided to expand the plan to include the securing of data on these subjects.

From time to time, other changes have been made in the original plan. Situations arose in which it was not possible to elicit sufficient data for the adequate coverage of a subject and such portions were eliminated. The plan was revised on 15 August 1960. Further revision, representing the actual coverage, was made on 16 October 1961 (Appendix 1).

Geographical coverage

For many reasons, it was not feasible to confine the present investigations to the celestial tropics, i.e., the regions of the earth lying between the Tropic of Cancer and the Tropic of Capricorn. To do so would have necessitated the exclusion of areas in which diseases commonly regarded as "tropical diseases" are endemic or epidemic. The geographical coverage finally decided on was as follows:

I. Caribbean, Central and South America
II. Africa
III. Southwest Asia
IV. South Central and Southeast Asia
V. Oceania

The majority of the data in the report have been compiled and are presented on a regional basis and seldom has it been found advantageous to mention tropical countries by name. The scope of the study would have been little enhanced by such a device.

The above-mentioned regional coverage is subject to many criticisms. One might contend, for instance, that the Republics of Argentina and South Africa are not in the tropics—yet many of the human and animal diseases which flourish in the tropics are found also in portions of these countries. Furthermore, both countries have long been identified with and have contributed eminently to research in tropical diseases. It would be well-nigh impossible to obtain a separation of the numerous required data on the basis of portions of a country in which tropical diseases are endemic, omitting data for the areas free of such diseases.

Since the inauguration of this study, many political upheavals have occurred in various parts of the world and more than a score of new countries have been created. Collection and recording of basic data have been related to the current political status. For instance, in the beginning, information was gathered for the various French communities in Africa, such as French West Africa and French Equatorial Africa. This information was incorporated into portions of the narrative report prior to the emergence of the several republics from these communities. It would now be impossible to unscramble these data and fractionate them on the basis of the component parts of the former areas; as a matter of fact, the records are no longer available. Under the circumstances, the information must stand as recorded. Later, in certain instances, newly emerged countries have been treated on a separate basis; however, most of the basic material had already been collected and compiled.

As the result of political changes, the reader will find that throughout this report different designations have been applied to the same country. Such differences are unavoidable. Even as this is being written, further change is taking place.

The countries and national health jurisdictions included in the geographical coverage at the beginning of the survey are listed as Appendix 2 together with current designations, if any change has taken place.

Definitions and subject inclusions

As much difficulty has been encountered in defining "tropical medicine" as in selecting the geographical areas which should constitute "the tropics" for the purposes of the current study. Tropical medicine is not a static concept of a fixed, unvarying group of diseases in tropical climates. Disease distribution and intensity may change with changing etiological factors. Among such factors are population shifts, cultural patterns and the physical environment. Changing economic, educational, nutritional, agricultural and industrial conditions are important factors also. In addition, research in tropical diseases, where the results have been applied, has been the means of protecting and freeing some areas of the tropics from certain indigenous diseases and has contributed fundamentally to population stability and economic improvement.

Inhabitants of tropical countries are subject to the same infections that are found in other parts of the world. Certain infectious diseases have been introduced through the growth of trade and travel. Furthermore, some infections that are endemic in the temperate zones take the form of severe epidemics among non-immune populations in the tropics and may continue as major health problems.

Some infectious diseases, such as African sleeping sickness, are indigenous to the tropics. Yellow fever is found usually in regions close to the equator. However, in the past in the presence of suitable vectors, the disease has ranged far outside of its customary endemic areas, and constant vigilance is still necessary for its containment. In warm countries, the climate in many areas affords conditions of rainfall and temperature conducive to the prevalence of vectors of certain viral, protozoal and helminthic agents of disease. Thus the tropical environment is more favorable for the spread of certain diseases than is that of other climatic zones.

Because of the broad scope of the survey, it has been necessary to confine subject coverage to public health problems and diseases which are predominant in the above-mentioned geographical areas. On an arbitrary basis, therefore, the following subject matter has been included:

Infectious diseases
Nutritional diseases
Tropical physiology and climatology
Environmental hygiene
The zoonoses and other diseases of domestic animals

The infectious diseases constitute the chief causes of morbidity and mortality in the tropics. The nutritional diseases are predominant in these areas largely because of low per capita income and undernourishment, especially in infants and young children. Tropical climatology and the physiological changes ascribable to it are of importance from a health standpoint. Standards of environmental hygiene are at a low level in many tropical countries and lack of sanitary facilities contributes materially to the spread of many infectious diseases. Many of the zoonoses flourish in the tropics by reason of the prevalence of arthropod and other vectors and intermediate hosts, feral reservoirs and frequency of certain animal diseases directly transmissible to man. Furthermore, animal diseases in general deprive tropical populations in many areas of essential animal protein.

The chronic and metabolic diseases (other than those concerned with nutrition) were not included in the survey. There are few tropical countries in which these diseases constitute main public health problems. Moreover, such diseases are not diagnosed and reported to the same degree as they are in the metropolitan countries.

It early became obvious that the disease coverage of the survey would have to be limited to those conditions of greatest public health importance, since it would have been impossible under the circumstances to attempt an evaluation of all diseases encountered in the tropics. As a consequence, the Advisory Committee was asked to compile a list of the most important diseases. As finally agreed upon, the list included 34 diseases and disease groups which are presented in Appendix 18. In consultation with Dr. W. A. Hagan, a member of the Advisory Committee, and other authorities familiar with diseases of domestic animals in the geographical areas of the survey, a list of such diseases was compiled and is found in Part II. The diseases in these two categories have been singled out for special attention in certain parts of this report.

Sources and limitations of available data

Primary sources of information were the publications of the United Nations, and particularly those of certain of its component agencies such as the World Health Organization and the Food and Agriculture Organization. Publications emanating from the metropolitan countries with interests in the tropics were gathered and consulted, as were similar publications issued by countries within the geographical coverage of the survey. Index files were maintained on pertinent items appearing in current scientific publications, especially those in the fields of medical parasitology, tropical medicine, epidemiology, microbiology, nutrition, virology, bacteriology, pathology and other disciplines bearing on the objectives of the survey.

The limitations of available data are obvious to anyone who has had to deal with disease problems in the tropics. Epidemiological services in many countries of the area are poorly developed, if at all. Disease reporting leaves much to be desired for the reasons that health services are not as highly organized as those in metropolitan countries, finances are restricted, medical practitioners are relatively few in number and are especially scarce in rural areas, and communications have not been adequately developed. In spite of these inadequacies, the epidemiological reports of the World Health Organization and the epizootiological data published by the Food and Agriculture Organization have been of immeasurable help.

There is no doubt that more and better information might have been obtained had it been possible to travel extensively in the countries embraced in this report. However, this was impossible because of the limited size of the staff and the budget. Nevertheless, some foreign travel was conducted; most of these trips involved temporary duty with international organizations which assumed the major expense of the travel. Three visits were made to the headquarters of the World Health Organization in Geneva, Switzerland; two to London, England; one to Paris, France; one to Lisbon, Portugal; one to Rome, Italy, the headquarters of the Food and Agriculture Organization; and one to Noumea, New Caledonia, the location of the general offices of the South Pacific Commission. In these visits, data were secured which would not otherwise have been available.

The bulk of the data going into the narrative report was secured through letters and questionnaires. While results in certain instances were frankly disappointing, on the whole the response of the hundreds of organizations and individuals solicited was gratifying. The specific sources of information pertaining to various sections of the report have been listed therein.

In surveying important research problems in tropical medicine, it was found desirable to draw up, with the aid of the Advisory Committee, a list of consultants, each of whom was then asked to furnish suggestions. The response of these individuals was most encouraging. A summary of the material has been made for each of the important diseases and these summaries are presented in the body of the report; the suggestions themselves have been incorporated in the appendix.

Time factors

It will be noted that the plan of the survey contained a provision for the accumulation of many of the data for the five-year period, 1954-1958. It was the concept that such coverage would provide an adequate insight concerning trends within the various categories with which the survey was dealing. It was possible to follow this objective in some of the sections, but this was not found feasible in other instances. This lack of uniformity in the collection and presentation of the material for a specified period is disadvantageous but was inevitable because of the nature of the task.

The disease coverage in terms of morbidity and mortality has been compiled insofar as possible for the years 1953-1957. At the time work was instituted on this section, complete data were not available beyond the calendar year 1957, since the volume of the Annual Epidemiological and Vital Statistics of the World Health Organization containing the 1958 summaries had not yet appeared. However, some more recent limited coverage was secured by consulting the monthly Epidemiological and Vital Statistics Reports. At the time data were being compiled on diseases of domestic animals in the tropics, the 1960 Animal Health Yearbook of the Food and Agriculture Organization had not yet been published and it was necessary to take information from the 1959 Yearbook.

The time lapse in the availability of much of the basic information necessary for a study of this magnitude constitutes a handicap which might seem to depreciate the value of the report even before it appears. It is anticipated, however, that the reader will bear this discrepancy in mind during his perusal of the report and will understand that it is unavoidable.

Part I

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Chapter 2

Significant Human Diseases in Tropical and Subtropical Areas—Preliminary Considerations

The purpose of this section was to provide necessary data on the population of the survey area and to secure information on vital statistics of the various regions, including morbidity and mortality, infant and neonatal mortality and natural increase. The resulting statistics were to be utilized in an analysis of the diseases of greatest public health importance in the tropics.

It soon became evident that many diseases of the survey area, both reportable and non-reportable, either were not of wide distribution or did not contribute significantly to the low health standards of the region. The Advisory Committee on Tropical Medicine was therefore requested to select a list of the most important diseases of the tropics. The diseases thus defined were divided into four main categories, as follows:

a. Diseases of high endemicity,
b. Diseases of relatively low endemicity at present but potentially great because of epidemic character in past and present unprotected populations,
c. Diseases of relatively low endemicity but high mortality or serious complications,
d. New diseases concerning which present knowledge is limited, but which appear to be of considerable health importance.

A list of the diseases included in each of these arbitrary divisions is given in Appendix 18.

A tentative estimate of the present status of these diseases in the areas under survey was carried out with attention in each case to geographical distribution, incidence, morbidity, mortality and public health importance. Evaluation of the magnitude of the problem is also attempted in each case.

There is a lack of agreement as to the sense of certain designations which are widely utilized in the literature. Appendix 3 contains a glossary of such terms, with a specification of the meaning which was adopted for this report.

Sources and adequacy of data

The sources utilized in this survey consisted primarily of the *Annual Epidemiological and Vital Statistics* published by the World Health Organization and the *Demographic Yearbook* issued by the United Nations. Annual health reports of the various countries and territories were consulted as was the *Tropical Disease Bulletin* and the literature in general.

Basic information concerning the disease picture in many of the areas is generally inadequate and in some instances is totally lacking. Many factors contribute to this situation. The underdeveloped state of most of the countries included in the survey is reflected in the scientific as well as social and economic spheres. There is a notorious lack of professional personnel trained in the health and statistical fields. To this must be added widely distributed inadequacies such as the lack of accepted standard methods of reporting, difficulties of diagnosis, grouping of diseases of similar nosology or etiology, and simple lack of reporting. Religious beliefs and local social customs contribute in some measure to the inefficiency of reporting. Health officers cannot record the cases they do not see. In many of the most underdeveloped areas of the survey the services of modern medicine are eschewed in favor of native medicine or witchcraft. Thus, it is difficult and often misleading to attempt comparisons of the epidemiological data reported from the various countries.

The present conclusions are known to be incomplete and perhaps in some cases inaccurate. The data do not represent a true picture of the situation but merely that picture offered by the available information. Moreover, it must be apparent that no conclusions can be drawn from the *absence of data,* except the obvious one that collection of such data would be desirable.

The relative importance of various diseases may be materially different from country to country, and even from area to area within a country, thus making hazardous any attempt to evaluate the disease situation on a comparable basis. A synoptic view of the relative public health importance of all of the diseases under study is thus most precarious.

It was not feasible in the time available to prepare an estimate of morbidity and mortality of the selected diseases throughout the five-year period 1954-1958. It was decided instead to utilize data referring to the year 1957, the last year for which annual data were available from WHO reports. No claim is made that this particular year is representative of the average for the period concerned; it was felt, however, that it would serve as a representative sample of prevailing conditions.

As far as possible an effort was made to separate the information on a regional basis. However, this was not always feasible, especially with regard to incidence and prevalence of certain diseases.

Population

Table 1 presents the information available with regard to the population in the areas under survey. It was decided to examine statistical data covering the five-year period 1953-1957.

Annual statistical reports published by the World Health Organization are about three years behind in time and the same is true for a large number of the annual reports of the countries. Data for 1958 were too scarce to be generally useful. Thus, in this section of the report, the five-year period 1953-1957, instead of the period 1954-1958, was selected for the population data.

Data for 100 per cent of the area were unobtainable for the period and the best that could be had was a coverage of 82.84 per cent for the years 1953, 1954 and 1955, 80.47 per cent for 1956, and 55.62 per cent for 1957.

It will be noted from Table 1 that the most favorable regional coverage in terms of the number of countries reporting data in relation to the total number of countries was in the Caribbean, Central and South America, which ranked first during the four-year period 1953-1956. In the year 1957 the best coverage was evidenced by the Southwest Asia region. Complete representation was secured only in one year (1953), this in the Caribbean, Central and South American region.

A considerable increase of population is seen between 1953 and 1956, when coverage is approximately equal for each year. The total population under survey rose from 1,031,591,000 in 1953 to 1,095,185,000 in 1956, of which South Central and Southeast Asia contributed 620,-839,000 in 1953 and 654,015,000 in 1956, or 60.18 per cent and 59.71 per cent of the totals. The data for 1957 in many instances are relatively inadequate. A highly populated country may have failed to report its total population for a given year thus changing the total picture. An example of this is in the decrease in total population for the Caribbean, Central and South American region between 1953 and 1954 when one less country reported in 1954 (Cuba, which had added 5,829,000 to the 1953 total for the Caribbean, Central and South America). On the other hand, lack of reporting from under-populated countries does not alter to any extent the final figure for a given year as exemplified again by the Caribbean, Central and South America; here, 41 countries in 1956 provided a larger figure than 45 countries in 1955 and only 21 in 1957 presented yet a larger total.

Coverage for 1957 reached only 55.62 per cent of the total area under survey, and thus the decrease in total population does not signify a real decrease in the area but merely a decrease in the number of countries and territories from which data were available. For this reason, 1957 is discarded in the following analysis. However, it is interesting to note that the population of the survey area in that year represented 38.06 per cent of the total world population of 2,795,000,000 as estimated by the United Nations.

All the regions showed a steady increase in population from year to year, ranging from 3.72 per cent in the Caribbean, Central and South America to 12.11 per cent in Southwest Asia. It is interesting that in the less developed countries the population increase is more marked. Taking into consideration the high mortalities in these areas, this suggests the existence of some compensatory factor that permits this increase. Religious practices and marital customs, of which polygamy is perhaps a prime factor, are in all probability the basis for such compensation.

The original intent to differentiate the population of the survey regions on the basis of age and sex was not realized. Available data were so scarce that a minimum of reliability in the total picture could not be reached. Only in 55 out of the 169 countries and territories surveyed was it possible to secure data covering the whole five-year period.

Table 1. Total population of area surveyed for the 5-year period 1953-1957, inclusive

AREA*	NUMBER OF COUNTRIES AND TERRITORIES SURVEYED	1953 NUMBER OF COUNTRIES AND TERRITORIES REPORTING DATA	1953 POPULATION (IN THOUSANDS)	1954 NUMBER OF COUNTRIES AND TERRITORIES REPORTING DATA	1954 POPULATION (IN THOUSANDS)	1955 NUMBER OF COUNTRIES AND TERRITORIES REPORTING DATA	1955 POPULATION (IN THOUSANDS)	1956 NUMBER OF COUNTRIES AND TERRITORIES REPORTING DATA	1956 POPULATION (IN THOUSANDS)	1957 NUMBER OF COUNTRIES AND TERRITORIES REPORTING DATA	1957 POPULATION (IN THOUSANDS)
I	46	46	173,544	45	171,692	45	175,848	41	179,906	21	181,757
II	58	47	177,411	46	180,474	49	189,122	49	194,420	37	196,259
III	18	10	56,635	10	57,979	10	59,859	10	63,496	12	29,261
IV	24	18	620,839	20	642,647	18	644,178	19	654,015	14	654,397
V	23	19	3,162	19	3,351	18	3,296	17	3,348	10	2,208
Totals	169	140	1,031,591	140	1,056,143	140	1,072,303	136	1,095,185	94	1,063,882

* I. Caribbean, Central and South America; II. Africa; III. Southwest Asia; IV. South Central and Southeast Asia; V. Oceania.

Table 2. General mortality in 32 out of 169 (18.9 per cent) countries and territories for which complete data were obtainable for the period 1953-1957, inclusive

AREA*	NUMBER OF COUNTRIES SURVEYED	NUMBER OF COUNTRIES WITH DATA	1953 POPULATION (THOUSANDS)	1953 MORTALITY	1953 PER THOUSAND	1954 POPULATION (THOUSANDS)	1954 MORTALITY	1954 PER THOUSAND	1955 POPULATION (THOUSANDS)	1955 MORTALITY	1955 PER THOUSAND	1956 POPULATION (THOUSANDS)	1956 MORTALITY	1956 PER THOUSAND	1957 POPULATION (THOUSANDS)	1957 MORTALITY	1957 PER THOUSAND	TOTALS POPULATION (THOUSANDS)	TOTALS MORTALITY	TOTALS PER THOUSAND	AVERAGE MORTALITY PER THOUSAND
I	46	17	98,696	1,269,531	12.86	101,126	1,165,550	11.53	103,684	1,238,786	11.95	106,362	1,193,095	11.21	109,101	1,296,135	11.88	518,969	6,103,157	11.76	11.89
II	58	4	27,292	278,526	10.20	27,439	268,774	9.79	28,538	286,213	10.03	29,270	263,987	8.80	29,957	267,391	8.93	142,496	1,364,891	9.58	9.55
III	18	3	6,535	43,085	6.59	6,727	40,484	6.01	7,021	41,245	5.87	7,233	41,735	5.77	7,531	42,929	5.70	35,047	209,478	5.98	5.99
IV	24	6	410,679	4,420,575	10.76	416,520	3,956,103	9.49	422,757	2,911,675	6.89	428,811	3,445,320	8.03	453,340	4,002,587	8.83	1,721,428	18,736,260	10.88	8.8
V	23	2	95	504	5.30	98	445	4.54	100	673	6.73	103	692	6.72	105	704	6.70	501	3,018	6.02	5.998
Totals	169	32	543,297	6,012,221	11.08	551,910	5,431,356	9.84	562,100	4,478,592	7.97	571,779	4,944,829	8.65	600,034	5,609,746	9.35	2,418,441	26,416,804	10.92	9.38

* I. Caribbean, Central and South America; II. Africa; III. Southwest Asia; IV. South Central and Southeast Asia; V. Oceania.

Vital Statistics—Mortality

Under-reporting of deaths occurs throughout the world. Causes of reported death are often incorrect and rates of medical certification of death can be as low as 12.1 per cent, as is the case in El Salvador.[1] It may be lower for countries in which medical facilities are even more inadequate. Mortality reporting is far from satisfactory and a large number of deaths occur annually without the knowledge of the proper authorities.

A further potential source of inaccuracy concerns the certification of deaths. Certification by physicians does not always involve accuracy. The methods employed in obtaining the data are important in determining accuracy and the fact that such methods are not yet standardized makes it impossible to establish valid comparisons. The World Health Organization is currently endeavoring to establish standardized reporting procedures.

Tables 2, 3, 4 and 5 present the data with regard to general, neonatal, and infant mortality, respectively. In view of the inadequacies of reporting, the data must be taken to represent a minimum portrayal of the actual situation.

General mortality

Complete data on this subject were obtained from only 32 of 169 countries and territories surveyed (Table 2). The mortality rate per 1,000 in the different regions varied from 4.54 in Oceania in 1954 to 12.86 in the Caribbean, Central and South America in 1953. During the five-year period under consideration, the Caribbean, Central and South America always showed a higher total mortality rate than any of the other regions. All the regions revealed a rate which was more or less constant.

The total mortality rate for the survey area in the five-year period was 10.92 per 1,000, the mean for each year being 9.38 per 1,000. There was a relative decrease in total mortality rate from 11.08 per 1,000 in 1953 to 9.35 per 1,000 in 1957.

Table 3 extrapolates data from late 1956, early 1958 and from previous years in order to obtain a larger coverage of the area. Even with this recourse, it was not possible to obtain a coverage equaling 50 per cent. This table shows that the extrapolations change the over-all picture to a certain extent. Africa and South Central and Southeast Asia become the regions where mortality rates were greatest, while Southwest Asia still showed the lowest mortality rate.

A comparison of Tables 2 and 3 reveals again how unreliable are the sources of information. However, the data in both tables indicate that the mortality rate of the area surveyed decreased in the five-year period of study. The causes of this decrease seem to be independent of the nature of reporting and are probably associated with other factors. Better medical facilities and achievements in control of certain communicable diseases no doubt are concerned in the lowering of mortality rates.

Neonatal mortality

Information concerning neonatal mortality proved to be scarce and relatively inaccurate. Table 4 gives some figures for this category for the five-year period 1953-1957.

Documentary search brought little reward since in only 11 of the 169 countries and territories were data available, even with recourse to extrapolation of the type mentioned in connection with Table 3 on general mortality. No information was available from Africa. In the other regions the number of countries reporting is small and the data cannot be considered representative.

Infant mortality

Information concerning infant mortality, although more substantial than that referred to in the previous paragraph, is also far from satisfactory. Data were obtainable from 64 of the 169 countries and territories under survey.

In Table 5, it can be seen that the over-all high infant mortality rate was 95.6 per 1,000 births. Africa with a total mortality rate of 140.4 per 1,000 births substantially outranked the other areas and could be taken to represent the region in which this problem is most acute; however, the data are based on reports from only 5 of the 58 countries and territories in this region.

The infant mortality rate per 1,000 decreased from 121.7 births in 1953 to 89.2 births in 1957. Again there is no accurate method of evaluating the decrease although the increasing number of countries and territories reporting infant mortality in recent years suggests that it is not totally due to insufficient reporting but may be associated with improved curative and prophylactic services and better socio-economic conditions. Maternal and child welfare programs appearing for the first time in many of the countries concerned are certainly associated with the decrease in infant mortality rate.

Natural increase

Due to the dearth of reports it is to be expected that any attempt to obtain an over-all picure of natural increase in the survey areas will not produce sufficient data to permit significant conclusions. Recourse was again had to extrapolations of the sort already mentioned

Table 3. General mortality in 78 out of 169 (46.1 per cent) countries and territories for the period 1953-1957, inclusive
(Data from late 1956, early 1958, and from previous years were sometimes used to augment available data for certain countries)

AREA*	NUMBER OF COUNTRIES SURVEYED	NUMBER OF COUNTRIES WITH DATA	1953 POPULATION (THOUSANDS)	1953 MORTALITY	1953 PER THOUSAND	1954 POPULATION (THOUSANDS)	1954 MORTALITY	1954 PER THOUSAND	1955 POPULATION (THOUSANDS)	1955 MORTALITY	1955 PER THOUSAND	1956 POPULATION (THOUSANDS)	1956 MORTALITY	1956 PER THOUSAND	1957 POPULATION (THOUSANDS)	1957 MORTALITY	1957 PER THOUSAND	TOTALS POPULATION (THOUSANDS)	TOTALS MORTALITY	TOTALS PER THOUSAND	AVERAGE MORTALITY PER THOUSAND
I	46	39	164,235	1,393,198	8.50	168,176	1,287,558	7.66	172,287	1,402,592	8.14	176,533	1,375,670	7.80	180,709	1,466,615	8.12	861,940	6,925,633	8.03	8.04
II	58	10	28,263	286,673	10.14	28,850	276,310	9.60	29,502	294,066	9.97	30,247	271,253	8.97	30,935	275,245	8.90	147,797	1,403,547	9.50	9.52
III	18	6	51,364	234,355	4.60	52,733	257,500	4.90	54,364	301,223	5.54	52,456	263,046	5.01	52,754	278,828	5.29	263,671	1,334,952	5.06	5.07
IV	24	14	539,314	5,452,353	10.11	547,381	4,877,939	8.91	555,917	3,924,385	7.06	564,596	4,523,457	8.01	574,413	5,089,212	8.86	2,781,621	23,867,346	8.60	8.60
V	23	9	1,293	9,952	7.70	1,329	9,368	7.05	1,365	8,998	6.60	1,394	8,971	6.44	1,396	9,012	6.46	6,777	46,301	6.83	6.85
Totals	169	78	784,469	7,376,531	9.40	798,469	6,708,675	8.40	813,435	5,931,264	7.30	825,226	6,442,397	7.81	840,207	7,118,912	8.50	4,061,806	33,577,779	8.27	8.30

* I. Caribbean, Central and South America; II. Africa; III. Southwest Asia; IV. South Central and Southeast Asia; V. Oceania.

Table 4. Neonatal mortality in 11 out of 169 (6.5 per cent) countries and territories for which data were available for the period 1953-1957, inclusive
(with arrangement of data from previous or subsequent years to complete information)

AREA*	NUMBER OF COUNTRIES SURVEYED	NUMBER OF COUNTRIES WITH DATA	1953 BIRTHS	1953 NEONATAL MORTALITY	1953 PER THOUSAND	1954 BIRTHS	1954 NEONATAL MORTALITY	1954 PER THOUSAND	1955 BIRTHS	1955 NEONATAL MORTALITY	1955 PER THOUSAND	1956 BIRTHS	1956 NEONATAL MORTALITY	1956 PER THOUSAND	1957 BIRTHS	1957 NEONATAL MORTALITY	1957 PER THOUSAND	TOTALS BIRTHS	TOTALS NEONATAL MORTALITY	TOTALS PER THOUSAND
I	46	5	334,910	1,780	5.31	349,768	2,343	6.70	340,046	2,142	6.70	344,270	2,194	6.30	361,943	2,179	6.02	1,730,937	8,444	4.90
II	58	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
III	18	1	44,364	311	7.01	41,045	197	4.80	42,339	219	5.20	52,287	219	4.20	54,532	393	7.21	234,567	1,339	5.71
IV	24	2	137,879	683	4.95	140,248	542	3.70	148,323	559	3.80	157,638	547	3.50	160,519	547	3.41	744,625	2,878	3.90
V	23	3	16,034	69	4.30	16,034	93	5.80	15,959	86	5.40	17,159	79	4.60	18,028	86	4.80	83,214	413	4.96
Totals	169	11	533,187	2,843	5.33	547,095	3,175	5.80	546,667	3,006	5.50	571,354	3,039	5.34	595,022	3,205	5.39	2,793,343	13,074	4.68

* I. Caribbean, Central and South America; II. Africa; III. Southwest Asia; IV. South Central and Southeast Asia; V. Oceania.

above; even so, coverage did not exceed 69 of the 169 countries and territories included in the survey.

Although Table 6 records a fairly steady increase in births, there is also an over-all decrease in deaths, with a resulting rise in the rate of natural increase. While in 1953, in the 69 countries and territories, there were 14,715,299 births and 6,773,412 deaths, yet in 1957, for the same 69 countries, these figures were 15,996,100 and 6,305,871, respectively, giving a natural increase of population of 7,941,887 for 1953 as compared with a natural increase of 9,690,229 in 1957. Thus, from 1953 to 1957 the increase was 18.04 per cent. On a regional basis, the Caribbean, Central and South American region showed a natural increase of 14.91 per cent. In Africa, Southwest Asia, South Central and Southeast Asia, and Oceania the respective figures were 5.64, 18.05, 21.17, and 10.52 per cent.

The lowest rate of natural increase occurred in Africa. It is only in South Central and Southeast Asia that the increase in population attains a magnitude of some concern, suggesting that the so-called "population explosion" may be more a regional than a world-wide problem.

Causes of death

Information regarding the role of the so-called great diseases of the tropics as agents of mortality was taken from a variety of disparate sources. Greatest reliance was placed on the records of the World Health Organization, as supplied in the form of the publication: *Annual Epidemiological and Vital Statistics*. Recourse was also had, occasionally, to official health reports and statistical yearbooks. A valuable source of data proved to be the Health Data Publications prepared by the Walter Reed Army Institute of Research.

The available data on the number of recorded cases of and deaths from the so-called great diseases in 1957 are presented in Tables 7 and 8. With regard to deaths, it will be seen that tuberculosis, cholera, malaria, bacillary dysentery and pneumonia head the list. It is interesting to note that the greatest toll in lives was taken by tuberculosis which has a world-wide distribution and is not generally considered to be a "tropical disease" in the classical sense. Yet it was responsible for more deaths than the next nine diseases on the list combined. The population of the survey area in 1957 was estimated to be approximately 1,204,501,000. The diseases listed in Tables 7 and 8 were reportedly responsible for 2,917,748 deaths, or 0.24 per cent of the total population, in this year. Tuberculosis alone was causative agent in the death of 0.13 per cent of this population.

Much variation with regard to major causes of death is to be found among countries in which the in-

Table 5. Infant mortality in 64 out of 169 (37.8 per cent) countries and territories for which data were obtainable for the period 1953-1957, inclusive (with arrangement of data from previous or subsequent years to complete the information)

AREA*	NUMBER OF COUNTRIES SURVEYED	NUMBER OF COUNTRIES WITH DATA	1953			1954			1955			1956			1957			TOTALS		
			BIRTHS	INFANT MORTALITY	PER THOUSAND	BIRTHS	INFANT MORTALITY	PER THOUSAND	BIRTHS	INFANT MORTALITY	PER THOUSAND	BIRTHS	INFANT MORTALITY	PER THOUSAND	BIRTHS	INFANT MORTALITY	PER THOUSAND	BIRTHS	INFANT MORTALITY	PER THOUSAND
I	46	36	3,949,464	518,200	131.2	4,059,488	339,626	83.7	4,209,669	358,731	85.2	4,320,736	340,422	78.8	4,492,814	379,793	84.5	21,032,171	1,936,772	92.1
II	58	5	854,463	165,060	193.2	894,957	116,620	130.3	903,607	108,239	119.8	809,781	99,076	122.4	729,751	99,644	136.6	4,192,559	588,639	140.4
III	18	5	178,762	10,583	59.2	175,890	10,822	61.5	192,731	9,817	51.2	206,996	9,597	46.4	198,791	9,659	48.6	953,170	50,478	52.9
IV	24	12	8,852,399	991,518	112.0	9,469,197	938,483	99.1	8,468,565	756,036	89.3	9,471,208	778,803	82.2	9,571,913	848,977	88.7	45,833,282	4,313,817	94.1
V	23	6	19,848	994	50.1	19,848	1,033	52.1	19,578	1,109	56.6	20,961	1,000	47.7	21,659	1,051	48.5	101,894	5,187	50.9
Totals	169	64	13,854,936	1,686,355	121.7	14,619,380	1,406,584	96.2	13,794,150	1,233,932	89.5	14,829,682	1,228,898	82.9	15,014,928	1,339,124	89.2	72,113,076	6,894,893	95.6

*I. Caribbean, Central and South America; II. Africa; III. Southwest Asia; IV. South Central and Southeast Asia; V. Oceania.

Table 6. Natural increase in 69 out of 169 (40.83 per cent) countries and territories for which data were available for the period 1953-1957, inclusive (with arrangement of data from previous or subsequent years to complete information)

AREA*	NUMBER OF COUNTRIES SURVEYED	NUMBER OF COUNTRIES WITH DATA	1953 BIRTHS	1953 DEATHS	1953 NATURAL INCREASE	1954 BIRTHS	1954 DEATHS	1954 NATURAL INCREASE	1955 BIRTHS	1955 DEATHS	1955 NATURAL INCREASE
I	46	37	4,067,117	1,358,904	2,708,213	4,198,555	1,253,130	2,945,425	4,305,167	1,322,634	2,982,533
II	58	9	1,001,693	516,832	484,861	1,044,399	517,376	527,023	1,055,858	391,906	663,952
III	18	5	774,242	178,732	595,510	820,040	200,059	619,981	1,028,697	243,248	785,449
IV	24	12	8,852,399	4,714,468	4,137,931	9,469,197	4,255,930	5,213,267	8,468,565	3,216,783	5,251,782
V	23	6	19,848	4,486	15,362	19,848	4,641	15,207	19,578	4,368	15,210
Totals	169	69	14,715,299	6,773,412	7,941,887	15,552,039	6,231,136	9,320,903	14,877,865	5,178,939	9,698,926

AREA*	1956 BIRTHS	1956 DEATHS	1956 NATURAL INCREASE	1957 BIRTHS	1957 DEATHS	1957 NATURAL INCREASE	TOTALS BIRTHS	TOTALS DEATHS	TOTALS NATURAL INCREASE	AVERAGE: FIVE YEARS BIRTHS	AVERAGE: FIVE YEARS DEATHS	AVERAGE: FIVE YEARS NATURAL INCREASE	PER CENT RISE OF NATURAL INCREASE IN THE FIVE-YEAR PERIOD
I	4,417,166	1,280,780	3,136,386	4,568,633	1,385,822	3,182,811	21,556,638	6,601,270	14,955,368	4,311,327.6	1,320,254.0	2,991,073.6	14.91
II	960,503	361,922	598,581	888,063	374,246	513,817	4,950,516	2,135,282	2,765,284	990,103.2	427,056.4	553,056.8	5.64
III	846,503	202,710	643,793	945,832	219,122	726,710	4,415,314	1,043,871	3,371,443	883,062.8	208,774.2	674,288.6	18.05
IV	9,471,208	3,756,033	5,715,175	9,571,913	4,322,190	5,249,723	45,833,282	20,265,404	25,567,878	9,166,656.4	4,053,080.8	5,113,575.6	21.17
V	20,961	4,387	16,574	21,659	4,491	17,168	101,894	22,373	79,521	20,378.8	4,474.6	15,904.2	10.52
Totals	15,716,341	5,605,832	10,110,509	15,996,100	6,305,871	9,690,229	76,857,644	30,068,200	46,789,444	15,371,528.8	6,013,640.0	9,357,888.8	18.04

* I. Caribbean, Central and South America; II. Africa; III. Southwest Asia; IV. South Central and Southeast Asia; V. Oceania.

fectious diseases occupy this level of importance. Tuberculosis is not the principal cause of death in every tropical country. In Aden Colony, for example, the principal causes of death are the gastrointestinal and respiratory infections and malnutrition.[2] In Ecuador in 1955 whooping cough was the major cause of death.[3] In British Guiana, the diseases of early infancy share the position with pneumonia and heart disease, suggesting the age limits of the most vulnerable segments of the population.[4]

Notifiable diseases

Differences exist among the many countries of the survey with regard to the criteria for notification of infectious diseases. In many countries, reporting is based exclusively on clinical symptoms, in others on laboratory procedures. Consideration of such variables leads to difficulty when an over-all picture for one or a group of regions is desired.

Table 9 names 39 infectious diseases which the World Health Organization lists as notifiable. Only five of these, namely, yellow fever, cholera, plague, typhus and smallpox, are notifiable in all of the countries and territories of the survey. These, with relapsing fever, constitute the six infections with which International Sanitary Regulations are concerned.

Twenty-two of the diseases listed in Table 9 are notifiable in more than half of the countries and territories under survey. Many, however, including such classically interesting diseases as malaria, trypanosomia-

Table 7. Number of cases reported for specific infections and nutritional diseases in a population of 1,204,501,000 in 1957

1. Yaws	12,588,252	19. Smallpox	93,363
2. Influenza	12,566,849	20. Leprosy	90,235
3. Tuberculosis	6,150,866	21. Meningococcal infections	43,748
4. Malaria	4,153,250	22. Typhus	15,384
5. Nutritional diseases	1,812,367	23. Poliomyelitis	14,807
6. Trachoma	1,080,354	24. Hydatid disease	14,770
7. Bacillary dysentery	767,070	25. Kwashiorkor	13,522
8. Pneumonia	693,886	26. Leishmaniasis	11,473
9. Ancylostomiasis	656,707	27. Trypanosomiasis	11,442
10. Measles	551,663	28. Relapsing fever	7,661
11. Cholera	534,106	29. Onchocerciasis	7,567
12. Syphilis	425,818	30. Paratyphoid fevers	6,109
13. Whooping cough	413,732	31. Infectious encephalitis	4,672
14. Amoebic dysentery	388,714	32. Dengue	801
15. Filariasis	264,872	33. Plague	662
16. Schistosomiasis	216,183	34. Leptospirosis	478
17. Mumps	168,786	35. Yellow fever	70
18. Typhoid fever	110,613	36. Rabies	—
		Total cases	43,880,852

Table 8. Number of deaths reported due to specific infections and nutritional diseases in a population of 1,204,501,000 in 1957

1. Tuberculosis	1,571,585	19. Trypanosomiasis	1,058
2. Cholera	534,101	20. Kwashiorkor	935
3. Malaria	310,842	21. Infectious encephalitis	810
4. Bacillary dysentery	192,163	22. Rabies	783
5. Pneumonia	104,218	23. Ancylostomiasis	533
6. Smallpox	48,085	24. Schistosomiasis	529
7. Influenza	37,397	25. Yaws	387
8. Nutritional diseases	29,028	26. Plague	320
9. Measles	22,425	27. Leptospirosis	105
10. Whooping cough	22,251	28. Mumps	82
11. Typhoid fever	10,466	29. Relapsing fever	66
12. Meningococcal infections	8,276	30. Filariasis	53
13. Amoebic dysentery	8,081	31. Yellow fever	34
14. Leprosy	4,534	32. Hydatid disease	26
15. Leishmaniasis	3,304	33. Onchocerciasis	8
16. Typhus	2,436	34. Trachoma	4
17. Poliomyelitis	1,560	35. Syphilis	—
18. Paratyphoid fevers	1,263	36. Dengue	—
		Total deaths	2,917,748

sis, schistosomiasis and leishmaniasis, are currently notifiable in only a small number of countries and territories.

Of the total listed in Table 9, 29 are included among the 34 entities which have been labeled, for the purposes of this report, as comprising the "great diseases of the tropics" (see Appendix 18).

Although there are specific laws or regulations in most countries requiring reporting of the notifiable diseases, a considerable lack of reporting is the fact. Requirements are far from homogeneous and vary from country to country and, sometimes, from territory to territory. Enforcement depends on the availability of properly trained personnel and cooperation between private physicians and health authorities. Other factors, such as cultural and economic conditions, public attitudes towards disease, and religious beliefs, also play their roles. It is a truism that reported cases do not represent the actual total number of cases of diseases. The same is true with regard to reporting of deaths.

Analysis of Diseases of Greatest Public Health Importance

Figure 1 presents in a most general fashion the percentage distribution among the five major survey areas of cases of the so-called great diseases of the tropics (listed in Appendix 18) as reported in the year 1957. In attempting to enumerate cases of infectious diseases as reported in the most underdeveloped of the world's areas, it has clearly not been possible to achieve an accuracy that will satisfy all requirements. Accordingly, the utility of the approximations depicted in Figure 1 should be assessed only within the framework of the present report.

Although figures for incidence and prevalence are frequently lacking in official reports, acknowledgment of the presence of disease entities in the various countries and territories is commonplace. This does not mean that in most of the areas studied the complete nosology is accounted for but rather that the documentation of disease occurrence is often substantial, even in the absence of data pertaining to incidence. In some countries the presence of certain diseases is still a matter of conjecture. Figures for disease occurrence, as indicated in Table 10, do not imply that these nosologic entities are necessarily autochthonous in the areas but only that their presence has been reported. Insofar as possible, indication is given when a disease is imported or its presence not fully confirmed.

Fifteen of the so-called great diseases of the tropics were reported in more than half of the 169 countries of the survey area. Bacillary dysentery (150 countries), measles (148 countries), typhoid (143 countries), poliomyelitis (142 countries), leprosy (141 countries) and influenza (140 countries) have the widest distribution. Meningococcal meningitis, whooping cough, malaria and syphilis were reported from almost three-quarters of the countries and mumps, tuberculosis, trachoma, pneumonia and nutritional diseases were noted in more than half of the countries surveyed.

Four of the "great" diseases of the tropics had rather restricted geographic distribution: Arthropod-

Table 9. Percentage of countries and territories in which specific diseases are notifiable

AREA	CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	ASIA	OCEANIA	TOTALS	
Number of countries	44	45	34	15	138	
DISEASES	NUMBER OF COUNTRIES NOTIFYING				TOTAL NUMBER OF COUNTRIES NOTIFYING	PER CENT OF COUNTRIES NOTIFYING
Yellow fever	44	45	34	15	138	100.0
Cholera	44	45	34	15	138	100.0
Plague	44	45	34	15	138	100.0
Typhus	44	45	34	15	138	100.0
Smallpox	44	45	34	15	138	100.0
Typhoid fever	43	44	34	15	136	98.6
Meningococcal meningitis	41	37	34	15	127	92.0
Diphtheria	40	38	33	15	126	91.3
Paratyphoid fevers	40	39	31	15	125	90.6
Scarlet fever	36	40	27	15	118	85.5
Poliomyelitis	43	42	25	15	115	83.3
Bacillary dysentery	36	35	25	15	111	80.4
Leprosy	39	35	21	15	110	79.7
Amoebic dysentery	36	27	23	15	101	73.2
Measles	33	30	22	13	98	71.0
Tuberculosis	37	28	18	13	96	69.6
Relapsing fever	23	38	21	6	88	63.8
Chickenpox	32	24	17	12	85	61.6
Influenza	32	20	14	12	78	56.5
Anthrax	27	22	15	13	77	55.8
Whooping cough	30	17	17	11	75	54.4
Rabies	27	26	14	4	71	51.4
Malaria	31	18	9	9	67	48.6
Mumps	27	14	10	11	62	44.9
Trachoma	26	11	8	13	58	42.0
Pneumonia	27	15	9	4	55	39.9
Syphilis	24	8	8	11	51	37.0
Erysipelas	19	15	9	7	50	36.2
Trypanosomiasis	11	29	4	5	49	35.5
Dengue	13	8	5	11	37	26.8
Leishmaniasis	15	14	5	3	37	26.8
Leptospirosis	9	8	2	12	31	22.5
Ancylostomiasis	15	4	2	7	28	20.3
Yaws	15	7	1	5	28	20.3
Infectious hepatitis	5	7	2	12	26	18.8
Rheumatic fever	11	4	1	4	20	14.5
Schistosomiasis	8	5	2	4	19	13.8
Filariasis	7	2	4	4	17	12.3
Hydatid disease	6	5	1	2	14	10.1

borne virus diseases (9 countries), Chagas' disease (9 countries), cholera (11 countries) and onchocerciasis (13 countries). Special reference must be made to Chagas' disease and cholera. The former is only known to be present in the American continent, and the latter has not been reported for many years either from the Americas or from Oceania. Chagas' disease was reported from 9 of 46 countries of the Caribbean, Central and South American region. Cholera occurred in 2 of 58 African territories, in 1 of 18 countries of Southwest Asia, and in 8 of 24 countries of South Central and Southeast Asia. The importance of cholera must not be underestimated because of this rather limited distribution. It is endemic in one of the most densely populated areas of the earth, and if the deaths due to this disease in 1957 be compared with the total population of South Central and Southeast Asia during the same year, it is found that cholera was responsible for the death of 0.08 per cent of the total, a figure exceeded only by tuberculosis among the infectious diseases.

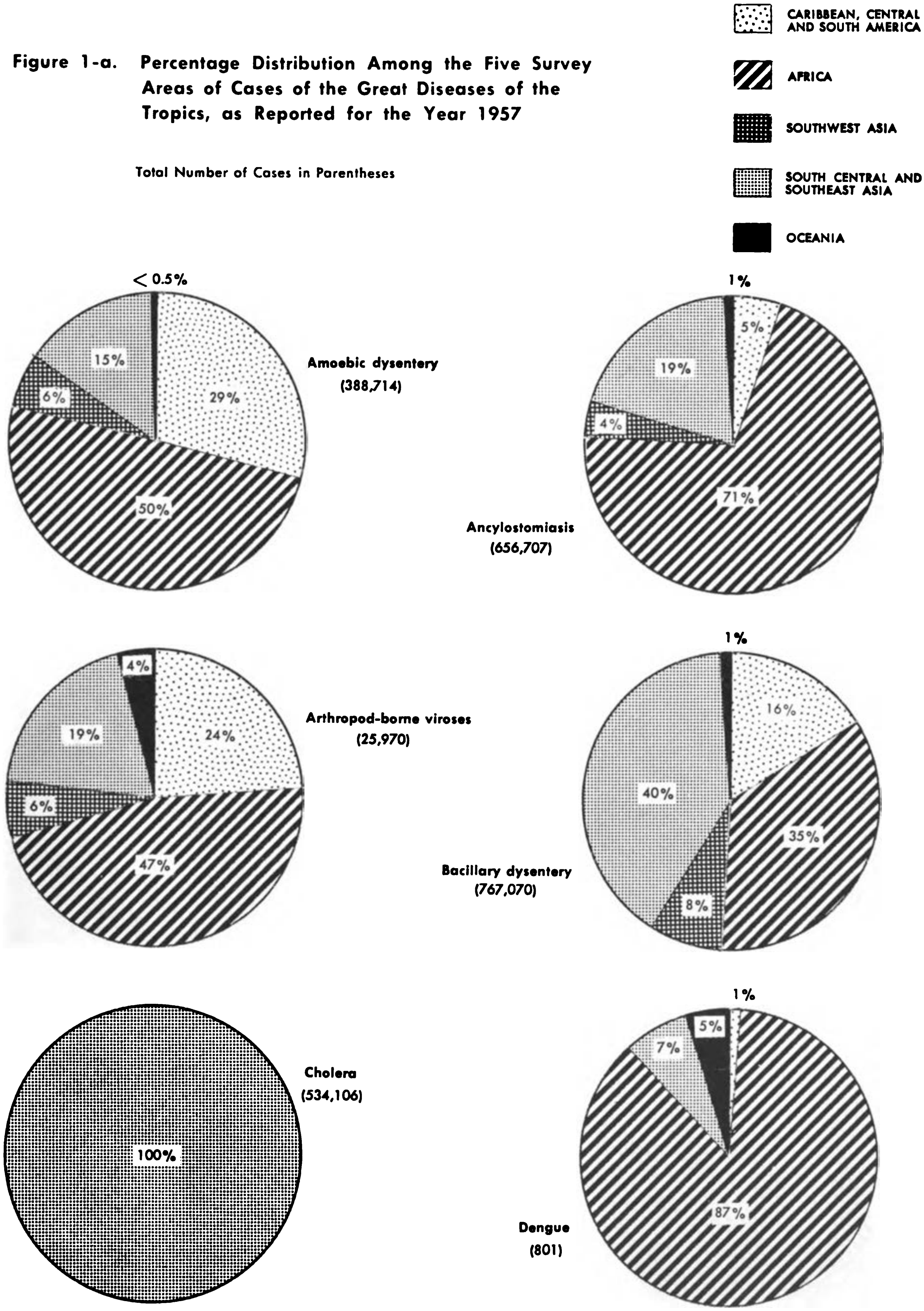
Table 10. Disease distribution in 169 countries for which data were available

DISEASES	CARIBBEAN, CENTRAL AND SOUTH AMERICA (46 COUNTRIES) NUMBER REPORTING DISEASE	AFRICA (58 COUNTRIES) NUMBER REPORTING DISEASE	SOUTHWEST ASIA (18 COUNTRIES) NUMBER REPORTING DISEASE	SOUTH CENTRAL AND SOUTHEAST ASIA (24 COUNTRIES) NUMBER REPORTING DISEASE	OCEANIA (23 COUNTRIES) NUMBER REPORTING DISEASE	TOTALS (169 COUNTRIES) NUMBER REPORTING DISEASE
Bacillary dysentery	41	55	12	22	20	150
Leprosy	40	49	10	21	21	141
Meningococcal infections	33	52	11	18	20	134
Pneumonia	26	27	8	15	11	87
Tuberculosis	27	32	11	20	13	103
Typhoid and paratyphoid fevers	43	54	11	22	13	143
Whooping cough	34	54	10	17	17	132
Syphilis	43	40	10	21	11	125
Yaws	13	22	2	11	9	57
Influenza	39	52	9	20	20	140
Measles	42	53	10	21	22	148
Mumps	29	41	6	14	18	108
Poliomyelitis	37	54	10	21	20	142
Trachoma	13	39	11	16	11	90
Ancylostomiasis	15	19	6	12	8	60
Filariasis	9	20	2	15	11	57
Malaria	30[1]	52	11	23	9	125
Schistosomiasis	6	29[2]	8[2]	8	1	52
Amoebiasis	17	22	6	15	5	65
Kwashiorkor	4	9	—	2	3	18
Cholera	—	2	1[3]	8[3]	—	11
Plague	5	8[4]	2[4]	9[4]	—	24
Relapsing fever	9	28	7	5	—	49
Leptospirosis	8	14	2	7	6	37
Typhus	19	34	10	17	1	81
Dengue	8	12	3	8	3	34
Smallpox	12	42	17	14	2	87
Yellow fever	11	9	1	1	—	22
Leishmaniasis	6	10	8	7	—	31
Rabies	12	31	6	11	—	60
Hydatid disease	1	9	4	5	2	21
Onchocerciasis	1	12	—	—	—	13
Chagas' disease	9	—	—	—	—	9
African trypanosomiasis	—	30	—	—	—	30
Arthropod-borne viral infections	4	3	1	1	—	9
Nutritional diseases	20	26	9	17	11	83

[1] One country reported malaria eradicated.
[2] Two countries (1 in Africa; 1 in Southwest Asia) reported schistosomiasis imported. [Kenya, Tanganyika, Swaziland and Zanzibar report the finding of **Schistosoma japonicum** cases but, unless they are among Chinese immigrants, it is in all probability **S. margrebowei** Le Roux. Emile A. Malek, 1961. The biology of mammalian and bird schistosomes. Bull. Tulane Univ. Med. Fac., v. 20 (3), pp. 181-207.]
[3] Two countries of Southwest Asia and 1 country of South Central and Southeast Asia reported cholera eradicated.
[4] One country in Africa; 1 in Southwest Asia; and 1 in South Central and Southeast Asia reported plague eradicated.

Figure 1-a. Percentage Distribution Among the Five Survey Areas of Cases of the Great Diseases of the Tropics, as Reported for the Year 1957

Total Number of Cases in Parentheses



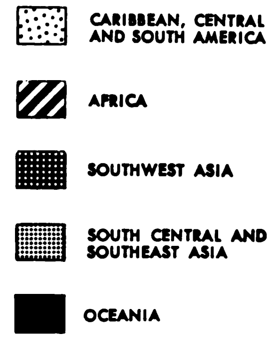


Figure 1-b. **Percentage Distribution Among the Five Survey Areas of Cases of the Great Diseases of the Tropics, as Reported for the Year 1957 (cont'd.)**

Total Number of Cases in Parentheses

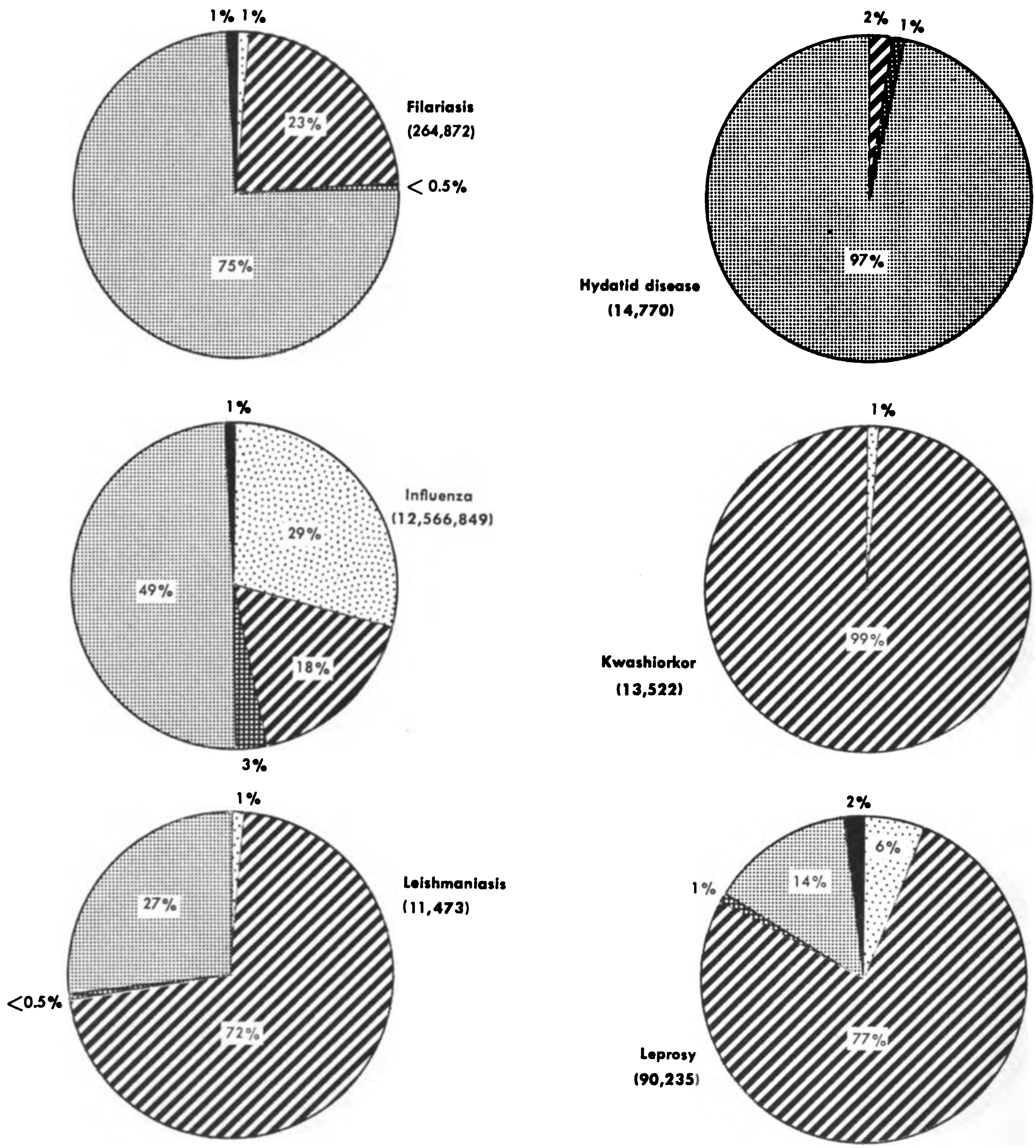


Figure 1-c. Percentage Distribution Among the Five Survey Areas of Cases of the Great Diseases of the Tropics, as Reported for the Year 1957 (cont'd.)

Total Number of Cases in Parentheses

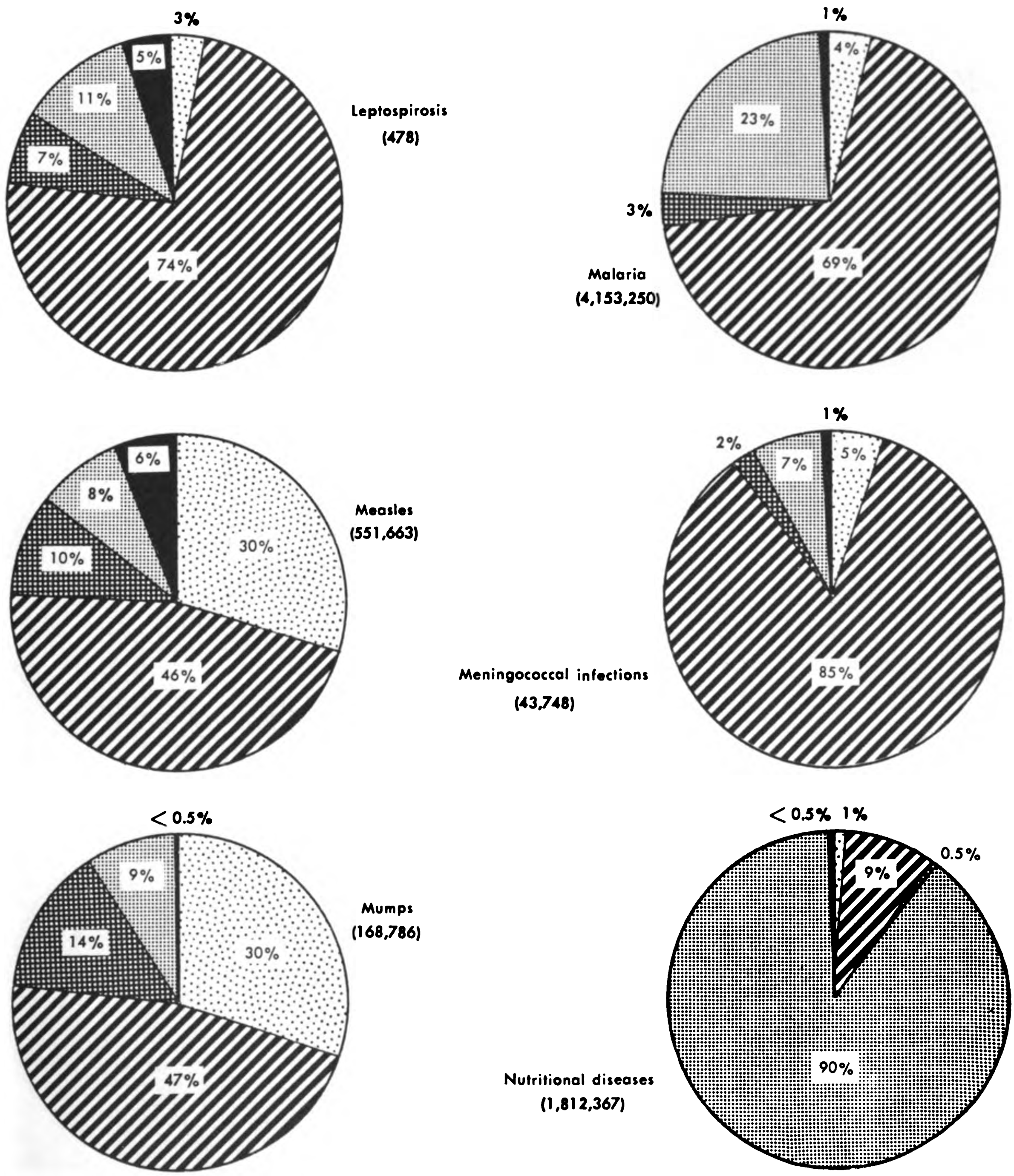


Figure 1-d. Percentage Distribution Among the Five Survey Areas of Cases of the Great Diseases of the Tropics, as Reported for the Year 1957 (cont'd.)

Total Number of Cases in Parentheses

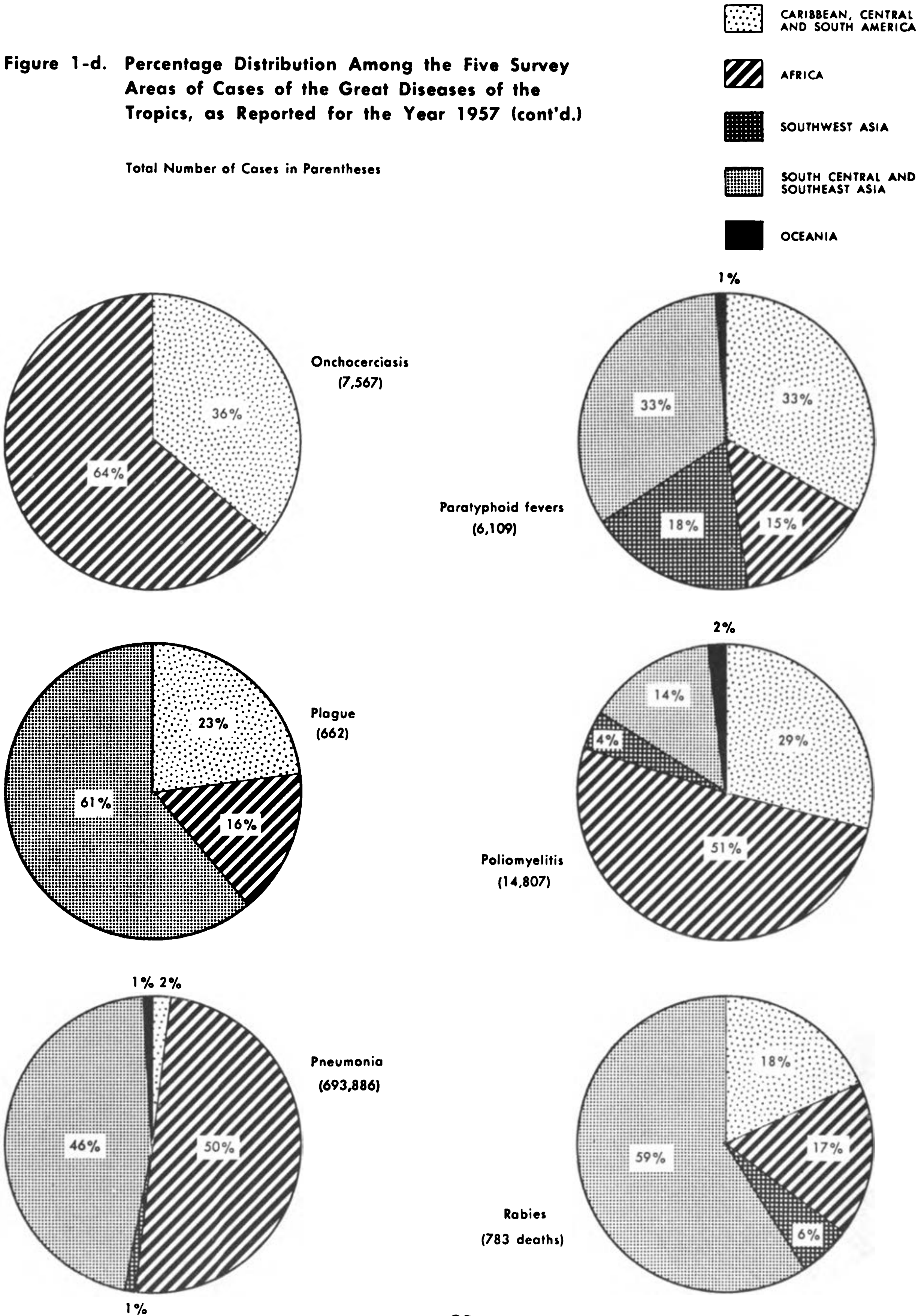
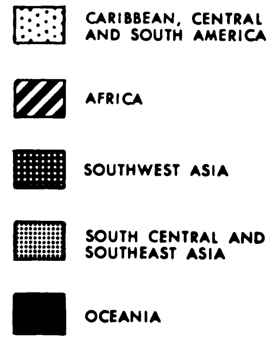
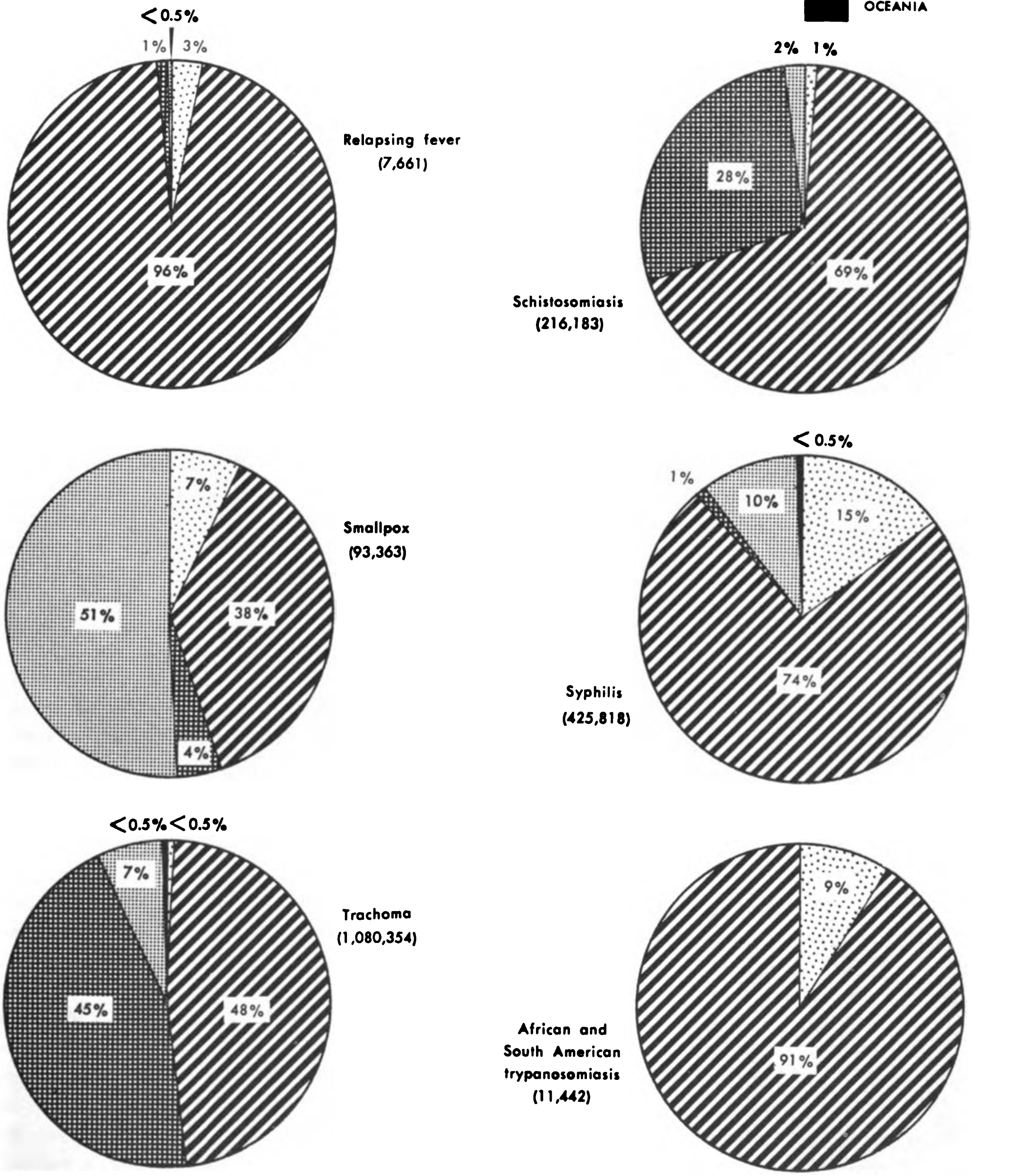


Figure 1-e. Percentage Distribution Among the Five Survey Areas of Cases of the Great Diseases of the Tropics, as Reported for the Year 1957 (cont'd.)

Total Number of Cases in Parentheses





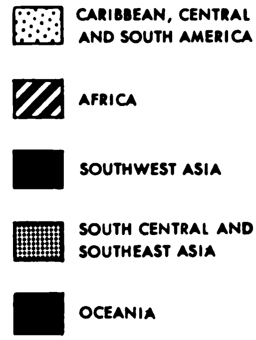
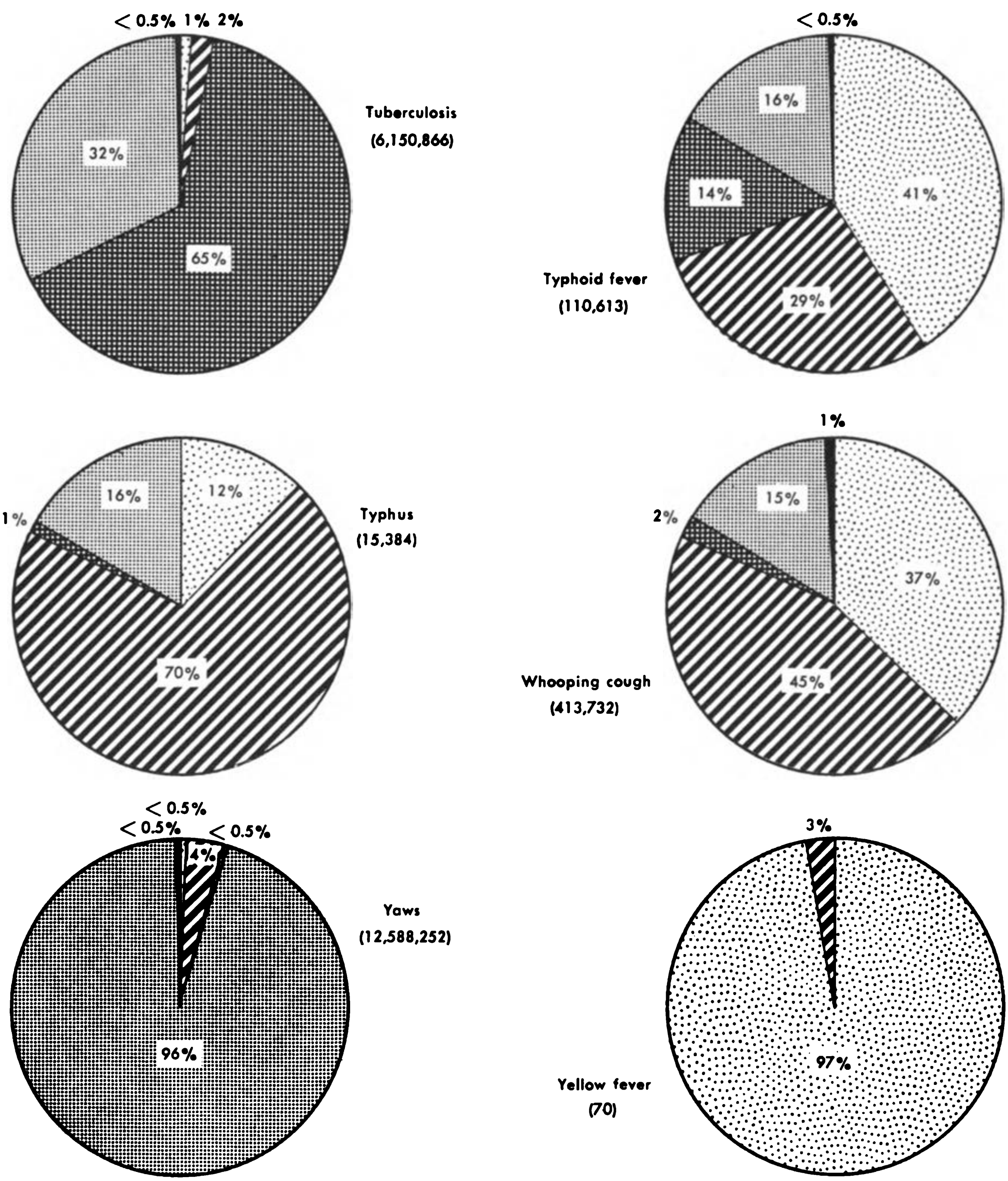


Figure 1-f. Percentage Distribution Among the Five Survey Areas of Cases of the Great Diseases of the Tropics, as Reported for the Year 1957 (cont'd.)

Total Number of Cases in Parentheses



Chapter 3

Diseases of High Endemicity

BACILLARY DYSENTERY

Distribution

For several reasons it is difficult to establish the detailed distribution of bacillary dysentery in the survey areas. Besides the usual under-reporting and lack of reporting, bacillary dysentery is often included under the generic designation "diarrheal disease." Even when amoebic dysentery is regarded separately, confusion exists as to the etiology of the dysentery that remains. In the classical sense, the name refers to infection with organisms of the genus *Shigella*. In fact, however, the number of cases of proven shigellosis is considerably inferior to the reported cases of bacillary dysentery. Dysentery symptoms have been identified with the recovery of *Salmonella*, *Proteus*, *E. coli*, and have also been present in the absence of demonstrable agents. Although few surveys have been done in order to identify the causative organism, the clinical diagnosis of bloody diarrhea, or dysentery, is simple to make, and this is the condition which has proved to be the most widely distributed of all 34 "great" diseases in the five regions surveyed, being present in 150 of 169 countries and territories. In the Caribbean, Central and South America, 41 of 46 countries reported its presence; in Africa 55 of 58 countries; in Southwest Asia 12 of 18 countries; in South Central and Southeast Asia 22 of 24 countries; and in Oceania 20 of 23 countries. In all cases, however, the entity "diarrheal diseases" was reported or suspected. It is most probable that bacillary dysentery occurs in all of the countries and territories surveyed.

Incidence and prevalence

Because many cases of bacillary dysentery remain undiagnosed in tropical areas or are reported under the general heading of diarrheal diseases or fail to come to the attention of health authorities, the total number of cases presented for each region and for the entire survey area must be taken to represent a minimum number. Cases of bacillary dysentery in 1957 numbered 767,070 in the entire survey area. In view of the difficulties listed above, the following figures may be said to have, in the absence of truth, only the virtue of relative uniformity in their collection and preparation. Of the total, 16 per cent were from the Caribbean, Central and South America, 35 per cent were from Africa, 8 per cent were from Southwest Asia, 40 per cent were from South Central and Southeast Asia, and 1 per cent were from Oceania (Figure 1-a).

Caribbean, Central and South America. In this area, the difficulty of documenting the prevalence of bacillary dysentery is compounded by the absence of any international agreement regarding the names of the various clinical entities associated with bloody diarrhea. The term "bacillary dysentery" appears infrequently in the literature of the southern continent. Etiologic agents have not been found in a large proportion of cases, of which usually between 40 and 60 per cent give negative results when tested for causative organisms. In recent years evidence has accumulated of a direct association between diarrheal disease and enteropathogenic *Escherichia coli*. The role of viruses has also been given attention.[5]

In Mexico, a study of children seen in one hospital would indicate that shigellosis is endemic in Mexico City and may account for as much as 17 per cent of admissions for diarrhea in children under the age of two.[6]

In Guatemala, examination of 2,342 specimens revealed that *Shigella* was much more prevalent in the community than was *Salmonella*. Of the total number of specimens, 175, or 7.4 per cent, were positive for *Shigella* and only 13, or 0.5 per cent, were positive for *Salmonella*.[5] These data further indicated that *Shigella* was not recovered as frequently in early infancy (under one year) as in later infancy and in childhood.

But the above data are fragmentary and it would be presumptuous indeed to attempt an extrapolation from them to the true prevalence of *Shigella* in the entire area. Some idea of the magnitude of the problem may be advanced by an inspection of data, from the World Health Organization, on reported numbers of cases of dysentery in this region during the period 1950-1960. There were a total of 2,300,437 cases of dysentery in the Caribbean, Central and South America during this period. Of these, only 126,837, or 5.5 per cent, were identified as bacillary dysentery. More than half of them (1,172,419, or 51 per cent) were unspecified with regard to etiology.

Africa. Data supplied by the World Health Organization indicate that there were 3,827,860 cases of dysentery reported in Africa during the period 1950-1960. Almost half of these (1,850,344, or 48.3 per cent) were unspecified as to etiology. Only 468,798, or 12.2 per cent, were identified as bacillary dysentery.

In the Republic of the Congo (former Belgian Congo), outbreaks of bacillary dysentery due to *Shigella dysenteriae* and *S. paradysenteriae* are known to occur commonly among both European and native populations. During the three-year period 1957-1959, the provinces of Leopoldville, Kivu and Orientale, in that order, produced the largest number of cases. An average of 1,000 European cases and 6,000 Congolese cases were reported annually over the five-year period 1953-1957, with a case fatality rate of approximately 0.2 per cent for Europeans and 2.4 per cent for Congolese.[7]

In South Africa, Boardman *et al.* found dysentery organisms to be present in less than 20 per cent of African children living on the Witwatersrand who exhibited diarrheal symptoms. Of 200 outpatients in one study, most of whom were under two years of age, *S. flexneri* was recovered from 12 and *S. sonnei* from 8.[8]

Information regarding morbidity cannot be extracted from the reports of the Health Department of the Republic of South Africa, partly because all clinical dysentery, independent of etiology, is classified together, but also because the non-European cases are not recorded at all. It has been reported, however, that the number of *Shigella* cultures identified annually at the South African Institute for Medical Research is increasing (169 in 1955, 157 in 1956, 259 in 1957).[9] Ordway has noted that diarrhea accounted for one-fifth of all deaths in the socio-economically less favored population of Johannesburg.[1]

Sénécal has remarked on the rarity with which shigellae are recovered from stool cultures done on pediatric service in Dakar (Republic of Senegal in former French West Africa). Of 377 cultures made in one study during 1957-1958, only 3, or 0.8 per cent, proved to be positive for any species of *Shigella*. This may reflect the readiness with which these organisms succumb following treatment. In another separate study, reported concurrently, shigellae were recovered from 80 per cent of African children seen with bloody diarrhea.[10]

Although the prevalence of dysentery of all forms in the Seychelles Islands is said to be a major cause of death, figures for prevalence were not found.[11]

Southwest Asia. According to data supplied by WHO in 1950-1960, there were 643,460 cases of dysentery in Southwest Asia, of which only 64,022, or 9.9 per cent, were reported as bacillary dysentery. The greatest proportion (426,656, or 66.3 per cent) of cases were unspecified as to etiology. In Cyprus, the prevalence of this disease has decreased.[12] Bacillary dysentery occurs in the Arabian Peninsula; however, amoebic dysentery is reported to be more common.[13] In Aden Colony and Aden Protectorate, bacillary dysentery is grouped in official reports with the amoebic form and with other forms of diarrhea but the disease is believed to be prevalent throughout the territory.[14] In Bahrain, Muscat and Kuwait the disease is thought to be endemic, and it is reported to be widespread in Qatar and common on the Trucial Coast, as well as in Iraq.[14] A few cases have been reported from Yemen, where Felsani performed serodiagnosis on patients in the Hodeidah Hospital; of 68 patients admitted between 1952 and 1957 with a diagnosis of bacillary dysentery, serodiagnosis was done on 42. In 29 patients, the finding was positive for the Shiga-Kruse group and in 5 patients it was positive for the paradysentery bacilli; in other patients it was negative.

The disease is known to occur in Jordan, Lebanon and Syria, but data on prevalence are largely lacking.[15, 16, 17]

Other areas. Bacillary dysentery occurs everywhere in South Central and Southeast Asia and Oceania. In the absence of specific survey data, recourse in reporting of recent figures must be had to the records of WHO. During the period 1950-1960, this international agency reported a total of 12,219,027 cases of dysentery in South Central and Southeast Asia, of which 2,874,988, or 23.5 per cent, were bacillary dysentery, while 5,702,371, or 46.7 per cent, were unspecified as to etiology. During the same period, there were 43,729 cases of dysentery reported from Oceania, including 12,699, or 29 per cent, labeled bacillary and 27,162, or 62.1 per cent, unspecified.

The large proportion of cases in which etiology is not specified supports the wisdom of utilizing these figures with considerable reserve, especially in view of the fact that they represent an international mixture of data. One of the outstanding features of "bacillary dysentery" is the lack of international agreement regarding diagnosis which accompanies official reporting.

Morbidity and mortality

Of the list of great diseases bacillary dysentery in 1957 occupied seventh place among the causes of morbidity, with 767,070 reported cases, and fourth place in mortality, with 192,163 reported deaths. Of a total population of 1,204,501,000 in the entire survey area, 0.06 per cent reportedly suffered from bacillary dysentery in 1957 and 0.02 per cent reportedly died from it in the same period. Mortality seems high but the number of cases suffers more from under-reporting than does the number of deaths, since the cases most apt to be seen by authorities are the most serious ones and those most likely to die. Eight of 128 countries reporting the disease recorded only the number of deaths.

Data on morbidity and mortality in 1957 (Table 11) were found for 128 of the 169 countries and territories under survey.

Of all regions, Oceania had the highest morbidity rate per 100,000 (119.95) followed by Africa (116.7), Southwest Asia (72.3), the Caribbean, Central and South America (64.7) and South Central and Southeast Asia (44.5). Since many countries in South Central and Southeast Asia, including India with its huge population, reported only deaths, this area presents a mortality rate for bacillary dysentery (26.5) which must be considered to be seriously skewed.

The morbidity rate of 63.7 per 100,000 for the entire survey area signifies that bacillary dysentery is a major health problem in the tropics. Lack of case reporting suggests that this rate is lower than the true rate.

In the Caribbean, Central and South American region, Venezuela, with 66,338 cases and 239 deaths from bacillary dysentery, is apparently the country where the problem presents its greatest importance, and rates for morbidity and mortality are, respectively, 1.08 and 0.30. Other American countries in which bacillary dysentery presents serious aspects as far as morbidity is concerned are Peru, Dominican Republic, Colombia and Argentina, with rates of 0.12, 0.42, 0.13 and 0.03 per 100,000, respectively.

Of the five countries where bacillary dysentery presents high rates of morbidity, three are geographically contiguous, Venezuela, Colombia and Peru, the rates decreasing from north to south.

In Africa, Sudan, with 124,902 cases and 99 deaths due to bacillary dysentery, tops the list of countries and territories of this region where the disease reportedly extracts its greatest toll, the morbidity and mortality rates being 1.22 and 0.001 per 100,000, respectively. Ethiopia, Tanganyika, Mozambique and Kenya are other areas where relatively high morbidity rates were seen (0.26, 0.22, 0.20 and 0.15 per 100,000, respectively). Mortality rates are surprisingly similar for all these countries (0.001), except for Ethiopia, where it is 0.0001. Thus, in Africa the eastern countries seem to be the ones in which bacillary dysentery is most serious, the reported rates for the western countries being far less imposing. Moreover, bacillary dysentery presents a pattern of morbidity in East Africa the importance of which decreases progressively from north to south.

In Southwest Asia contiguity of areas of high morbidity is not evident. Of the five countries with high morbidity rates, three are geographically contiguous, i.e., Afghanistan, Iran and Iraq, but the morbidity rates per 100,000 range from 0.02 (Afghanistan) to 0.47 (Iraq) with Iran in between with a rate of 0.07.

An evaluation of the countries in which bacillary dysentery has a high degree of morbidity in South Central and Southeast Asia is difficult since the two most heavily populated countries, India and Pakistan, reported only deaths. In preparing Table 8 the number of deaths in these countries is also considered as the number of cases, but this admittedly introduces a high degree of error in estimating the relative importance of the disease.

Since the number of deaths in India was greater than the number of cases in the following countries and the number of deaths in Pakistan is only exceeded by the number of cases in Ceylon and deaths in India, India and Pakistan emerge as countries in which bacillary dysentery is extremely serious. If the relationship between morbidity and mortality rates for the Philippines and for Ceylon are adopted for India and Pakistan, it is possible to extrapolate morbidity rates of 0.11 and 0.03 per 100,000, respectively, for the latter countries.

In Oceania there are four countries which have the highest morbidity rate per 100,000 from bacillary dysentery. These are the Cook Islands (3.56), Gilbert and Ellice Islands (1.97), Tonga Islands (1.33) and New Guinea (0.1). Mortality rates for these countries were 0.002, 0.002, 0.03 and 0.11 per 100,000, respectively.

Of all the countries and territories under survey, the Cook Islands reported the highest morbidity rate (3.56 per 100,000), followed by Bahrain (2.53 per 100,000).

Public health importance

Widespread in the survey areas and attaining morbidity and mortality rates of considerable significance in many countries, bacillary dysentery occupies seventh place among the major causes of morbidity and fourth

Table 11. Morbidity and mortality due to bacterial diseases of high endemicity as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY: CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Bacillary dysentery	Relative population[1]	94.54	77.02	86.35	94.98	84.82	90.85
	Morbidity (per hundred thousand)	64.70	116.70	72.30	44.50	119.95	63.70
	Mortality (per hundred thousand)	3.15	0.37	0.085	26.50	2.39	15.95
Leprosy	Relative population[1]	93.03	83.69	46.66	12.76	62.81	41.52
	Morbidity (per hundred thousand)	2.62	30.10	0.81	1.81	58.60	7.49
	Mortality (per hundred thousand)	0.16	1.68	0.009	0.048	0.33	0.38
Meningococcal infections	Relative population[1]	94.52	97.79	86.35	97.76	56.81	96.37
	Morbidity (per hundred thousand)	1.03	16.10	1.25	0.46	8.38	3.63
	Mortality (per hundred thousand)	0.16	2.03	0.17	0.44	2.47	0.69
Pneumonia	Relative population[1]	20.05	48.03	42.22	69.17	78.10	55.56
	Morbidity (per hundred thousand)	7.16	148.20	9.97	45.80	251.10	57.60
	Mortality (per hundred thousand)	1.31	3.75	8.04	12.30	18.60	8.65
Tuberculosis	Relative population[1]	30.89	63.04	65.77	84.60	90.73	70.71
	Morbidity (per hundred thousand)	16.70	68.30	4,964.00	280.10	243.10	510.70
	Mortality (per hundred thousand)	1.86	4.09	4.45	222.70	11.70	130.50
Typhoid fever	Relative population[1]	95.33	82.48	86.35	25.47	40.02	51.60
	Morbidity (per hundred thousand)	23.70	13.75	18.75	2.60	5.80	9.20
	Mortality (per hundred thousand)	3.60	0.59	0.53	0.26	0.14	0.87
Paratyphoid fevers	Relative population[1]	52.61	42.50	60.10	24.81	39.77	35.02
	Morbidity (per hundred thousand)	1.06	0.41	1.36	0.29	0.86	0.51
	Mortality (per hundred thousand)	0.58	0.016	0.021	0.015	—	0.11
Whooping cough	Relative population[1]	83.84	58.78	52.13	11.98	55.56	36.12
	Morbidity (per hundred thousand)	80.30	79.80	12.70	8.80	6.60	34.30
	Mortality (per hundred thousand)	10.70	0.51	0.15	0.08	1.19	1.85

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

place as an agent of mortality in the list of great diseases. It is one of the major health problems of the tropics.

The root of this disease problem is to be found in environmental factors which characterize many underdeveloped countries, such as low socio-economic status, limited education, poor hygienic habits, together with religious and traditionalistic inhibitions with regard to change.

LEPROSY

Distribution

Leprosy was reported from 141 of the 169 countries and territories under survey (Table 10) and is one of the most widely distributed diseases dealt with in this report. Lack of reporting and under-reporting inevitably contribute to incomplete knowledge of the total distribution of the disease, but the data available cover the main areas where the disease constitutes a public health problem. It is known that leprosy occurs mainly in warm countries, all territories with a prevalence of more than 5 per 1,000 population being in the tropics.[14] Only bacillary dysentery, measles, typhoid and paratyphoid fevers, and poliomyelitis are reported to be more widely distributed.

Of the five regions surveyed, Oceania presents the widest distribution of leprosy; it is known to exist in 21 of the 23 countries and territories of this region. South Central and Southeast Asia follows with distribution recorded in 21 of 24 countries. In the other regions, the following number of countries reported: 40 out of 46 in the Caribbean, Central and South American region; 49 out of 58 in Africa; and 10 out of 18 in Southwest Asia.

Of the 141 countries acknowledging the presence of the disease, one reported that the disease has been eradicated (Mauritius in 1954).

A general picture of the distribution of leprosy in 1958 is given in Figure 2.

Incidence and prevalence

The stigmata which accompany leprosy traditionally have caused sufferers to avoid human contacts and thus medical attention. With the advent of sulfone treatment and its strikingly visible results, this situation has changed somewhat for the better.

In 1957, official reports disclosed 90,235 new cases of leprosy, of which 6 per cent were in the Caribbean, Central and South America, 77 per cent were in Africa, 1 per cent were in Southwest Asia, 14 per cent were in South Central and Southeast Asia, and 2 per cent were in Oceania. It cannot be emphasized too strongly that such figures reflect reporting practices rather than real relationships (Figure 1-b), and it is considered that the total number of patients thus far diagnosed is far removed from the actual number of existing cases. Guinto estimates that in 1959 the true number of leprosy patients in the world should be around 4,760,437, considering that 2,045,869 cases had been reported between 1953 and 1959.[18] The Leonard Wood Memorial, on the other hand, considers it probable that the total number of cases of leprosy in the world has reached 10,000,000, of which Africa has probably 2,000,000, India 1,500,000 and Communist China about 1,000,000.[19]

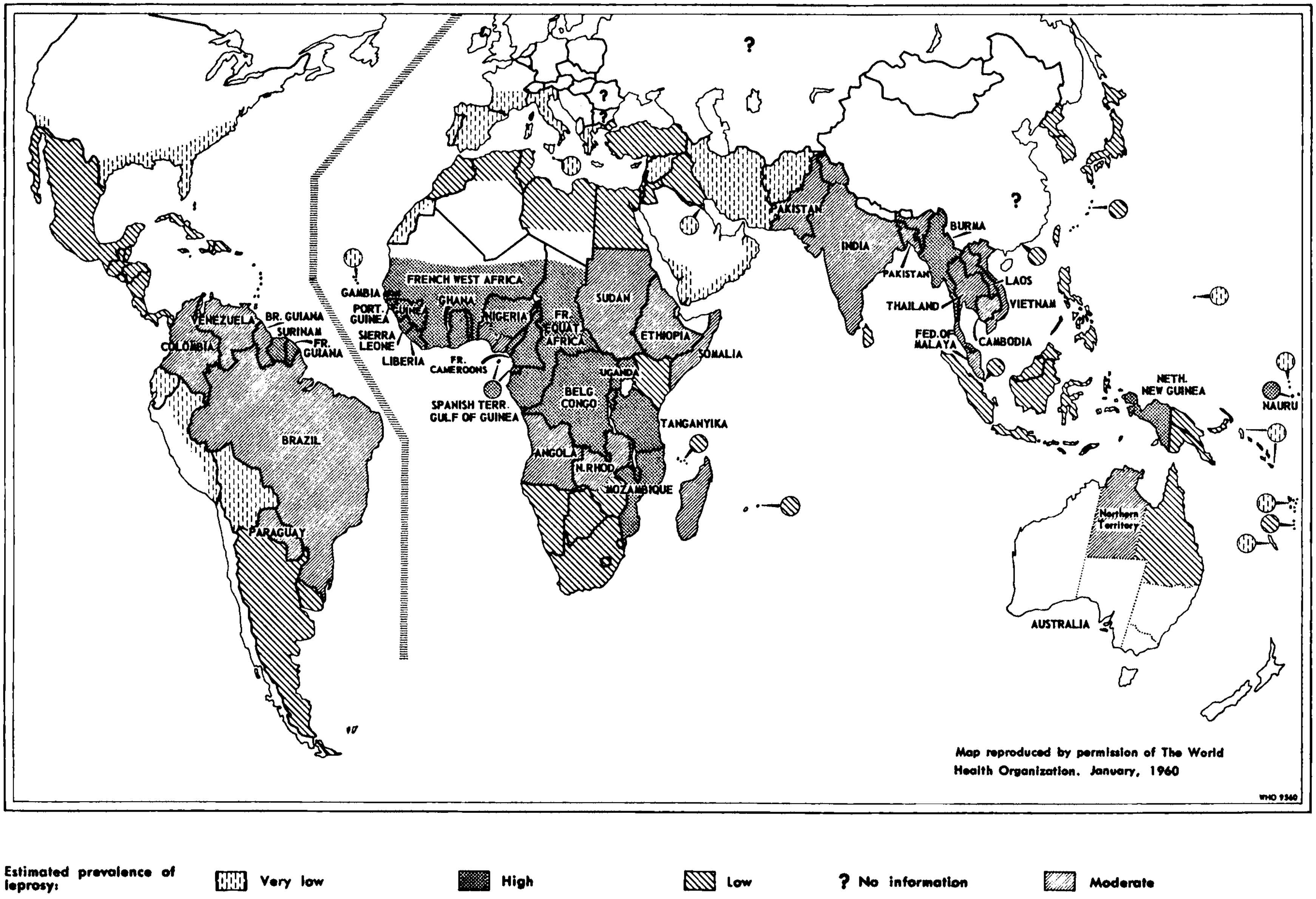
Caribbean, Central and South America. According to Lima,[20] the American Continent may be divided into five areas with regard to the occurrence of leprosy:

1. Area of very high endemicity—with prevalence indices over 2 per 1,000.
2. Area of high endemicity—with prevalence indices between 1.5 and 2 per 1,000.
3. Area of medium endemicity—with prevalence indices between 1 and 1.5 per 1,000.
4. Area of low endemicity—with prevalence indices between 0.5 and 1 per 1,000.
5. Area of very low endemicity—with prevalence indices below 0.5 per 1,000.

In the first area Lima includes: French Guiana, Martinique, Guadeloupe, Surinam, British Guiana, St. Martin (Netherlands Antilles), Puerto Rico and Brazil, of which French Guiana with a prevalence index of 48 per 1,000 ranks first. The second area includes only Antigua and the British Virgin Islands. In the third are Venezuela, Paraguay, Trinidad and Tobago, 'and the U. S. Virgin Islands. The fourth includes: St. Kitts-Nevis-Anguilla, Colombia, Cuba and Argentina. In the fifth are Costa Rica, Mexico, Jamaica, Bolivia, Barbados, Dominica, St. Vincent, St. Lucia, Bahamas, Peru, Panama, Dominican Republic, Netherlands Antilles (other than St. Martin), Ecuador, Nicaragua, Honduras, El Salvador, Bermuda, Guatemala, Uruguay, British Honduras, Chile and Haiti.

At the Fifteenth Pan American Sanitary Conference (1958), it was reported that the number of known cases of leprosy in the Americas exceeds 100,000.[21] In the Caribbean Islands the number of estimated cases in 1960 was 8,681, of which 8,078 had been reported between 1953 and 1959. In Central America in 1960, there were 881 estimated cases, of which 809 were reported between 1953 and 1959. In South America analogous figures were 180,922 and 123,490, respectively.[18]

Figure 2. Distribution of Leprosy, 1958



Information is meager with regard to the type of leprosy found in this area. Montestruc *et al.* noted an encouraging diminution in the proportion of new lepromatous cases in Martinique, but the ratio of lepromatous to non-lepromatous cases is not reported.[22] In Trinidad and Tobago, of 410 contacts tested, 52 per cent were strongly positive, 25 per cent moderately positive, and 23 per cent negative or only slightly positive.[23] In British Guiana, of 33,702 children examined, 50 manifested early tuberculoid leprosy in 1955, this number becoming 78 in 1956 and again 50 in 1957.[4] The incidence of the disease in this country was estimated by 1957 to be 2.8 per 1,000. In Venezuela, Convit and González reported that 58.4 per cent of leprosy cases were lepromatous, 20.2 per cent tuberculoid and 21.4 per cent indeterminate.[24] In Paraguay, the incidence of the tuberculoid type of leprosy in Asunción is 39 per cent and is more common than the other two forms.[25]

A study of the disability resulting from leprosy was made by Guinto in Brazil, Martinique and Venezuela.[18] Of 2,640 persons examined in Brazil, 34.4 per cent showed disability. In Martinique, of 685 examinations, 16 per cent were disabled. In Venezuela, examination of 8,286 cases revealed a disability rate of 16.4 per cent.

Africa. According to Guinto, the number of cases of leprosy registered between 1953 and 1959 in Africa was 1,426,039 and the estimated number of true cases 2,321,594.[18] The Leonard Wood Memorial reported only 839,048 registered cases and 1,610,360 estimated cases for 1960.[19]

In Morocco, Rollier *et al.* estimated the incidence of leprosy to be 1 per 1,000 among Moslems and 1 per 10,000 among Jews and Europeans.[26] Schaller reports that the number of persons suffering from this disease in Ethiopia is above 200,000, or 1.5 per cent of the population. The highest incidence occurs in the central provinces of Begemdir, Wollo, Shoa and Gojiam, where it is assessed at 15 per 1,000. At altitudes of 6,000 feet or more, 49 persons per 1,000 are affected.[27]

In Nigeria leprosy is considered to be of primary significance. In the Northern Region a conservative estimate of the prevalence rate is 2 per cent but the true incidence probably extends from 3 to 5 per cent, and the number of cases in this region may be estimated at 300,000, of which but 175,000 had probably received treatment in 1957. No accurate data are available for the Western Region but the incidence of leprosy is known to be high, particularly in the east, the over-all estimated number of cases being 50,000 to 80,000. The Eastern Region presents prevalence rates from 1.2 to 5.6 per cent in the various provinces, certain villages having rates as high as 15 per cent. The total number of cases in this region is estimated at 100,000, but it is considered that the control campaign in progress has been successful, as the number of new patients is diminishing and the mildness of their symptoms is a striking feature. In this region, 29,000 patients were under treatment in 1957. The total number of leprosy cases estimated for the whole of Nigeria is around 700,000.[28]

In a study of the disability resulting from leprosy in Katsina, Northern Nigeria, Guinto showed that 87.1 per cent of 303 lepromatous cases and 28.8 per cent of 1,364 non-lepromatous cases examined presented disability. In the whole of Northern Nigeria this author reported that of 1,294 examinations of leprosy cases, 31.6 per cent were disabled.[18]

In Gambia, a recent survey reported a high incidence of leprosy, the number of patients in need of treatment being estimated at 10,000.[28]

In the former Belgian Congo the disease is widespread, particularly in Equateur and Orientale Provinces.[7] An estimate for 1958 set the prevalence rate at 35 per 1,000. Eighty to 90 per cent of the leprosy cases in the former Belgian Congo are of the tuberculoid type and about 10 per cent of the lepromatous variety. It was reported in 1957 that there were 300,000 known patients in this country.[29] This makes a rate of approximately 2 per cent, but Kivits has calculated that in the equatorial forest belt the percentage may go up to 4 or 5 per cent.[30]

In the territories that formerly constituted French West Africa the prevalence rate was estimated in 1957 to be 2.5 per cent of which only about one-half had been reported.[28] The problem was most acute in Upper Volta, Ivory Coast, Sudan and Guinea. The smallest number of cases were reported from Mauritania. WHO reports give the following prevalence rates for the republics of former French West Africa: Upper Volta (2.75 per cent); Ivory Coast (2.32 per cent); Mali (1.78 per cent); Dahomey (1.52 per cent); Senegal (1.26 per cent); Niger (0.55 per cent); and Mauritania (0.11 per cent).[31]

Leprosy is endemic in the entire Republic of Cameroon,[28] but distribution is uneven, the forested areas in the south showing the highest prevalence. In 1957, 23,633 cases of leprosy were known in the country, but it is suggested that the true number of cases must be at least double this number. In Angola, the Commission for Leprosy Inspection observed 901 cases out of a population of 37,009 in the central district of Huambo. Prevalence rates for the country are lacking.[32] In the republics of former French Equatorial Africa, the following prevalence figures are found: Congo (1.7 per cent); Gabon (2.2 per cent); Central African Republic (5.8 per cent); and Chad (2.2 per cent). In certain heavily infected areas the prevalence rate is as high as 26 per cent, placing these areas among the most important foci of leprosy in the world. In this region 51.8 per cent of the cases are tuberculoid, 7.4 per cent lepromatous and 40.8 per cent undetermined.[28] Another census, reported in 1958 and done under the auspices of the Service Général Mobile d'Hygiène et de Prophylaxie, showed slightly different figures for numbers of patients and percentage of population according to former territories, as follows: former Middle Congo, 11,188 (1.6 per cent); Gabon, 7,057 (1.8 per cent); Ubangi-Shari, 56,508 (5.1 per cent); Chad, 40,883 (1.6 per cent). The percentages of the different forms of leprosy were lepromatous 6.85, tuberculoid 54.19 and indeterminate 38.94.[33]

In Uganda, Nelson found the incidence to vary from 0.6 to 53.3 per 1,000, 72.6 per cent of the cases being tuberculoid and 18.4 per cent lepromatous.[34] Worsfold reported an incidence of 11.8 per 1,000 in the Upper Zambesi basin of Northern Rhodesia, one-fourth of the cases being lepromatous.[35]

In Bechuanaland the disease seems to be unimportant, only 34 cases, mostly of long standing, being reported in 1957.[36] In the Seychelles Islands from 1955 to 1956 only four cases were found.[11] Figures from specific surveys indicating prevalence of disease are lacking for other African regions.

Southwest Asia. Guinto estimated a true total of 8,905 cases for the region of Southwest Asia, based on the 3,545 cases reported in 1960.[18]

Few data are available with regard to the prevalence of leprosy in the countries comprising this area. Available reports are vague and limited to general statements regarding the relative importance or potential danger of the disease.

In the Arabian Peninsula, the disease seems to be more common in the southern than in the northern areas and is considered endemic.[13] In Bahrain it is seen occasionally in the Baharna but seldom in the Arabs. In Aden Colony and Protectorate leprosy is most commonly seen in immigrants; it is not considered a health problem at present.[14] In Yemen the disease seems to be endemic throughout the country with the anesthetic form prevailing; 53 new cases were found from 1952 to 1957.[37] In Jordan leprosy is not a health problem.[15] In Turkey, 6,000 to 12,000 cases are believed to exist, mostly in the eastern, central and northern areas, the majority of cases being found in eastern Anatolia and along the Black Sea Coast, with only sporadic cases from the rest of the country.[38] In Syria the disease is considered uncommon.[17]

South Central and Southeast Asia. The Leonard Wood Memorial estimated the total number of cases for South Central Asia in 1960 to be 985,666.[19] Guinto gave a somewhat larger estimate of 1,475,340 for the same region in the same year.[18] In Southeast Asia estimated numbers of cases vary from 407,125[19] to 594,191.[18] In East Asia the number of estimated cases ranged from 15,044[18] to 89,322.[19]

Information regarding prevalence in the different countries of this region is scarce and often contradictory.

In Portuguese Timor, the incidence of leprosy was estimated to be 0.8 to 1.9 per 1,000.[39] In Thailand, Miquel reported an incidence of about 1 per cent in the province of Khon Kaen, 31.5 per cent being of the lepromatous type.[40] Estimates place the number of leprosy patients in India at about 1,500,000. A study of 6,616 patients revealed that 50.4 per cent presented disability. Disability rates for 2,034 lepromatous patients were 62.8 per cent and for 4,582 non-lepromatous patients, 44.8 per cent.[18] The Government of India has collaborated with the State Governments in establishing leprosy centers for purposes of special study. In 1957, 38,000 cases had been recorded at these, of which 25,000, or 66 per cent, were non-lepromatous and 13,000, or 34 per cent, were lepromatous. The Gandhi Memorial Leprosy Foundation operates units which covered, in 1958, a population of 192,835. Of these, 512 had been discovered to have lepromatous leprosy and 3,181 non-lepromatous leprosy, an average incidence of 18.1 per 1,000.[41]

Highly endemic areas of West Bengal have displayed infection rates approaching 10 per cent of the population, and Mullick reported in 1958 that the incidence in these areas is apparently increasing.[42]

In Pakistan the disease is common but the number of patients is not known.

The percentage of lepers has been estimated at 0.1 per cent for the whole of Indonesia, with 75,000 to 80,000 persons suffering from the disease. Lepromatous forms account for about 30 per cent of the aggregate.[43] The number of registered cases of leprosy increased from 16,062 in 1952 to 24,019 in 1956.[44]

In the Philippines, Cebu Island is the most important focus of leprosy, with a rate of 2.37 per 1,000.[45] According to Guinto, studies of 2,487 cases on this island revealed a disability rate of 16.6 per cent. Of the 1,122 lepromatous cases, 25.7 per cent had disability and 1,364 non-lepromatous cases had 9.1 per cent disability.[18]

In Taiwan the total number of patients is estimated at 8,000 to 10,000, the major areas of infection being Kinmen (Quemoy) and the Pescadores Islands.[46] A health survey of Shi-yu Island in the Pescadores, performed under the Rural Health Program of the Chinese-American Joint Commission on Rural Reconstruction in 1956-1957, uncovered 16 cases and 2 doubtful cases of leprosy among 7,975 persons, placing the incidence here at 2 per 1,000.[47]

Oceania. The importance of leprosy varies from island to island, although in 1957 the highest morbidity rate for leprosy was recorded in Oceania (Table 11). Data regarding prevalence are scarce. The total number of cases in 1960 was estimated to be 3,168.[18]

The incidence of known leprosy in American Samoa was 5.3 per 1,000 in 1958. The total known cases numbered 107. Of these, 26 had left Samoa. Of the remaining 81 still in residence in American Samoa, 40, or 49.4 per cent, were of the lepromatous type, 34, or 42 per cent, were of the tuberculoid type and 7, or 8.6 per cent, were of indeterminate type.[48]

In Fiji there were 559 leprosy patients under treatment at the leprosy hospital on Makogai at the end of 1957. Of these, 384 were from within the Colony of Fiji, while the rest came from other island colonies under British influence. The number of new admissions to the hospital was 45 in 1955, 60 in 1956 and 49 in 1957.[49]

In the Gilbert and Ellice Islands, an average yearly figure of 15 new cases of leprosy was recorded between 1945 and 1955.[50]

In the Territory of Papua and New Guinea, Russell has reported the existence of 2,272 known cases of leprosy and an estimated number of 6,000 to 8,000. By type, the rate per 100,000 of total population is: lepromatous, 27; tuberculoid, 99; borderline, 0.84; and indeterminate, 0.13.[51] The disease appears to be endemic in most parts of the territory. Although comprehensive epidemiological surveys have not yet been made in all areas, case finding surveys have always revealed an incidence of the disease in areas selected for preliminary investigation. Some of the areas investigated have revealed the following figures:[52]

Area Investigated	*Number of People Examined*	*Incidence of Leprosy Per Thousand*
Southern Highlands, Haibugu Marsh, Tari	1,999	16.50
Western Highlands, Wabag Subdistrict	15,071	3.66
Baiyer River Area	2,876	6.67
Eastern Highlands, Okapa Area	5,416	4.61
Gulf and Western Districts: Aramia, Bamu, and Fly Rivers; coastal towns	7,578	18.40
Gulf District, Ihu-Orokolo Area	9,439	14.90
Madang District	12,617	6.18
Bagasin Census Division, Madang District	3,421	36.80
North Fore Census Division, Eastern Highlands	4,576	3.93

Morbidity and mortality

Table 7 reveals that leprosy ranks 20th in the list of great diseases as defined for the purposes of this survey. There were 90,235 cases reported in 1957. In Table 8 it is the 14th in order of causes of death, being identified as a prime cause in 4,534 fatalities in 1957. Of the total population of the survey area in 1957 (1,204,501,000), 70 per 100,000 were affected by leprosy and 0.37 per 100,000 died of it. Six of the 123 countries which reported the disease in 1957 indicated only figures for mortality.

The data available for 1957 concerning the occurrence of leprosy in the regions under survey are summarized in Table 11. Of the 169 countries and territories of the survey, 123 reported this disease in 1957. Of a total estimated population of 1,204,501,000 for the area under survey, 500,156,000, or 41.52 per cent, lived in infected areas.

The morbidity rate for the area under survey was relatively low, 7.49 per 100,000. Leprosy, although a public health problem, would not be considered a major one if only numbers were to be considered. Two factors, however, tend to color this situation: the high rate of disability in certain areas, and, more universally, the stigmata associated with the disease. The promising results obtained with diaminodiphenyl sulphone (DDS), the reduced need to isolate patients for treatment, and the growing confidence of the populations at risk in the promise of future results suggest that an emphasis on mass treatment campaigns could be stressed now with hope for profit.

Oceania had the highest morbidity rate, 58.6 per 100,000, almost double the next highest rate of 30.1 for Africa. However, in Oceania the disease is important mainly in Papua and New Guinea, while in Africa the problem is widespread.

In the Caribbean, Central and South America, French Guiana, with a morbidity rate of 48 per 1,000, was the most seriously affected area.

In Africa, Nigeria, former French Equatorial Africa and the Republic of Cameroon are the areas in which the problem appears most acute. However, Ethiopia, with 10,799 cases reported in 1957, must also be taken into account, as well as Mozambique (6,724 cases and 759 deaths in 1957) and the former Belgian Congo (4,266 cases and 302 deaths in 1957). Tanganyika, Kenya and the Sudan are also relatively important centers. Thus, in Africa, the main area of involvement is seen to be the equatorial belt.

Using Lima's criteria for classifying endemic areas of leprosy, Africa, with a morbidity rate of 30.1 per 100,000 in 1957, must be considered an area of very low endemicity.[20] This is not in accordance with the impression obtained from the reports of others, and there is a likelihood of underestimating the relative importance of many health problems in Africa because of inadequate reporting.

In 1957 only 8 out of 18 countries in Southwest Asia reported cases of leprosy. The disease appeared to be most common in Iraq, Israel and Yemen, where the morbidity rates were 4.6, 10.8 and 2.4 per 100,000, respectively. Mortality rates in these three countries were negligible. The available data appear to indicate that leprosy cannot be considered a major public health problem in this region with the possible exception of Israel. If Lima's criteria are employed, Iraq and Yemen may be considered areas of very low endemicity and Israel of low endemicity. The total morbidity and mortality rates for this region are 0.81 and 0.009 per 100,000, respectively; thus Southwest Asia as a whole may be considered as a region of very low endemicity.

Evaluation of the situation in South Central and Southeast Asia presents extreme difficulty since only Ceylon reported cases in 1957 from the Indian subcontinent, where individual reports of prevalence would appear to indicate a problem of relatively large magnitude. Fifteen of the 24 countries in this area reported cases of leprosy in 1957 but the morbidity and mortality rates are in general very low. Leprosy seems not to be an important problem in this region, although reservations must be made with regard to India and Pakistan.

In Oceania, New Guinea seemed from local surveys to be the most important region for leprosy but no cases or deaths were officially reported in 1957. Papua reported 1,724 cases and 4 deaths, with morbidity and mortality rates of 3.68 and 0.009 per 100,000, respectively. According to Lima's criteria, Papua is thus to be classified as a zone of very high endemicity. Based on available data the figures for the total region would indicate that the region is an area of low endemicity. Again the dispersion of the problem throughout a vast area acts to reduce its apparent over-all importance.

Public health importance

Leprosy is not a public health problem of major importance throughout the entire survey area but it is of considerable concern in selected areas within the tropics. It occurs predominantly in warm countries and all territories with a prevalence of more than 5 per 1,000 are in the tropical belt.[19]

Utilizing the classification of Lima, none of the regions under study can be considered an area of even medium endemicity and only Oceania can be classified as an area of low endemicity.[20] The other four regions fall in the group of very low endemicity. The values obtained from the data available for 1957 confirm this, when comparison is made of morbidity and mortality rates alone.

MENINGOCOCCAL INFECTIONS

Distribution

One hundred and thirty-four of 169 countries and territories surveyed reported the presence of meningococcal infections (Table 11). The population represented in the reports was 96.37 per cent of that of the total area.

There were 43,748 cases of meningococcal infections, principally cerebrospinal meningitis, reported in 1957. Of these, 5 per cent were in the Caribbean, Central and South America, 85 per cent were in Africa, 2 per cent were in Southwest Asia, 7 per cent were in South Central and Southeast Asia and 1 per cent were in Oceania (Figure 1-c).

In the region of the Caribbean, Central and South America no cases of meningococcal infections were officially reported in the Dominican Republic, Cuba, French Guiana, Grenada, Guadeloupe, Montserrat, Martinique, Netherlands Antilles, St. Lucia, St. Vincent and Surinam.

In Africa there were no reports from the British Cameroons, St. Helena, St. Thomas and Prince Islands, Somalia, South West Africa and the Spanish Colonies.

In Southwest Asia data concerning the disease were not found for Kuwait, Muscat and Oman, Qatar, Saudi Arabia, Syria and Trucial Oman.

In South Central and Southeast Asia no data were available from Bhutan, Maldive Islands, Nepal, Portuguese India, Sarawak and Portuguese Timor.

In Oceania information was lacking for the Bonin, Cook and Tokelau Islands, Norfolk and Pitcairn.

Incidence and prevalence

In spite of wide distribution, meningococcal infections have been little studied from an epidemiological point of view in the areas of the survey.

Average rates per 100,000 in the Caribbean, Central and South America were 2.3 in 1953, 1.7 in 1954, 2.1 in 1955, and 2.2 in 1956.[21] The picture suggested is one of steady endemicity, although it is characteristic of meningococcal infections to occur occasionally in epidemic outbreaks lasting months or even years. In Brazil, Schmid and Galvão carried out a study of meningococcal meningitis in the city of São Paulo between 1935 and 1958. Between 1935 and 1944 and again after 1951, the disease was endemic in the city but between 1944 and 1951 it was epidemic. During endemic periods the greatest incidence was in children in the 0-4 year age group, but during the epidemic period the highest incidence was in the 15-19 year age group. The prevalence during endemic years varied from 2.09 to 3.79 per 100,000. In the epidemic period it varied from 4.8 to 25 per 100,000. The disease was most common during the winter months and favored socio-economically depressed areas of the city.[53]

In Africa, meningococcal meningitis occurs on an outstanding scale in the dry savannah area south of the Sahara known as the African Sudan, and including Nigeria, Ghana and the intervening French-speaking countries.

Waddy reports that the total attack rate in the western Northern Territories of Ghana during a cycle of epidemics between 1943 and 1950 was 81.9 per 1,000. Epidemics of such severity occur only during the dry season. The disease apparently dies out completely during inter-epidemic periods, new cycles occurring upon reintroduction of virulent organisms from an endemo-epidemic focus, presumably in the Republic of the Sudan.[54] In the past extremely high attack rates have been recorded from almost all the savannah areas of the Sudan. Recent reports have been rare. Sénécal *et al.* report on 202 sporadic cases of acute purulent meningitis in children under five, in Dakar. Here, however, the meningococcus was the chief causal agent in only 13 per cent of cases, the most common offending organism being *Haemophilus influenzae* (39 per cent) followed by the pneumococcus (19 per cent). Both the pneumococcal and meningococcal infections have been most commonly observed in the dry season, the former but not the latter being accompanied by very high mortality.[55]

Local outbreaks of meningococcal meningitis have occurred commonly in the Republic of the Congo (former Belgian Congo), particularly in Leopoldville and Kasai provinces. For the period 1953-1959, inclusive, the average annual number of cases reported was 575, principally among the Congolese. In recent years, case fatality rates have been affected by improvements in therapeusis; high rates of 30 to 80 per cent, recorded some ten years before, dropped to 22 per cent in 1958 and 21 per cent in 1959.[7]

Southwest Asia. Because of the generally dry climate characteristic of much of this area, and because of the prevalence of certain poor living conditions, it is to be expected that the meningococcal infections will thrive here. Survey data are, however, generally lacking. Meningococcal meningitis is considered to be a rare disease in Saudi Arabia.[13] In Aden Colony and Protectorate, localized outbreaks of cerebrospinal meningitis are known to occur, although figures on frequency are absent.[14] The disease is occasionally mentioned in reports from Bahrain and Yemen. Elsewhere in the Arabian Peninsula it is not reported.

About 60 cases of meningococcal meningitis were reported to the Health Ministry of Jordan in 1957. In 1956, there were 75 cases and 10 deaths. Since 1954, approximately 237 cases with 50 deaths have been officially reported, although it is believed that the actual incidence is greater.[15]

In Lebanon, epidemic cerebrospinal meningitis accounted for 5.8 per cent of all cases of communicable disease reported in 1955. This number was 72 cases, or 2.8 per cent, in 1956, and 24 cases, or 1.1 per cent, in 1957.[56]

Epidemics of cerebrospinal meningitis have been reported from Turkey. An estimated 500 to 1,000 cases have occurred annually in recent years, the highest incidence being registered from January through April. The number of cases officially reported each year is much less, being of the order of 200 to 300.[38]

Other areas. In South Central and Southeast Asia reference information was available only from Taiwan. There are no figures for prevalence, but at the National Taiwan University Hospital in 1954 and in 1955, 14 and 13 cases, respectively, were admitted.[46] No data were found from Oceania.

Morbidity and mortality

Tables 7 and 8 reveal that, in the list of great diseases, meningococcal infections occupied 21st and 12th places as causes of disease and death, respectively, in 1957. Of the 1,204,501,000 population estimated for the entire area in the survey, 0.004 per 100,000 were affected by this disease in 1957, while only 0.0007 per 100,000 died of it.

Table 11 is based on the reported number of cases and deaths occurring in 1957. In the entire survey area 59.76 per cent of the countries reported cases of this infection. The region where reporting was most complete was South Central and Southeast Asia, with 70.83 per cent of countries represented, followed by Africa, with 62.07 per cent. In all the regions more than 55 per cent of the countries and territories reported, Southwest Asia being the region where fewest countries did so (55.56 per cent).

The percentage of the total population represented in the reporting was 96.37. In the Caribbean, Central and South America, the figure was 94.52 per cent, in Africa 97.79 per cent, in Southwest Asia 86.35 per cent, in South Central and Southeast Asia 97.76 per cent, and in Oceania 56.81 per cent.

According to Table 11 the disease presents low morbidity and mortality rates in all the regions surveyed, ranging from morbidity rates of 0.46 per 100,000 in South Central and Southeast Asia to 16.1 per 100,000 in Africa, and mortality rates of 0.16 per 100,000 in the Caribbean, Central and South America to 2.47 per 100,000 in Oceania. Total morbidity and mortality rates in the area under survey of 3.63 and 0.69 per 100,000, respectively, fail to place meningococcal infections among the most important health problems of the tropics.

Clinical diagnosis of meningococcal infections being difficult, it is to be expected that the figures reported for morbidity and mortality are not indicative of the true number of cases and deaths. It is also important to note that of 101 countries and territories reporting data 13, or 12.9 per cent, reported only deaths.

Within the regions studied for 1957 the relative importance of meningococcal infections presents considerable variation from territory to territory. In the Caribbean, Central and South America, the disease is of greatest importance in Colombia and Brazil, where 686 cases and 36 deaths and 348 cases and 134 deaths were reported, respectively. Morbidity and mortality rates of 5.19 and 0.27 per 100,000 for Colombia and 0.57 and 0.22 per 100,000 for Brazil were obtained. In Chile and Venezuela also the disease is of relatively great importance.

In Africa, former French West Africa had a morbidity rate of 128.43 per 100,000 and a mortality rate of 16.2 per 100,000. The Sudan had morbidity and mortality rates of 60.63 and 6.12 per 100,000, respectively. These countries appear to rank high in regard to the relative importance of the disease. Following these are former French Equatorial Africa, South Africa and Ethiopia.

In Southwest Asia, Iraq, Iran and Turkey present the highest rates of morbidity and mortality for meningococcal infections. In Iraq morbidity per 100,000 was 4.93 and mortality per 100,000 was 1.17. In Iran the equivalent figures were 1.41 and 0.005, respectively, and in Turkey 1.06 and 0.17, respectively. The four other countries of this region reporting the disease in 1957 presented much smaller figures.

In South Central and Southeast Asia evaluation of the situation is difficult since 5 out of 17 countries reported only deaths. Among them, India reported 2,226 deaths, a figure larger than the number of cases reported by any other country. Next in order of importance was Taiwan, also only represented by the number of deaths. With mortality rates of 0.57 and 3.95 per 100,000 population, respectively, India and Taiwan must be considered the most important foci of meningococcal infection in this region in 1957.

With only 56.52 per cent of countries reporting the disease in 1957, Oceania is the region second with regard to morbidity and first with regard to mortality. A morbidity rate of 51.99 per 100,000 was found for Papua, with an accompanying mortality rate of 15.38 per 100,000. Tonga had a higher morbidity rate of 66.67 and a mortality rate of 10.53.

Public health importance

The data suggest that meningococcal infections cannot be considered a major tropical public health problem. Morbidity and mortality rates, together with the total number of cases and deaths, indicate that this disease is not among the ten major causes of disease or death in the survey area.

PNEUMONIA (ALL TYPES)

Distribution, incidence and prevalence

Data pertaining to the distribution of all forms of pneumonia were obtained from only 87 of 169 countries (Table 10), representing 55.56 per cent of the total population of the survey area. It must be assumed, however, that pneumonia as a clinical entity has a nearly world-wide distribution, and it is difficult to present figures purporting to represent the pattern of distribution since considerable under-reporting and lack of reporting are known to contribute to this picture.

There were 693,886 cases of pneumonia of all kinds reported in 1957. Of this number, 2 per cent were from the Caribbean, Central and South America, 50 per cent were from Africa, 1 per cent were from Southwest Asia, 46 per cent were from South Central and Southeast Asia, and 1 per cent were from Oceania. It seems extremely unlikely that the relative distribution of this universal infection would naturally vary so distinctly from the figures for population distribution in the major survey areas. It is rather suspected that serious defects in medical reporting are again illustrated. (Figure 1-d.)

In the almost complete absence of surveys of this disease, knowledge concerning the prevalence of pneumonia must be based entirely on reported cases, although such figures must be viewed cautiously as incomplete and frequently unreliable. Certainly, many cases of pneumonia will have been diagnosed as common colds, influenza, or simply as respiratory ailments.

Morbidity and mortality

Of the countries reporting pneumonia in 1957 morbidity and mortality figures for the entire survey area were 57.6 per 100,000 and 8.65 per 100,000, respectively.

There were 693,886 cases reported and 104,218 deaths due to pneumonia, thus placing the disease in eighth position as a cause of morbidity in the list of great diseases and in fifth position as a cause of mortality in 1957. (Tables 7 and 8.) In the entire survey area morbidity and mortality rates due to pneumonia were 0.06 and 0.009 per 100,000 population, respectively.

Taking into account only the population of the countries and territories from which data were obtained, Table 11 shows that in the Caribbean, Central and South America pneumonia had a morbidity rate of 7.16 per 100,000 and a mortality rate of 1.31 per 100,000; in Africa these rates were 148.2 and 3.75, respectively; in Southwest Asia 9.97 and 8.04; in South Central and Southeast Asia 45.8 and 12.3; and in Oceania 251.1 and 18.6.

Oceania and Africa undoubtedly present very heavy morbidity rates and in these two major areas the problem of pneumonia must be considered a very important one. Doubtless, many of the cases reported as pneumonia are, in fact, tuberculosis, but, even with this possibility, pneumonia is of concern in these regions. In the Caribbean, Central and South America and in Southwest Asia the disease seems to be of only moderate importance. In South Central and Southeast Asia pneumonia, although achieving a higher rate than in Africa and Oceania, does not parallel either of these areas.

In Oceania in 1957, New Guinea had the highest morbidity rate, which reached 532.65 per 100,000, with a mortality rate of 32.49 per 100,000. Other areas in Oceania where pneumonia attained high morbidity and mortality rates were, as follows: Papua with rates of 302.13 and 24.79 per 100,000, respectively; Ryukyu Islands with 21.93 and 11.52; and the U. S. Trust Territories, which reported a morbidity rate of 302.81 with no reports on mortality.

Of the African countries, the Sudan with morbidity and mortality rates of 658.17 and 4.43 per 100,000, respectively, headed the list of territories in which pneumonia figured significantly. Kenya, with respective rates of 584.05 and 34.99, stands second with regard to morbidity and first with regard to mortality. Former French West Africa, with rates of 575.19 and 1.06, is also an important focus of the disease, as is the former Belgian Congo (55.36 and 28.19). Other African areas where the disease attained considerable importance are Nigeria, Uganda, Republic of Cameroon, Ghana and Mozambique.

In Southwest Asia the disease is important in Iraq and Turkey but since these countries reported only deaths an estimate of morbidity is not possible. Nevertheless the mortality rates of these countries, 22.53 and 19.95, respectively, indicate that morbidity rates should be very high indeed. The four remaining countries reporting cases and deaths in this area did not have exceptional rates.

In South Central and Southeast Asia high rates were recorded for India, Ceylon, Philippines and Vietnam. In India morbidity and mortality rates were 462.78 and 6.24 per 100,000, respectively; in the Philippines 327.79 and 148.21; in Ceylon 234.81 and 23.93; and in Vietnam 83.99 and 1.80. Taiwan, Hong Kong and Thailand also had high mortality and morbidity rates, but only mortality figures were available for Taiwan.

Public health importance

Although reporting is unrealiable, evidence indicates that pneumonia represents one of the major health problems of the tropics. Its importance varies from region to region, with highest rates indicated for Oceania and Africa and the lowest rate in the Caribbean, Central and South America. Notification is not compulsory in more than 50 per cent of the countries and territories surveyed, a fact which probably has considerable bearing on attempts to devise its relative geographical significance as a health problem.

TUBERCULOSIS

Distribution

Tuberculosis is a notifiable disease in fewer than half of the countries and territories surveyed. This circumstance coupled with problems of differential diagnosis is responsible to a great extent for the fact that data were only available from 103 of the 169 countries in the survey. (Table 10.) The disease was reported from 27 of the 46 countries of the Caribbean, Central and South American region; from 32 of the 58 countries in Africa; from 11 of 18 countries in Southwest Asia; from 20 of the 24 countries in South Central and Southeast Asia; and from 13 of 23 countries in Oceania.

Tuberculosis is widespread in tropical regions. Figures in official reports leave the impression that adequate epidemiological surveys would show the disease to have a much wider distribution than is indicated at present.

From the data available it will be seen that 851,762,000 people live in areas from which the disease was reported or 70.7 per cent of the total population represented in the survey.

Tables 7, 8 and 11 summarize the number of cases, the number of deaths and the morbidity and mortality rates for tuberculosis in the survey area during 1957.

In this year, there were 6,150,866 cases of tuberculosis reported. Of these, 1 per cent were in the Caribbean, Central and South America, 2 per cent were in Africa, 65 per cent were in Southwest Asia, 32 per cent were in South Central and Southeast Asia and less than half of 1 per cent were in Oceania. If these ratios were real, an astonishing situation would be indicated which would invite serious investigation. However, the problem of tuberculosis in the Americas and Africa is certainly not as small in proportion to the rest of the tropical world as would be indicated here. The answer would seem to be that the data themselves are quite inadequate. If these figures are not real, they at least supply evidence of the need for some research and study on methods of securing more realistic data. (Figure 1-f.)

Figures for incidence and prevalence by country will not be emphasized here. In much of the world, especially the underdeveloped areas in which tuberculosis constitutes a major problem, no reliable data are available and planning and evaluation of control programs in these places must yet be preceded by prevalence surveys. May has summarized the distribution of tuberculosis throughout the world for the 1950's. He points out that the distribution of tuberculosis is undergoing considerable change. The extension of BCG vaccination campaigns will cause an increasing number of hosts to become resistant to the invasion of the agent. However, he adds that the only factor which is unlikely to be changed in the more underdeveloped parts of the world is the way of life and the diet. Although this would make the future dim for the countries in question, prevention and treatment will still do much to alter the pattern of distribution.[57]

At the present time, there is no internationally accepted definition of pulmonary tuberculosis. Thus, official figures for morbidity have limited value when utilized in international comparisons. In like vein, the advent of effective antituberculosis chemotherapy can render mortality rates almost useless as indicators of tuberculosis trends. Prevalence surveys of large samples of population selected at random are a useful means of ascertaining the extent of tuberculosis in countries where the disease has a relatively high prevalence (2-20 cases per 1,000 adult population).[58] The World Health Organization has devoted much time to the development of standard survey methods and has undertaken such surveys in several countries in Africa.

Caribbean, Central and South America. Although the extent of the tuberculosis problem in this area is not known, the disease is an important public health problem in many of the countries. In British Honduras, death rates showed a marked decrease from 44 per 100,000 in 1954 to 16 per 100,000 in 1957, yet the disease continues to present a major problem.[59] Tuberculosis is common and, in certain instances, increasing in incidence in many islands of the British West Indies. On the other hand, a steady decline in the death rate has been noted since 1947 in Trinidad and Tobago, where examination of 2,099 children of the age group 0-6 years with tuberculin tests showed that 43.9 per cent had had tubercular contacts.[23]

In Nicaragua, an X-ray survey in 1960 showed that 2.24 per cent of persons selected at random in Managua were suffering from active pulmonary tuberculosis and 4.09 per cent were judged suspicious. If these percentages were extrapolated to include the entire country, there would be 100,000 cases requiring further study and treatment.[60]

Mortality rates have been decreasing in Colombia since 1945, although tuberculosis continues to pose a serious public health problem. Tuberculosis morbidity per 100,000 diminished from 167.6 in 1948 to 119.3 in 1959. Moreover, there is good reason to believe that a large number of infected persons fail to come to the attention of medical authorities in charge of compiling statistics.[61] In Peru, surveys made in urban communities have revealed a prevalence of 2.34 per cent.[61]

Africa. World Health Organization teams have carried out sample surveys in Kenya and have estimated that there are between 30,000 and 60,000 active infectious cases of pulmonary tuberculosis in a population of 6 million. Other surveys conducted in Somalia, Tanganyika, Uganda, Swaziland, Basutoland, Sierra Leone, Liberia, Nigeria, Bechuanaland, Ghana and the Gambia have shown sputum positivity rates (by direct microscopy) ranging from 0.3 per cent in Nigeria and almost 1 per cent in East Africa to over 2 per cent in Somalia. In general, the prevalence surveys have revealed that some 90 per cent of the cases discovered are new cases, only 10 per cent being known and already under treatment.[62]

In a project to ascertain the distribution of infectious cases of tuberculosis by type of household, Anderson *et al.* conducted studies on 6,680 households in 9 countries, including Basutoland, Bechuanaland, Swaziland, former British Somaliland, Tanganyika, Uganda, Ghana and Nigeria. Tuberculin testing was done on 13,366 children 0-14 years of age, of whom 15.7 per cent were positive. Sputum examinations were made on 20,985 children and adults, and the percentage of those excreting acid-fast bacilli varied from 2.4 per cent in British Somaliland to 0.3 per cent in Uganda and Nigeria. Of 121 infectious cases, 34 per cent lived in households without children in the 0-14 year age group, while 66 per cent lived in households which included children of this age group.[63]

In Algeria, the Saharan community of El Golea was the site of a survey in 1958-59, when 3,000 persons were tested for tuberculin reaction. Of 2,489 successful readings, the total reactor rate in whites proved to be 71.9 per cent (58.9 per cent at 1-15 years and 85 per cent over the age of 15). In Negroes the total reactor rate was 65.4 per cent (43.5 per cent at ages 0-15 and 87.4 per cent over 15). The reactor rate in the whole group was 70.1 per cent (54.3 per cent and 86 per cent). In this survey the conclusion was made that tubercular infection was increasing since the rates tended to be in excess of figures obtained previously. It was necessary, in this study, to assume that positive reactions were, in all cases, due to experience with tubercle bacilli.[64]

In Egypt, available data are quite incomplete because, although notification has been compulsory since 1928, the fact of tubercular infection carries a social stigma and physicians are still reluctant to report cases. In a study made during the period 1951-59, a total of 21,750 children aged 0-15 years underwent tuberculin testing. The reactor rate for the entire group proved to be 17 per cent. The rate was 2.7 per cent at 0-1 year in both sexes. In those aged 12-15 years the rates were 55.8 per cent and 66.2 per cent in boys and girls respectively. X-ray examination of 3,866 reactors revealed tubercular lesions in 618 (16.7 per cent).[65]

In Ghana in 1957 tuberculin testing on 7,400 persons of all ages revealed that 55 per cent of the sample were tuberculin positive, and in the age group up to 4 years positive reactions were found in more than 35 per cent. The population of Ghana in 1957 was probably about 5 million. The data would permit an estimate of about 40,000 cases of tuberculosis, if it is assumed that each positive indicates infection with the tubercle bacillus.[66]

It is thought that tuberculosis may be increasing in incidence in the Ivory Coast. Moreover, a serious rural incidence may be developing. In the first four months of 1960, of 323 new patients, 28 per cent were from Abidjan, 22 per cent from other towns and 48 per cent were from small villages.[67]

It is estimated that the morbidity rate for Nigeria is about 2 per 1,000 in rural areas and about 6 to 7 per 1,000 in urban areas. The disease is a serious problem in Lagos.[62] In the Eastern Region of Nigeria, a tuberculin survey of 40,000 children primarily from urban areas found that 12 to 16 per cent were positive in the age group 5-9 years, 22 to 30 per cent were positive in the age group 10-14 years, 34 to 47 per cent were positive in the age group 15-19 years, and 58 to 76 per cent were positive in the group older than 19 years.[68]

In the Republic of Congo (Brazzaville), tuberculin testing of children in the age group 5-12 was done between 1957 and 1959. The positivity rates in towns with a population of 30,000 to 50,000 were from 23 to 27 per cent; in towns with a population of 3,000 to 8,000, the rates were from 20 to 30 per cent; and in rural areas under 5 per cent.[62]

In the Republic of the Congo (Leopoldville), pre-independence surveys, covering more than half a million people in urban and rural areas, showed that approximately 100,000 persons (in a population of 13 million) suffered from tuberculosis in the entire country. Of these, 50 per cent were in need of or were undergoing hospitalization.[62]

In Ruanda-Urundi, incidence of tuberculin reactivity was 12 per 1,000 in advance of a recent BCG campaign. Incidence in tested groups fell to 4 per 1,000 and 11.5 per 1,000 after the campaign. It was estimated that there are 80,000 cases of tuberculosis in this country, of which more than 80 per cent are probably curable.[69]

In Southern Rhodesia, the general tuberculin positive rate was 40.6 per cent, rising from 23 per cent at age 5 (21.3 per cent at age 6) to 69.9 per cent at age 18, boys having slightly higher rates than girls. Incidence and prevalence rates were low in rural areas at higher altitudes and on farms. Rates were high in low-lying rural areas and in rural industrial areas. In towns, the incidence of infection was low but the prevalence of disease was relatively high.[70]

In Bechuanaland, tuberculosis is considered a most serious public health problem. A mass radiographic survey carried out in 1952 revealed tubercular lesions in 1.3 per cent of those examined. Sputum examinations showed that 93.3 per cent of the active cases were presenting tubercle bacilli by direct microscopy.[28] A WHO survey in 1956 confirmed the results of the previous work. It was estimated that at least 3,000 persons in the country were in an infective state.

A WHO survey in Swaziland revealed a prevalence rate of 1 per cent of highly infectious cases.[28]

In 1957-58, a WHO survey in Basutoland found 0.5 per cent of the entire population presenting tubercle bacilli in the sputum at any given time.[28]

In Mauritius the infection rate is very high. Tuberculin tests carried out in 1953 and 1956 in schools gave rates of 25.7 per cent in 1953 and 20 per cent in 1956 in the age group 5-9 years, 34.2 per cent in 1953 and 38 per cent in 1956 in the age group 10-14 years, and 51.7 per cent in 1953 and 61 per cent in 1956 in the age group 15-19 years. Again, incidence is reported to be higher in urban than in rural areas.[28]

Southwest Asia. Only meager information is available concerning the incidence and prevalence of tuberculosis in most of the countries comprising this area. It is a major problem in the countries of the Arabian Peninsula, but exact figures are not known.

Tuberculosis constitutes one of the most important public health problems of Turkey. A study of average mortality rates in three cities, Ankara, Istanbul and Izmir from 1943 to 1951 gave figures of 181.1, 269.5 and 236.9 per 100,000, respectively.[38]

Arabs are particularly prone to tubercular infection and all forms of the disease are encountered in this area. In spite of its prevalence in Syria, Jordan and Iraq, and indeed its paramount position among infectious diseases in Yemen and Kuwait, figures are lacking which might indicate its prevalence. It is known that the pulmonary form predominates.

South Central and Southeast Asia. In India, a sample survey, sponsored by the Indian Council of Medical Research in 1955-1958, made X-ray examinations of 290,758 persons in six independent zones (the population included in the zones constituted 40 per cent of the Indian Union). Bacterial examinations were carried out on approximately 82 per cent of persons in the sample. Active and probably active tuberculosis varied from 13 to 25 per 1,000; 2 to 8 per 1,000 were bacteriologically positive. Little difference in the prevalence rate was shown in the cities, towns and villages. Very little minimal disease was discovered. From the figures obtained it was estimated that about 5 million persons in India are suffering from pulmonary tuberculosis.[71] A more recent survey utilizing mass radiography techniques was performed in Bombay and reported in 1960. Different groups of individuals were investigated. The first group consisted of 1,120 members of 280 families, well-housed but of low income. In this group 282 children aged 10-14 and 357 adults aged 15-70 were tested. Reactor rates were 31 and 95 per cent, respectively. X-rays were done on 516 adults and 376 children and active pulmonary tuberculosis was found in 3.2 per cent in adults and 0.5 per cent in children (total, 2.2 per cent). A second group of schoolboys, 5-20 years, were from higher income families; 1,066 boys gave a reactor rate of 50 per cent but no active tuberculosis was uncovered. A third group consisting of 116 destitute girls, 11-20 years, living in welfare institutions gave a reactor rate of 68 per cent. Three of the girls proved to have active tuberculosis. A last group of 84 hospital nurses, aged 17-27, and mostly from poor homes, was tested and X-rayed. The reactor rate was 72 per cent, no active cases being found.[72]

Estimates for Pakistan place the number of active tubercular cases at 500,000 to 750,000.[73] In a recent survey of students at Dacca University, 1,645 individuals were given tuberculin tests. The total reactor rate was 66.3 per cent. Only 621 of the 1,092 reactors reported for further X-ray testing. Of these, 55 (8.7 per cent) proved to have pulmonary tuberculosis.[74]

Tuberculosis claims a heavy toll in Indonesia. The present tuberculosis mortality rate is conservatively estimated at 190 per 100,000 population, and the figure for the number of active cases has been estimated to be 1.52 million (in a total population of 80 million).[43]

In Taiwan, an epidemiological survey performed in 1957 revealed a prevalence rate for tuberculin reactors of 39 per 1,000 and a rate for excreters of tubercle bacilli of 7 per 1,000.[46]

Oceania. On Manus Island (Manus District of Northeastern New Guinea), 10,849 persons were tested with old tuberculin. The rate of positive reactions varied from 2.3 per cent at age 0-1 to 35.1 per cent at ages 7-14, 86.2 per cent at ages 15-30, and 98 per cent above the age of 31.[75]

The incidence of tuberculosis may be as high as 1.5 per cent of the total population of the New Hebrides.[76] It remains the most important of communicable diseases in Fiji, where between 1953 and 1957 an average of 635 cases a year was reported.[49]

In Western Samoa, a survey of 755 tuberculin tested persons showed that 78 per cent in the age group above 20 years were positive; in the age group 15 to 19 years, 48.1 per cent were positive; in the age group 10 to 14 years, 56.3 per cent were positive; in the group 5 to 9 years, 59.2 per cent were positive; and in the group 0 to 14 years, 27.8 per cent were positive.[77]

In one recent survey of the Cook Island group, 195 out of 365 Mantoux reactions, or 53.4 per cent, were positive on Rarotonga and 136 out of 144, or 94.4 per cent, were positive on Pukapuka.[77]

In all of the foregoing it cannot be stressed too strongly that the findings are based on surveys of particular localities (with few exceptions) and international comparisons are not justified. Certain impressions, nevertheless, stand out. In the areas of the survey tuberculosis is seen as a disease of underprivileged surroundings associated with urban life. Although it is not correct to equate tuberculin sensitivity with the incidence of tubercular disease, yet surveys employing the use of old tuberculin in various dilutions constitute the least expensive and frequently the only form of survey available to authorities in many underdeveloped areas. Until more reliable indices of infection, such as the bacteriological examination of sputum and the chest X-ray, are resorted to, the present figures must suffice for an understanding of the distribution, incidence and prevalence of this disease in the areas included in the survey.

Morbidity and mortality

Morbidity and mortality rates due to tuberculosis in 1957 are summarized in Table 11. Tables 7 and 8 give the total number of cases and deaths reported for the area under survey in the same year. With 6,150,866 cases and 1,571,585 deaths reported in 1957, tuberculosis is the first cause of death and the third cause of morbidity in the survey area among the great diseases included in this report.

Considering the total estimated population of the area under survey, the morbidity and mortality rates per 100,000 for tuberculosis in 1957 were 510.7 and 130.5, respectively. The morbidity figure is biased because 7 out of the 80 countries and territories reported only deaths and fewer than half of the countries and territories of the area reported cases. The morbidity and mortality rates present an inadequate picture of the problem.

Of the regions considered, Southwest Asia with a morbidity rate of 4,964 per 100,000 ranks first, followed by South Central and Southeast Asia with a morbidity rate of 280.1 per 100,000. The latter region is nevertheless the one in which the mortality rate is the highest (222.7 per 100,000) but rates for both morbidity and mortality in this region are very much skewed by the fact that Indonesia and Thailand reported only deaths. Had Indonesia and Thailand reported cases, South Central and Southeast Asia might have had a morbidity rate approaching that of Southwest Asia. In India, of 213,523 cases 10,966 died, giving a fatality rate of 5.14 per cent. Utilizing the same fatality rate for Indonesia and Thailand would place the number of cases in these two countries at 29,773,852 and the morbidity rate for the region at 3,545.44 per 100,000. This figure, although theoretical, is in accordance with the reports concerning prevalence of the disease in Indonesia (see below).

The morbidity and mortality rates for the other regions fall below the rates estimated for the two mentioned above but are substantial enough to indicate that tuberculosis is a serious problem in the entire survey area.

In the Caribbean, Central and South America the highest morbidity rates per 100,000 for tuberculosis were registered in Ecuador (1,177.1), Chile (245.8), Panama (186.04) and Puerto Rico (137.6), and the highest mortality rates per 100,000 in Ecuador (32.9), Cuba (16.2) and Bolivia (4.6).

In Africa the countries in which tuberculosis is of major concern are Kenya, with a morbidity rate of 427.7 per 100,000 and a mortality rate of 15.2 per 100,000; the former Belgian Congo, with respective morbidity and mortality rates of 235.5 and 14.2 per 100,000; Morocco, with a morbidity rate of 145.7 per 100,000; and Sudan with respective morbidity and mortality rates of 70.2 and 2.9 per 100,000. Morocco did not report deaths.

In Southwest Asia, Iran reported the relatively high morbidity rate of 20.96 per 100,000, but mortality figures were lacking. The next highest rates were reported from Iraq, with a morbidity rate of 198.04 per 100,000 and a mortality rate of 4.16 per 100,000. Turkey had a mortality rate of 13.22 per 100,000; since only deaths are reported, it is not possible to compare morbidity rates with those elsewhere in the region.

In South Central and Southeast Asia the highest morbidity and mortality rates per 100,000 were found in the Philippines (519.11 and 11.28), Vietnam (252.9 and 2.83), Ceylon (138.34 and 10.56) and India (54.41 and 2.79).

The most seriously affected areas in Oceania included the United States Trust Territory Islands, with a morbidity rate of 700 per 100,000 (mortality not reported); the British Solomon Islands, with morbidity and mortality rates, respectively, of 480.7 and 6.14 per 100,000; the Ryukyu Islands (396.03 and 26.64, respectively); Papua (348.5 and 16.45, respectively); Fiji, with a morbidity rate of 172.16 (deaths were not reported); and New Guinea (143.86 and 7.17, respectively).

Public health importance

The rates reported for the incidence, prevalence, morbidity and mortality of tuberculosis lead to the conclusion that this disease probably constitutes the most important public health problem among the diseases considered in the survey area.

TYPHOID AND PARATYPHOID FEVERS

Distribution, incidence and prevalence

Typhoid and paratyphoid fevers may be included among the most widespread of infectious diseases in the areas of the survey. During the period under consideration these conditions were recorded in 143 of the 169 countries and territories of the survey.

These diseases have some characteristics in common and are often reported together under the heading "enteric fever." Paratyphoid fevers are milder than typhoid and the mortality of the former is lower; thus there is some reason for separating them in the present treatment when this is possible.

Since the basis for reporting varies widely from country to country, and may change with time within a single country, it is not wise to attempt to compare incidence rates from different countries.

In the Caribbean, Central and South America, 43 of 46 countries reported these conditions (Table 10). In 1958, extremely high rates were reported from some of the islands of the West Indies. In St. Lucia, the rate for typhoid fever rose to 240 per 100,000 during this year. In general the rates for the countries of this area seem relatively high.

In Africa, 54 of 58 countries and territories reported these conditions. In 1958, the lowest rates for enteric fever were recorded in Nigeria (0.2 per 100,000) and Mozambique (1.9 per 100,000). The United Arab Republic (Egypt) recorded a high incidence of 59.2 per 100,000 in 1957. Apart from these extremes, the range was between 8 per 100,000 (Mauritius) and 25 per 100,000 (Tunisia) in 1958.[78]

Only very incomplete data are available from the countries of Southwest Asia. Lowest rates were reported from Cyprus, in 1958, where the rate for typhoid was 7.6 per 100,000 and that for paratyphoid fevers was 0.2 per 100,000. High rates for enteric fever were recorded in Jordan (35.9 per 100,000) and Israel (24.5 per 100,000), and the highest rate was reported from Iraq (50.4 per 100,000).[78]

In South Central and Southwest Asia, the very low rate of 2 per 100,000 was reported from Taiwan in 1958. Reporting from other countries was not frequent and data are quite incomplete. A rate of 24.4 per 100,000 for typhoid cases only was reported from Ceylon in 1958. In the same year, Hong Kong had a rate for enteric fevers of 29.7 per 100,000 and Malaya had a rate of 13.6 per 100,000 for this combination.[78]

In Oceania, the rate for enteric fevers in Fiji was 7.9 per 100,000 in 1958. Of the total population of the survey area, approximately 621,572,000 or 52 per cent, inhabited the areas reporting enteric fevers.

In almost all cases, the incidence of typhoid fever exceeded that of the paratyphoid fevers.[78]

Morbidity and mortality

Tables 7 and 8 indicate that in the list of great diseases typhoid fever ranked 18th among major causes of illness and 11th among major causes of death in 1957, while paratyphoid fevers ranked 30th as a cause of illness and 18th as a cause of death.

In tropical regions fever with intestinal disturbances is not infrequently diagnosed under a general heading of "gastrointestinal disease" or with no reference to etiology. Or gastrointestinal disturbances are ignored in areas where many factors can contribute to dysfunction of the gastrointestinal tract and only the symptom of "fever" is considered. In many parts of the tropics it is common to associate a diagnosis of "malaria" with any type of fever. For these reasons the true morbidity and mortality rates for typhoid and paratyphoid fevers are no doubt greater than those indicated in the available figures.

Typhoid fever

Table 11 summarizes the data obtained for typhoid fever and the paratyphoid fevers. More than three-quarters of the countries and territories of the survey areas comprising 51.6 per cent of the total population reported typhoid fever in 1957. Since the disease is reportable in almost all of the countries dealt with here, an impression of serious under-reporting is substantiated.

In 1957, of 110,613 reported cases of typhoid fever, 41 per cent were from the Caribbean, Central and South America, 29 per cent were from Africa, 14 per cent were from Southwest Asia, 16 per cent were from South Central and Southeast Asia and less than half of one per cent were from Oceania (Figure 1-f).

In the Caribbean, Central and South America reports covered 95.33 per cent of the population. This was the highest figure for any of the survey areas. In Oceania the fewest countries reported typhoid fever but in South Central and Southeast Asia reports are represented by the smallest percentage of population. This figure (25.47), however, represents a considerable distortion, since India contributes the greatest bulk of population to this area but does not report cases of the disease.

The highest morbidity was recorded in the Caribbean, Central and South America, for which the rate was 23.7 per 100,000. South Central and Southeast Asia had the lowest rate (2.6 per 100,000). Caribbean, Central and South America also had the highest mortality rate (3.6 per 100,000), while the lowest rate (0.14 per 100,000) was found in Oceania.

Within the Caribbean, Central and South America, the greatest toll in illness and death from typhoid fever was found in Colombia with morbidity and mortality rates, respectively, of 95.58 and 8.01 per 100,000; Peru with a morbidity rate of 72.18 per 100,000, reported no deaths due to this disease; Chile with a morbidity rate of 71.21 per 100,000 also reported no deaths; and Mexico registered morbidity and mortality rates, respectively, of 18.66 and 11.79 per 100,000.

In Africa the highest morbidity and mortality rates per 100,000, respectively, were found in the following countries: Egypt (59.7 and 2.64); Kenya (26.33 and 2.91); Uganda (23.98 and 1.06); and South Africa (22.07 and 1.15).

In Southwest Asia the highest respective rates were as follows: Jordan (71.18 and 0.54); Iraq (27.36 and

0.87); Iran (26.17 and 0.09); and Turkey (24.68 and 1.38).

In South Central and Southeast Asia highest rates were reported by Ceylon (72.83 and 2.62), Malaya (21.17 and 1.16) and Indonesia (7.88 and 0.87).

In Oceania, Tonga recorded the highest morbidity rate of all the islands, 205.3, accompanied by a mortality rate of 2.62. Similar rates for French Polynesia were 61.33 and 2.67, respectively. Western Samoa reported a morbidity rate of 29 but gave no mortality data.

Paratyphoid fevers

Somewhat more than 50 per cent of the total population of the survey areas inhabited countries which reported paratyphoid fevers. In 1957, morbidity for the entire survey area reached only 0.51 per 100,000 and mortality was 0.11 per 100,000 (Table 11). Thus this group of entities does not have the importance of typhoid fever. It is possible that a substantial number of cases and deaths attributed to it are, indeed, of typhoid origin.

There were 6,109 reported cases of fever caused by the paratyphoid bacilli in 1957 in the survey areas. Of them, 33 per cent were in the Caribbean, Central and South America, 15 per cent were in Africa, 18 per cent were in Southwest Asia, 33 per cent were in South Central and Southeast Asia, and 1 per cent were in Oceania (Figure 1-d).

The disease achieved its highest reported level of morbidity in Southwest Asia, where a rate of 1.36 per 100,000 was found. Mortality was highest in the Caribbean, Central and South American region (0.58 per 100,000 population). South Central and Southeast Asia with a morbidity rate of 0.29 per 100,000 and Oceania, from which no mortality was reported, rank lowest in these respects.

In the Caribbean, Central and South America, evaluation is difficult since Mexico, with a mortality rate of 3.27 per 100,000, reported no morbidity and the Netherlands Antilles, Chile and Argentina, with morbidity rates of 136.76, 4.21 and 0.76 per 100,000, respectively, reported no mortality figures.

In Africa rates for morbidity and mortality were highest in the former Belgian Congo (3.25 and 0.07 per 100,000, respectively), in Ruanda-Urundi (2.3 and 0.17) and in former French West Africa (0.47 and 0.04).

In Southwest Asia, Jordan, Israel, Iraq and Turkey presented the highest morbidity rates, which were 11.9, 7.11, 4.47 and 2.05 per 100,000, respectively. Proportionately more deaths due to paratyphoid were recorded in Israel (0.12 per 100,000) than in any other country in this area. Jordan, Turkey and Iraq follow with mortality rates of 0.07, 0.05 and 0.02 per 100,000, respectively.

Laos with a morbidity rate of 26.34 per 100,000 and a mortality rate of 0.96 per 100,000 had the highest rates in South Central and Southeast Asia. Ceylon followed with a morbidity rate of 4.4 per 100,000 and a mortality rate of 0.06, and Indonesia with morbidity and mortality rates of 1.11 and 0.03, respectively.

In Oceania no country reported deaths due to paratyphoid fevers. The highest rates for morbidity were found in Fiji (5.11 per 100,000), Wallis and Futuna Islands and French Polynesia (both with a rate of 4) and Western Samoa (0.29).

Public health importance

Due to marked differences in reporting typhoid and paratyphoid fevers, it is not possible to estimate the relative public health importance of the combined diseases.

The wide distribution of typhoid fever is not accompanied by markedly high indices of morbidity or mortality in the countries of the survey. In the list of great diseases, it was neither among the ten major causes of death nor among the ten major causes of illness in 1957.

Although also widely distributed in the survey area, paratyphoid fevers present extremely low morbidity and mortality rates and are of even less importance than typhoid fever.

WHOOPING COUGH

Distribution

Whooping cough was reported from 132 of the 169 countries and territories of the survey. Although a spectacular disease of which the public in general is well aware even in the most underdeveloped areas, whooping cough receives little public attention unless it reaches a degree of seriousness that leads the patient or his parents to seek medical assistance. Thus there is undoubtedly an inadequacy in reporting and whooping cough may certainly be assumed to be more widespread than the reports indicate (Table 11).

There were 413,732 cases of whooping cough reported in 1957 in the survey areas, of which 37 per cent were from the Caribbean, Central and South America, 45 per cent were from Africa, 2 per cent were from Southwest Asia, 15 per cent were from South Central and Southeast Asia and 1 per cent were from Oceania (Figure 1-f).

The disease is quite widely distributed in Africa, where 54 of the 58 countries of the region report its presence. In the remaining major survey areas it was reported from almost three-quarters of the countries, excepting only Southwest Asia, where reports were confined to 10 of 18 countries.

With regard to Africa, no reference to the disease was found in the British Cameroons, St. Thomas and Prince Islands, Spanish North Africa and Spanish West Africa. The number of countries for which distribution data were lacking is larger for the other regions, i.e., 12 for the Caribbean, Central and South America; 8 for Southwest Asia; 7 for South Central and Southeast Asia; and 6 for Oceania.

Whooping cough is considered a notifiable disease in only about half of the countries of the survey.

Incidence and prevalence

Surveys of the incidence and prevalence of whooping cough in the survey areas are almost nonexistent, and few conclusions can be drawn from the data available. A relatively accurate picture of the importance of this disease is presented by the morbidity and mortality figures for 1957 (see below).

In three major areas (Caribbean, Central and South America, South Central and Southeast Asia and Oceania) no references to prevalence and incidence of the disease were found.

In Africa an epidemic of whooping cough is reported to have occurred on St. Helena during the winter of 1957.[79] The disease seems to be endemic in Swaziland, where 252 cases (0.1 per cent of the total population) were recorded in 1955.[80] In the Republic of the Congo (former Belgian Congo), whooping cough is endemic with sporadic epidemic outbreaks. An average of 32,000 cases with about 250 deaths was recorded each year during 1958 and 1959.[7]

Doctors in the Arabian Peninsula reportedly see whooping cough as often as they might in the United States.[13] It is common in Kuwait and Bahrain.[14] In Cyprus, 639 cases were reported in 1954, compared with only 11 in 1956 and 82 in 1957, illustrating the tendency of the disease to occur in epidemic waves.[12] In Turkey, there were 5,437 cases and 39 deaths due to whooping cough in 1951 and 7,612 cases and 57 deaths in 1952. The actual incidence is undoubtedly much higher than would be indicated by these figures.[38]

It must be emphasized that the above data, selected on the basis of their availability, in no way represent a distributional trend.

Morbidity and mortality

The data for 1957 show that in the list of great diseases whooping cough ranks as the 10th major cause of death in the survey area and as the 13th major cause of illness. Of the total population of the survey 36.12 per cent lived in countries in which the disease was reported.

Table 11 summarizes the morbidity and mortality due to whooping cough in 1957. The morbidity rate for all countries reporting data was 34.3 per 100,000 and the mortality rate 1.85 per 100,000.

The Caribbean, Central and South America had the highest morbidity rate, followed by Africa. Lesser degrees of morbidity were found for Oceania and South Central and Southeast Asia. The disproportion of mortality rates between the Caribbean, Central and South America and all the other regions deserves attention. The rate for this region was almost ten times that shown for Oceania, which had the next highest rate.

Several countries in the Caribbean, Central and South America reported a substantial number of cases in 1957, the highest morbidity rates per 100,000 being found in Colombia (258.5), Argentina (243.12), Venezuela (131.04), Mexico (88.5) and Brazil (12.82).

In Africa, the Republic of Cameroon (former French Cameroun) had a morbidity rate of 402.49 per 100,000, the highest of the region, followed by the former Belgian Congo (293.26), Ruanda-Urundi (223.35), Sudan (166.97), Kenya (160.06) and former French West Africa (102.1).

The highest rates in Southwest Asia were in Israel (168.5), Jordan (69.32) and Turkey (19.56).

In South Central and Southeast Asia, Laos had a rate of 644.97 per 100,000 population, followed by Cambodia (225.11), Ceylon (137.18), the Philippines (98.04) and Vietnam (18.68).

In Oceania the highest morbidity rate was attained by Tonga (3,522.8 per 100,000), followed by the New Hebrides (492.31), New Caledonia (292.65), Papua (163.03) and Fiji (74.15).

Highest figures for mortality per 100,000 in the five survey regions were as follows:

Caribbean, Central and South America: Colombia (23.15), Mexico (22.3), Venezuela (3.36) and Brazil (0.38);

Africa: Former Belgian Congo (3.08), Kenya (1.95), Ruanda-Urundi (1.55) and Republic of Cameroon (1.05);

Southwest Asia: Turkey (0.45) and Israel (0.26);

South Central and Southeast Asia: Philippines (1.89), Ceylon (0.83) and Cambodia (0.06);

Oceania: Tonga (42.11), New Hebrides (9.61), Papua (2.56) and New Caledonia (1.47).

Public health importance

Lack of information regarding prevalence and incidence of whooping cough hinders to a great extent an evaluation of its public health importance. Nevertheless, morbidity and mortality rates for 1957 show that it should be considered as a disease of major public health significance in tropical countries.

SYPHILIS

Distribution, incidence and prevalence

Information was available regarding the occurrence of syphilis in 125 of the 169 countries and territories of the survey area (Table 10). However, records of specific epidemiological surveys are rare. Syphilis is frequently lumped with other venereal diseases in the official reports of many countries. It is unlikely that syphilis has not been introduced sporadically into every corner of the earth visited by modern man. With regard to indigenous races, however, endemic syphilis frequently is not recognized, being replaced by some non-venereal form of treponematosis which may be variously named.

Because of sociological factors, the number of officially reported cases of clinical disease appears to be low. In 1957, there were only 425,818 cases of syphilis reported in all the areas of the survey. Of these, 15 per cent were from the Caribbean, Central and South America, 74 per cent were from Africa, 1 per cent were from Southwest Asia, 10 per cent were from South Central and Southeast Asia, and less than half of 1 per cent were from Oceania (Figure 1-e). Distinction between sporadic and endemic syphilis is not made.

Syphilis is reported from all the countries of the Western Hemisphere. In 1956, the highest rates per 100,000 were from the Virgin Islands (2,070.3) and the American Virgin Islands (2,037.5). High rates were also recorded from other Caribbean countries; the figure was 934.5 per 100,000 in the Dominican Republic, 532.7 in Jamaica, 438.7 in Antigua and 431.7 in the Panama Canal Zone. Interestingly, the island of Martinique regularly reports a low rate of infection; in 1956 this was 2.4 per 100,000. In South America, rates varied in 1956 from a high in Venezuela of 271.5 per 100,000 to a low in Bolivia of 9.5 per 100,000.[21]

In Africa, endemic syphilis appears primarily as a disease of urban communities. In many rural areas, it is replaced by yaws or non-venereal treponematoses. Indeed, 18 of the 58 countries and territories of Africa were not found to report cases of syphilis. Reports differ with regard to its distribution among the various nomadic and sedentary groups of North Africa. One recent study found that certain sedentary tribesmen in the Moroccan Sahara displayed ten times the amount of endemic syphilis shown by true nomads.[81] Another group of authors found low incidences in tribes inhabiting the Algerian Sahara, with no appreciable differences in incidence between nomads and sedentary persons.[82] In 1957-58 and 1958-59, surveys were carried out in the Republic of the Sudan to discover the prevalence of endemic syphilis; in 1957-58, 141,980 cases were diagnosed, compared with 122,685 in 1958-59.[83]

Ten of the 18 countries of Southwest Asia record the disease. It is common in the urbanized areas of the Arabian Peninsula (including Aden, Muscat, Qatar, Bahrain and Kuwait). In Bahrain, local authorities estimate the infection rate to be as high as 60 to 70 per cent of the population.[14]

Elsewhere in this area, recent figures on incidence appear to be lacking. However, in Turkey, the endemic form of the disease is decreasing in incidence due to that country's highly developed control system. In 1953 there were 76,617 cases of syphilis, which figure was 13,779 less than for 1952. A survey carried out in seven provinces during 1953 and 1954 found that the incidence in heavily populated Istanbul Province was 0.51 per cent. Elsewhere the figures ranged from 0.85 per cent in Ordu Province (population 372,000) to 0.34 per cent in Izmir Province (population 767,000).[38]

Data regarding the occurrence of syphilis were lacking in only 3 of the 24 countries of South Central and Southeast Asia. However, data concerning incidence and prevalence were available in few places. In Taiwan, in 1958, the incidence of positive serological reactions in the total adult population was as high as 4 or 5 per cent.[46] It is quite probable that unidentified foci of the endemic disease occur elsewhere in this area. For instance, in the absence of more recent figures, the estimates for Pakistan made in 1948 must be assumed to be still valid; the rates per 1,000 were 0.29 in East Pakistan, 0.46 in the Northwest Frontier Province, and 0.27 in the Punjab.[73]

In Oceania, specific survey data of recent date are available only from New Caledonia, where a total incidence of 4.4 per cent was recorded in 1956.[84]

Morbidity and mortality

In Tables 7 and 8 it is seen that syphilis was responsible for 425,818 cases of illness. No deaths were reported. Of the diseases considered, syphilis is the 12th major cause of illness in the survey area during 1957.

Africa provided the highest morbidity rate, 135.6 per 100,000, which exceeds the rates from the other regions by a large margin. The next highest rate was found in the Caribbean, Central and South America (33.7 per 100,000) and the lowest rate (5.78 per 100,000) in South Central and Southeast Asia. (Table 12.)

Public health importance

Endemic syphilis is said to have low fatality rates. In 1957 no country in the survey area listed deaths due to this disease. Nevertheless in at least one territory it is reputed to be a principal cause of death.

It would appear that endemic syphilis may be linked with yaws. Indeed, Hudson has called it the "yaws of the subtropics."[85] The role of environmental factors and the mode of transmission (congenital) differentiate it from the sporadic, or venereal, form of the disease.

At the present time the lack of adequate data does not permit an evaluation of the public health importance of syphilis in the areas of the survey. To be valid, such an evaluation would have to take into account the fact that venereal syphilis offers a different sociological problem than does endemic syphilis.

YAWS

Distribution, incidence and prevalence

Yaws is found predominantly within the bounds of the celestial tropics, but the pattern of distribution is not uniform. The disease occurs only in regions which have an annual rainfall of at least 50 inches, in conjunction with a mean annual temperature between 70° and 80° F. (see Plate I). The equatorial belt of Africa is thought to harbor at least half of all the cases in the world. Although it is most extensive in Africa and in South Central and Southeast Asia, case reporting appears to be quite inadequate in the former area. Of the 12,588,252 cases reported in 1957, 96 per cent were from South Central and Southeast Asia, while only 4 per cent were from Africa. In the remaining three major survey areas, the total number of reported cases did not, in 1957, exceed half of 1 per cent of the total for all areas. (Figure 1-f.)

Caribbean, Central and South America. In this region the distribution of yaws is very patchy, with few areas of high endemicity. In Haiti, which has for many years been the focus of an extensive eradication campaign, 82,905 persons were examined in 1958-59, of which 271, or 0.32 per cent, had yaws. There were 46 active cases. Comparable data from an earlier survey of 1954-55, wherein 91,624 persons were examined, found

Table 12. Morbidity and mortality due to spirochaetal diseases of high endemicity as reported in 169 countries and territories in 1957

		GEOGRAPHIC AREAS OF THE SURVEY					
		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
DISEASES	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Syphilis	Relative population[1]	54.19	44.27	44.77	10.47	50.40	26.30
	Morbidity (per hundred thousand)	33.70	135.60	8.53	5.78	6.05	35.40
	Mortality (per hundred thousand)	—	—	—	—	—	—
Yaws	Relative population[1]	5.46	48.23	0.81	73.56	67.67	53.03
	Morbidity (per hundred thousand)	3.53	218.50	0.0012	1,729.00	201.80	1,045.10
	Mortality (per hundred thousand)	—	0.17	—	—	0.028	0.032

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

0.65 per cent of examinees to have yaws and 0.15 per cent to have infectious yaws. In midyear 1957 it was estimated that the total yaws prevalence on Haiti was 0.5 per cent.[86]

In Jamaica, of 71,866 persons examined, 5,070, or 7.1 per cent, had a history of yaws in 1955.[87] In more recent years, a downward trend in incidence almost to the vanishing point is recorded.[88] In Trinidad there was a recorded incidence of 4.5 per cent diagnosed yaws in 1953; a comparable figure of 9.2 per cent was forthcoming from Tobago in 1956.[89]

In Peru, yaws is confined to the jungle areas of the Amazon River basin, especially in the departments of Loreto, San Martin and Madre de Dios. The total number of cases between 1951 and 1955 in Loreto, San Martin and "other departments" was 3,143, 1,312 and 55, respectively.[90]

Pinta (see Plate II) is apparently limited to the Western Hemisphere, being particularly prevalent in Mexico and Colombia. It has been estimated that there are 600,000 infected individuals in each of these countries.[91] In certain heavily endemic districts in Mexico the infection rate is reported to be as high as 20 per cent.[91] Elsewhere in this hemisphere pinta has a patchy distribution regarding which there is little recent information.

Africa. WHO surveys carried out in Africa between 1950 and 1958 revealed that of an examined population exceeding 10 million, more than 100,000 cases of active yaws were discovered, including almost 40,000 infectious cases.[92]

As the basis for a proposed control program in former French West Africa, a survey of 230,733 persons was carried out in 1957, of which 15,290, or 6.6 per cent, were found to be active yaws cases and 204,443, or 88.6 per cent, were latent cases or contacts. A follow-up of this survey early in 1958 found that of 531,545 persons examined, 4.8 per cent were active cases and 76.3 per cent contacts or latent cases. After the treatment campaign, the first resurvey, of 63,188 persons, found 2.6 per cent to be active cases and 77.9 per cent contacts or latent cases.[28]

A WHO assisted program in the Republic of the Sudan in 1959 indicated that about 20 per cent of the population of the endemic regions suffers from endemic syphilis or yaws or both in the active clinical stage. A proposed national control program would have to cover some 5 million people in an area of 1.5 million square kilometers. The most heavily endemic areas include the provinces of Equatoria, Bahr el Ghazal, the Upper Nile and Darfur, the northern part of Kassala Province and the Nuba Mountains in Kordofan Province.[93]

In Ghana, examination of 500,000 or so individuals in the Northern Region, out of a population of approximately 1 million, showed that the yaws incidence was 9.4 per cent, with 1.5 per cent infectious cases, in 1956. By the time of resurvey following a WHO-sponsored treatment campaign, the incidence had fallen to 1.2 per cent, with 0.19 per cent of infectious cases.[31]

In Sierra Leone, the yaws survey conducted in 1958 by WHO found that 6.4 per cent of those examined in the Koinadugu District of Northern Province were infected, including 0.2 per cent of infectious cases. In Bombali, Kambia and Port Loko Districts, the incidence was 6.6 per cent, with 0.8 per cent infectious. In Kailahun District of Southeastern Province, an incidence of 8 per cent, with 0.2 per cent infectious, was found.[28]

McFadzean *et al.* report that the incidence of early yaws lesions in the Gambia seems to be less than 1 per cent.[94]

An estimate of 600,000 cases of yaws has been made for Liberia. Examination of 20,619 persons produced an incidence of 50.8 per cent with signs of yaws, the incidence increasing in proportion to the distance of the village involved from the motor roads. In 1957, WHO carried out an extensive survey in six counties and districts. A total examined population of 769,361 persons produced a yaws incidence of 19.1 per cent, with 1.6 per cent being infectious cases. Following a treatment campaign, the resurvey done in 1958 found no incidence higher than 3.6 per cent in any district, and low rates of less than 1 per cent in several.[28]

The initial WHO survey in Nigeria commenced in 1954. Initial survey teams saw 937,139 persons in the Eastern, Western and Northern Regions and the Cameroons, and treated 53,777 cases of active yaws. By 1958, more than 8 million persons had been seen in the entire Federation of Nigeria, of which almost half had received injections. Incidence rates for infectious cases have fallen sharply and it is foretold that yaws may be eradicated in Nigeria in the near future. As an example, in Nsukka Division of the Eastern Region, the incidence of infectious cases discovered during the initial treatment survey was 5.2 per cent. In four years it had fallen to 0.09 per cent. In Udi Division, an initial figure of 0.39 per cent became 0.008 per cent following the campaign. In the Western Region, Kukuruku Division displayed an incidence initially of 7.2 per cent of infectious cases. The figure became 0.32 per cent according to the second resurvey after treatment.[28]

Yaws is still widespread in the Republic of the Congo. Foci have been reported in Equateur Province, in the tropical areas of Kivu Province and in parts of Leopoldville and Orientale Provinces. From 1951 to 1957, approximately 170,000 cases were reported annually.[7]

In Mozambique the total number of yaws cases coming voluntarily for treatment in 1950 was more than 64,000. Following a control program inaugurated in 1952 and pursued for a year, the number of treated cases dropped to 49,000. No recent general survey for yaws has been carried out in Mozambique, but the incidence of yaws is said to decline with distance from the coast.[95]

Southwest Asia. Yaws is not reported from this area. In its place, bejel, a non-venereal treponematosis, has a limited distribution and is particularly prevalent among the nomadic Bedouin tribes of the Euphrates Valley in the Northeastern province of Deir-ez-Zor, Syria. It is seen mostly in children.[85] (See Plate I.)

South Central and Southeast Asia. Initial surveys carried out by WHO in this area between 1950 and 1958 revealed that of more than 45 million people examined, approximately 10 per cent had active yaws and 1.3 per cent had infectious yaws. Resurveys following campaigns during the same period provided data on 70 million persons; 4.3 per cent had yaws and 0.2 per cent were infectious cases.[92]

In India, yaws occurs in southern India and in portions of Andhra Pradesh, Maharashtra, Madhya Pradesh and Orissa. Incidence varies widely according to area. For example, in Uttar Pradesh, incidence in the Mirzapur District is reported to be 5.1 per cent, but the incidence in different villages of the district ranges from 0.13 to 16.7 per cent.[96]

The disease is known to be endemic in the Chittagong Hill tracts of East Pakistan but has not been reported elsewhere in this country.[73]

In Malaya a control campaign inaugurated in 1954 led to the initial examination of 478,366 persons, among whom 62,115, or 13 per cent, presented cases of yaws.[97]

In Thailand, yaws has traditionally been heavily endemic. In 1950, 11 million Thais were living in yaws prevalence areas and the incidence of clinical cases sometimes reached as much as 25 per cent, corresponding to a serological infection rate in excess of 60 per cent. An antiyaws campaign was carried out in 44 provinces between 1950 and 1959. At the end of 1959, no infectious cases remained in 10 provinces, while in 33 others the percentage of cases with infectious lesions did not exceed 0.09 per cent.[98]

In Indonesia, a survey conducted in 1956 in the southwest coastal area of Borneo revealed that infectious lesions were apparently more prevalent among the Malays than the Dyaks. Of 3,966 Malays, 17.6 per cent had active lesions, whereas 26.6 per cent of 1,959 Dyaks had active lesions. However, infectious yaws were found in 56.8 per cent of Malay cases and in but 11.8 per cent of cases among Dyaks.[99]

Four surveys carried out during a period of two years in the subdistrict of Tjawas, Central Java, disclosed 7,000 cases of yaws among a population of 40,000.[100]

In Netherlands New Guinea, the prevalence of clinically active yaws found on mass treatment surveys, 1955-57, was 5 per cent and the accompanying rate for infectious yaws was 2.9 per cent. About 96.5 per cent of the population in the administered areas were examined.[101]

In summation, it may be mentioned that, in 1960, in the course of antiyaws campaigns undertaken with the help of WHO and UNICEF, 42 million persons were examined in the countries of South Central and Southeast Asia. The regional director of UNICEF was recently able to state that "all Asia is now in the last stages of the eradication of this disease."[102]

Oceania. In the recent past, yaws was widely endemic in many of the Pacific islands. The introduction of prophylactic penicillin in connection with eradication campaigns has produced a significant diminution in numbers of active and infectious yaws cases in many areas. Indeed, in some, the disease has entirely disappeared. Although survey data are largely absent, a few selected examples may serve to suggest the extent of the yaws problem in this area at the present time.

In the British Solomon Islands, a mass campaign to eradicate yaws commenced in 1957, at which time an initial survey of 77,684 persons found 8,488, or 10.9 per cent, to have active yaws, and 2,467, or 3.2 per cent, to have infectious yaws. The relative success of the campaign may be gauged by the data obtained in 1959-60 on the occasion of the first post-campaign resurvey, when 33,989 persons were examined; 0.9 per cent were found to have active yaws and only 0.4 per cent had infectious yaws.[103]

Data are not available for Papua and New Guinea with regard to yaws incidence, although the disease is known to exist. In the New Hebrides, it is considered one of the major causes of morbidity.[76] It is also widespread in the Gilbert and Ellice Islands.[50]

In New Caledonia, there are marked differences in prevalence according to area, but the total incidence of yaws is reported to be 9.1 per cent, active disease being represented by a figure of 5.3 per cent.[84]

Yaws was at one time a problem in the Fiji Islands, but in 1957 virtual eradication of the disease was achieved after a campaign of four years.[49]

In the United States Trust Territory of the Pacific islands, yaws was widespread before 1948. In 1948-53, serological examination of 16,320 individuals was performed in the Saipan, Palau and Marshall Islands Districts. The Kahn test was employed and, in the general absence of malaria coupled with the low incidence of syphilis, leprosy and infectious mononucleosis, the results may be taken to represent the prevalence of yaws. Approximately 50 per cent of Kahn tests were positive, with little difference between the sexes. The rate in Palau District was 65.4 per cent, compared with 38.1 per cent in the Marshall Islands District and 30.4 per cent in the Saipan District. Yet very little active yaws was noticed clinically. Effective treatment, utilizing penicillin, is considered to have brought the disease under control in the Trust Territory.[104]

Morbidity and mortality

Tables 7 and 8 show that in the list of great diseases yaws was the 1st major cause of illness and the 25th cause of death in the survey area during 1957. For the whole estimated population of the area under survey, yaws presented a morbidity rate of 1,045.1 per 100,000 and a mortality rate of 0.032 per 100,000 (Table 12). It must be taken into account that mortality was reported from only two of the five regions of the survey area, Africa and Oceania, and if only the population of these two regions is taken into consideration, the mortality rate is 0.17 per 100,000, a comparatively low rate. It is interesting to note that South Central and Southeast Asia, with the highest rate of morbidity (1,729 per 100,000), was one from which no deaths were reported. Striking differences in morbidity rates were found for the five regions studied. A range of 0.0012 to 1,729 per 100,000 is remarkable.

Yaws is a notifiable disease in 28 of the 169 countries and territories covered in this survey. However, the distribution of the disease in 57 of 169 countries (Table 10) would suggest that wider notification is desirable.

Eradication programs are being carried out in many areas; these are most numerous in South Central and Southeast Asia. It is possible that such programs may be responsible for bringing about striking differences in morbidity, since the programs are always preceded by epidemiological surveys which uncover substantial numbers of new cases.

In the Caribbean, Central and South America, the highest rates of morbidity per 100,000 were found in the Canal Zone (471.7), Jamaica (318.07), Trinidad and Tobago (143.53) and the Leeward Islands (93.08). In Africa the Republic of Cameroon with a morbidity rate of 3,955.08 and Zanzibar with a rate of 2,520.74 had highest rates. The former Belgian Congo ranks next (967.14), followed by Ruanda-Urundi (949.41), former French West Africa (600.44) and Ghana (534.58). In South Central and Southeast Asia, Indonesia, with a rate of 13,808.9, offers the highest figure of the entire survey area, followed by Netherlands New Guinea (3,239.57) and the Philippines (105.8). The highest rates in Oceania were in Papua (397.65), New Guinea (331.88) and Western Samoa (258).

Public health importance

Yaws does not contribute significantly to mortality in the area surveyed. Yet, from the figures for morbidity, it may be considered among the foremost health problems of the entire area. Such a verdict must be qualified by the knowledge that the pathological effects of the infection are not strikingly dangerous except when the tertiary stage is reached, and that penicillin as employed in mass treatment campaigns may be expected to produce eventual eradication of the disease.

INFLUENZA

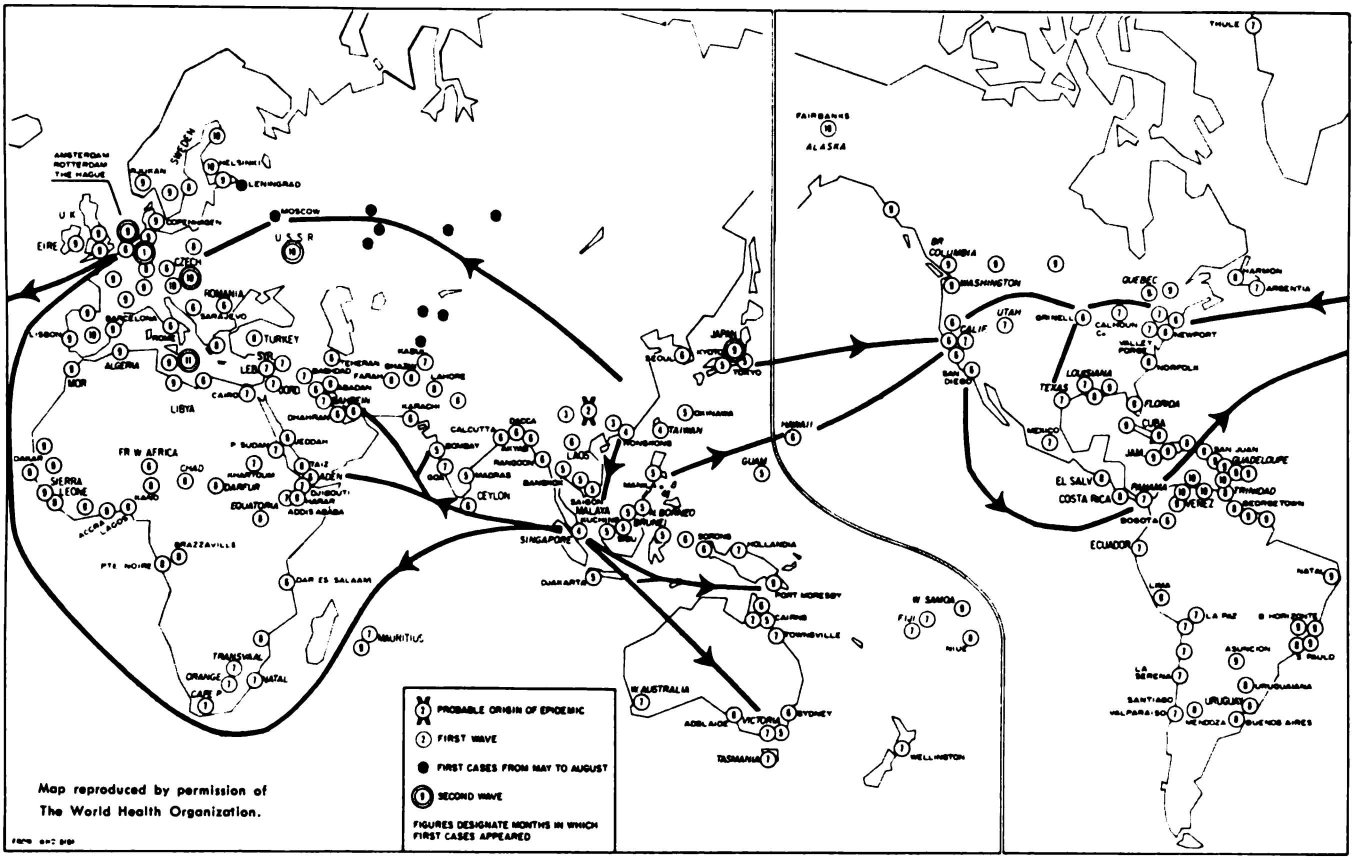
Distribution, incidence and prevalence

Reports on the existence of influenza were available from 140 of the 169 countries and territories in the survey. It was the sixth most widely distributed disease in the entire survey area. Because it is not limited by geographical or environmental barriers, it must be considered potentially endemic in all of the countries of the survey.

The year 1957 was of singular importance with regard to influenza. The pandemic of "Asian flu" swept around the globe in this year, producing the inflated number of 12,566,849 cases reported, many from tropical areas which heretofore had ignored the existence of this disease. Of the total, 29 per cent were from the Caribbean, Central and South America, 18 per cent were from Africa, 3 per cent were from Southwest Asia, 49 per cent were from South Central and Southeast Asia and 1 per cent were from Oceania. This distribution approximates rather closely the true distribution of population in the five major survey areas. (Figure 1-b.) Figure 3 indicates the routes whereby this condition achieved a world-wide distribution in little less than a year. The pandemic began early in 1957 in China. Late in the same spring it appeared in Hong Kong and Singapore, where its arrival was recognized and notice was given to the whole world through the energies of the World Health Organization. The disease spread rapidly to Taiwan, the Philippines and Indonesia, thence throughout most of the Orient. It was reported almost simultaneously in Madras, Bombay and Calcutta and spread through the rest of India within

Figure 3. Progress of Asian Influenza Pandemic

February 1957 to January 1958



six weeks. By June, the westward march through the countries of Southwest Asia was well marked and by the end of this month it had attained the east coast of Africa.

Notified cases were approximate in number, yet instructive with regard to the mildness of the disease. In India, it is estimated that the morbidity varied, according to the region, from 400 to 2,800 per 100,000 inhabitants, the latter figure referring to Bombay. In West Bengal, which contains 7.2 per cent of the population of India, notified cases accounted for only 6.4 per cent of the total morbidity, although the number of deaths represented 40.5 per cent of the total mortality.[105]

In July the pandemic increased in Southwest Asia and Africa and extended itself to the Caribbean, Central and South America; epidemics were reported in Ecuador, Bolivia, Chile, Colombia, Panama and Mexico. In August, epidemics were recorded in the remaining countries of Africa and Central and South America. The disease declined in Southwest Asia in September and a month later the decline was noticeable in Africa and in Central and South America.

Until the advent of the pandemic of 1957, influenza had not been widely considered among the major endemic tropical diseases. It was rarely diagnosed clinically, being frequently masked by other more marked diseases, such as malaria, or unrecognized in the event of more serious pulmonary complications. For instance, in the Republic of Congo (former French Equatorial Africa), the pandemic reached Brazzaville at the beginning of 1958. Although seasonal epidemics of influenza had hitherto escaped attention among the indigenous population, the Asian form was clearly recognized under conditions of expectation.[106] It is quite probable that the pandemic of "Asian flu" performed a service in alerting health authorities in many tropical areas to the significance of influenza as an endemic tropical disease.

Morbidity and mortality

The disease is only notifiable in 78 of 138 countries with notification legislation (Table 9). The figures obtained through increased reporting in 1957 must be considered with care since the number of cases and deaths were much greater than usual because of the pandemic. The extent to which the data of this year can be used to represent the situation during more "normal" times is of course subject to question. For the same reason, Tables 7 and 8, showing that influenza was the second major cause of sickness and the seventh major cause of death of the diseases considered must be viewed with some reserve.

From Table 13 it can be seen that influenza attained a morbidity rate of 1,043 per 100,000 and a mortality rate of 3.1 per 100,000 in the entire survey area. The disease attained its highest morbidity rates in Oceania (2,033) and in the Caribbean, Central and South America (1,877). The rates in Africa and South Central and Southeast Asia were also considerable. Even the rate for Southwest Asia, although the lowest, is remarkably high (484).

The mortality rate per 100,000 in the Caribbean, Central and South America was more than 5 times that for Oceania and 122 times greater than the lowest rate for any survey area (Southwest Asia—0.12 per 100,000). Since the morbidity rate in Oceania was higher than that in the Caribbean, Central and South America, it would seem that in 1957 influenza was more widely distributed in this latter region than in the others.

Of the five regions surveyed, the countries with the

Table 13. Morbidity and mortality due to viral diseases of high endemicity as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY					
		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Influenza	Relative population[1]	87.61	89.96	32.01	14.76	61.42	42.05
	Morbidity (per hundred thousand)	1,877.00	979.00	484.00	897.00	2,033.00	1,043.00
	Mortality (per hundred thousand)	14.70	0.56	0.12	1.13	2.72	3.10
Measles	Relative population[1]	95.93	78.18	84.45	13.48	56.67	43.82
	Morbidity (per hundred thousand)	86.89	108.89	71.50	6.58	841.13	45.80
	Mortality (per hundred thousand)	7.60	2.21	1.04	0.28	0.69	1.86
Mumps	Relative population[1]	61.84	64.86	12.50	6.67	44.74	27.10
	Morbidity (per hundred thousand)	27.00	34.10	28.90	2.12	7.69	14.00
	Mortality (per hundred thousand)	0.033	0.0048	0.0025	0.00086	—	0.0068
Poliomyelitis	Relative population[1]	87.46	95.84	46.66	26.91	50.18	51.14
	Morbidity (per hundred thousand)	2.26	3.23	0.79	0.29	8.79	1.23
	Mortality (per hundred thousand)	0.30	0.19	0.056	0.072	0.28	0.13
Trachoma	Relative population[1]	68.33	60.41	43.46	9.91	49.76	31.23
	Morbidity (per hundred thousand)	1.37	224.00	606.00	10.10	36.50	89.70
	Mortality (per hundred thousand)	0.00053	0.0013	—	—	—	0.00033

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

highest morbidity and mortality rates per 100,000, respectively, were as follows:

Caribbean, Central and South America: Chile (19,-778.5 and no deaths), Venezuela (6,203.97 and 16.92), Puerto Rico (5,084.47 and 8.6), El Salvador (4,425.95 and 45.62) and Colombia (2,473.52 and 28.83);

Africa: Sudan (6,514.69 and 0.96), Spanish Africa (4,499.43 and 1.7), former Belgian Congo (2,509.43 and 1.49), Republic of Cameroon (2,342.13 and 1.16) and Tanganyika (1,067.33 and 1.85);

Southwest Asia: Israel (10,923 and 2.86), Aden Colony (2,353.96 and 2.74), Iraq (1,766.99 and 0.09) and Jordan (1,425.15 and 1.09);

South Central and Southeast Asia: Ceylon (49,728.8 and 10), Portuguese Timor (6,951.67 and 13.81), Malaya (5,976.68 and 1.35), Philippines (5,509.39 and 27.5) and Netherlands New Guinea (2,001.28 and no deaths);

Oceania: Gilbert and Ellice Islands (24,095.12 and no deaths), Guam (22,183.78 and no deaths), Tonga (21,359.6 and 1.69), Western Samoa (5,631 and no deaths) and Fiji (3,463.06 and 1.14).

It is interesting to note the considerable range of these rates and also that it was not in the countries where the highest morbidity rates obtained that the highest mortality rates were present. Geographic proximity seems to have no bearing. For example, Chile, with the highest morbidity rate in the Caribbean, Central and South America, is surrounded by countries with noticeably lower rates (Peru, Bolivia and Argentina). There is no way of evaluating with the means available in this survey the extent to which this may be due to poorer reporting in some countries compared to others.

Public health importance

The exceptional conditions associated with the influenza pandemic in 1957 make it difficult to evaluate the public health importance of the disease on the basis of the available figures. The pandemic reached several regions of the tropical world only in 1958, and no data were available from many countries of the survey area for the year 1957.

The impression to be gained from the literature is that the disease occurred in the tropics in a rather mild form even under epidemic conditions, with an over-all mortality rate lower than the rates for many other endemic tropical diseases, such as bacillary dysentery, tuberculosis, pneumonia, malaria, cholera and smallpox.

Generally, influenza virus is not a highly pathogenic agent and it acts more as a predisposing factor to bacterial complications than as a morbid factor in itself. Variability of virulence in influenza strains is so marked that a total picture for the tropical world is not feasible. Influenza is of greater pathogenic potential among populations with a low immunity, especially those that are also subject to the burden of bacterial, parasitic and nutritional diseases. Such a combination of factors is especially characteristic of many of the underdeveloped countries of the survey.

MEASLES

Distribution, incidence and prevalence

Although not considered to be one of the classical "tropical diseases," measles has a wide distribution as an endemic infection in the countries included in the survey, with no less than 148 of the 169 surveyed countries reporting its presence (Table 10). In 1957, reports were obtainable from all countries of the Caribbean, Central and South America, with the exception of French Guiana, Grenada, St. Vincent and Surinam. In Africa, information was lacking from five countries, in Southwest Asia from eight countries and in South Central and Southeast Asia from only three. All of the countries and territories of Oceania recorded its presence, with the exception of the Bonin Islands.

There were 551,663 cases of measles reported in the survey areas in 1957. Of these, 30 per cent were from the Caribbean, Central and South America, 46 per cent from Africa, 10 per cent from Southwest Asia, 8 per cent from South Central and Southeast Asia and 6 per cent from Oceania. (Figure 1-c.)

In the Caribbean, Central and South America, the number of cases of measles varies from year to year, with epidemics at two- and three-year intervals. Case rates are relatively high, but recent survey information is lacking.[21]

In Africa, dangerous outbreaks of measles have been known to occur. In 1961, an epidemic in Keneba, Gambia, was responsible for the deaths of approximately 18 per cent of children under five years of age. At the same time, mortality in children aged 5 to 10 years was less than 2 per cent.[107] A recent epidemic of a severe nature involving some 2,600 cases was reported from the Seychelles Islands in October 1955.[11]

In general, however, measles in Africa remains endemic with rare epidemics occurring and data on prevalence of cases are infrequent.

Measles is endemic and common in the Arabian Peninsula.[14] It seems to be of a mild type with a seasonal occurrence in Cyprus.[12] It is not reported to be common in Syria.[17] In Turkey, however, it is often severe, frequently being accompanied by pneumonia and associated with high mortality.[38]

In Hong Kong, the incidence of measles has shown a tendency to decrease in recent years. The reasons for this are not clear.[108]

Elsewhere in the survey areas, data on incidence and prevalence are lacking and the only source of information is contained in records of morbidity and mortality as conveyed in official reports.

Morbidity and mortality

Measles is the 10th major cause of morbidity (Table 7) and the 9th major cause of mortality (Table 8) of those diseases considered in the survey area during 1957, with 551,663 cases and 22,425 deaths reported. The fatality rate of the disease is high, 4.06 per cent. However, in most instances only the serious cases report for treatment to the medical authorities and often when the patient is more or less beyond help. This increases the reported fatality rates, which refer for the most part only to inpatients.

Measles is a notifiable disease in 98 of the 138 countries and territories surveyed with notification regulations. At least 43.8 per cent of the total population of the survey area lived in areas where the disease was reported. (Table 13.)

In 1957 measles presented a relatively high morbidity rate for the entire survey area of 45.8 per 100,000 with a mortality rate of 1.86 per 100,000. Morbidity rates per 100,000 were highest in Oceania (841.13) and in Africa (108.89), the lowest rate having been found in South Central and Southeast Asia (6.58). The mortality rate per 100,000 was high in the Caribbean, Central and South America (7.6) and low in Oceania (0.69) and South Central and Southeast Asia (0.28).

The following countries and territories of the five regions of the survey area presented high morbidity and mortality rates per 100,000:

Caribbean, Central and South America: Argentina (334.47 with no reported deaths), Colombia (250.97 and 10.46), Chile (176.77 and no deaths), Peru (96.13 and 6) and Mexico (only deaths reported: 28.75);

Africa: Republic of Cameroon (467.91 and 0.44), Ruanda-Urundi (417.43 and 0.89), former Belgian Congo (354.67 and 1.77), former French West Africa (315.15 and 4.9), Morocco (195.3 and no deaths), Sudan (193.19 and 0.03) and Egypt (71.02 and 15.15);

Southwest Asia: Israel (505.25 and 0.83), Iraq (196.65 and 0.63), Turkey (71.91 and 1.75) and Iran (57.23 and 0.19);

South Central and Southeast Asia: Ceylon (284.19 and 0.79), Philippines (53.5 and 3.58), Vietnam (10.41 and 0.01) and Hong Kong (only deaths reported: 35.46);

Oceania: Gilbert and Ellice Islands (20,453.65 and no deaths), Nauru (15,075 and no deaths), Tonga (11,966 and 1.75), Fiji (2,007.39 and no deaths) and Western Samoa (1,216 and no deaths).

Extremely high morbidity rates were found for several countries in the Oceania region where the disease exists in a mild form. At least two countries with high rates of mortality, Mexico and Hong Kong, failed to report cases, thus apparently reducing the morbidity rates of these areas.

Public health importance

The role of measles as an agent of morbidity and mortality, in association with its demonstrated wide distribution, suggests that this disease occupies an important position among those selected for attention in this survey. It is primarily associated with children in whom respiratory complications of an acute nature occur often enough to cause concern. The imminence of the availability of a protective vaccine against measles will undoubtedly attract the attention of tropical health authorities toward this disease, and it may be anticipated that an improvement in the supply of data pertaining to incidence and prevalence will be noted from the survey areas in the future.

MUMPS

Distribution, incidence and prevalence

Mumps is considered a notifiable disease in 62 of the 138 countries and territories of the survey area in which specific diseases are reportable. The disease was indicated as being present in 108 of the 169 countries in the survey. No doubt it is more widely distributed than would be indicated by the following data.

In 1957, 168,786 cases of mumps were reported from the survey areas. Of these, 30 per cent were in the Caribbean, Central and South America, 47 per cent in Africa, 14 per cent in Southwest Asia, 9 per cent in South Central and Southeast Asia and less than half of 1 per cent in Oceania (Figure 1-c).

Mumps has its widest distribution in Oceania, where 18 of the 23 countries reported its presence, and was least often reported in Southwest Asia, where only 6 of the 18 countries acknowledged its existence. No reference to specific epidemiological surveys was found and information on detailed distribution is thus not available.

Likewise, information of value with regard to incidence and prevalence in the survey area is not available. Hence, the only available data in this regard are from official reports.

Morbidity and mortality

A summary of information concerning morbidity and mortality from mumps during 1957 is presented in Tables 7, 8 and 13. Of the diseases included in the survey, the tables show that mumps was the 17th cause of sickness and the 28th cause of death.

More than half of the countries surveyed reported the presence of mumps. No doubt many cases failed to be reported. Of the total survey area population, only 27.1 per cent lived in regions in which the disease was reported in 1957.

Africa had the highest morbidity rate (34.1 per 100,000) and South Central and Southeast Asia the lowest rate (2.12 per 100,000). Caribbean, Central and South America had the highest mortality rate (0.033 per 100,000). No deaths were reported from Oceania. The over-all morbidity rate for the survey area of 14 per 100,000 places mumps among the major causes of disease but its almost non-existent mortality rate diminishes its comparative importance.

In several countries morbidity rates were of considerable significance. The following countries reported the highest rates per 100,000 for the various regions:

Caribbean, Central and South America: Argentina (102.2), Colombia (67.01), Peru (33.82) and Mexico (24.3). None of these countries reported deaths. The highest death rate was found in Guatemala (1.25 per 100,000) but this country did not report cases.

Africa: None of the countries with high morbidity rates reported deaths. The highest morbidity rates were found in Republic of Cameroon (294.09), Sudan (193.21), former French Equatorial Africa (123.87) and former Belgian Congo (79.86). Egypt had the highest mortality rate per 100,000 (0.02) in this area.

Southwest Asia: Bahrain presented the highest morbidity rate of all the countries in the survey area (1,095.97) but reported no deaths. Other countries in the region with high rates were Israel (412.01) and Iraq (68.77). Iraq had a mortality rate of 0.01, the highest in this region.

South Central and Southeast Asia: The highest morbidity rates in this region were found in Laos (282.9), Ceylon (79), Malaya (34.3) and Vietnam (5.4). Of these countries only Ceylon reported deaths and had a mortality rate of 0.06.

Oceania: No countries reported deaths from this area. The highest morbidity rates were found on Guam (164.86) and the U. S. Trust Territory Islands (28.17).

Public health importance

Except in certain localized areas, the data would indicate that mumps is not a disease of prime importance in the survey areas.

POLIOMYELITIS

Distribution, incidence and prevalence

Poliomyelitis has a very wide distribution in the tropics, being present in 142 of the 169 countries and territories considered here (Table 10). It is the fourth most widely distributed disease of all those included as "great" diseases of the tropics. In Africa, 54 of 58 countries reported its presence. The least representation is in Southwest Asia, where only 10 of 18 countries acknowledged it. Characteristically, only the paralytic form comes to the attention of medical authorities in the tropics.

Since poliovirus produces clinical disease in but a small proportion of those infected, the distribution of acute paralytic cases is quite different from the distribution of poliovirus throughout the world.

Acute poliomyelitis was reported only 14,807 times in 1957 throughout the entire survey area. Of this number, 29 per cent were from the Caribbean, Central and South America, 51 per cent from Africa, 4 per cent from Southwest Asia, 14 per cent from South Central and Southeast Asia and 2 per cent from Oceania (Figure 1-d).

Morbidity fluctuates strongly, especially in the better developed areas, although the distribution of virus can be assumed to remain rather constant in a population. It is particularly difficult to gain an impression of world distribution of the clinical disease since epidemics in most afflicted areas occur with varying degrees of severity year after year, and the most heavily affected region of one year will often not appear to be so in the following year. However, there is some evidence that paralytic cases in adults occur less frequently in the tropics than in the northern countries.[109]

In the Caribbean, Central and South America, rates for clinical poliomyelitis during the four-year period 1955-1958 have been published by the Pan American Health Organization and are reproduced in Table 14. It must be stressed that these figures are based on data reported to health authorities and undoubtedly represent only a fraction of actual cases. Although the total number of poliomyelitis cases reported annually in all the Americas (including North America) from 1955 to 1958 has decreased by more than two-thirds, from 35,761

Table 14. Cases of poliomyelitis per 100,000 population in the Americas, 1955-1958

COUNTRY OR TERRITORY	1955	1956	1957	1958
Argentina[1]	2.3	33.3	3.8	4.0
Bahama Islands	—	—	1.7	...
Barbados	—	—	0.4	—
Bermuda	—	—	2.4	—
Bolivia	0.0	0.6	0.4	0.1
Brazil[2]	4.1	7.4	4.8	...
British Guiana[1]	0.4	0.8	18.2	—
British Honduras	1.3	—	—	...
Canal Zone	10.3	42.9	—	...
Chile	6.4	10.9	5.0	...
Colombia[3]	1.4	0.9	1.4	1.7
Costa Rica	4.7	17.2	4.9	5.4
Cuba	4.4	0.9	1.5	1.6
Dominican Republic	—	0.6	0.0	...
Ecuador	1.1	0.8	1.1	0.9
El Salvador[1, 3]	0.4	2.4	2.9	...
French Guiana	—	30.7	—	—
Guadeloupe	5.5	1.6	—	...
Guatemala	2.6	4.4	3.1	...
Haiti	—	—	1.3	...
Honduras	...	...	...	1.2
Jamaica	4.6	0.9	25.0	...
Leeward Islands				
Antigua	—	...	...	...
Montserrat	...	...	...	...
St. Kitts, Nevis, Anguilla	—	1.8	—	—
Virgin Islands	—	—	...	—
Martinique	0.8	—	—	—
Mexico[1]	6.1	2.0	5.0	2.8
Netherlands Antilles	7.7	13.0	—	...
Nicaragua[1]	9.1	3.7	5.1	18.4
Panama	1.6	16.3	0.5	0.5
Paraguay	5.2	7.2	2.1	...
Peru[3]	4.9	6.9	6.5	9.8
Puerto Rico	19.2	2.4	1.9	...
Surinam	—	...	—	—
Trinidad and Tobago	2.2	1.2	35.0	...
Uruguay	21.1	2.7	1.8	...
Venezuela[3]	11.7	9.3	7.6	5.7
Virgin Islands (USA)	4.2	—	—	—
Windward Islands				
Dominica	—	...	...	...
Grenada	—	...	33.0	—
St. Lucia	1.1	9.0	4.4	—
St. Vincent	—	...	...	...

[1] Paralytic poliomyelitis
[2] Federal District and State capitals (excluding Niterol, 1955)
[3] Data from reporting areas
Symbols: — No cases ... Data not available

to 11,123, yet the percentage of these which are reported from the Caribbean, Central and South America is constantly rising. In 1955, less than 20 per cent of the total for the Americas was ascribed to this area. In 1958, the corresponding figure was over 40 per cent.[110]

In Africa, the poliomyelitis rates per 100,000 are relatively low in most of the countries. Poliomyelitis is sporadic and endemic in the Republic of the Congo (Leopoldville), with occasional epidemics occurring during the rainy season, which corresponds to the summer in the southern hemisphere. In 1954-1955, an epidemic was noted in Elisabethville, and in 1956 and 1958 in Bukavu. Antibodies against all three types of poliovirus have been recovered in children over 6 years of age.[7]

An epidemic of type 1 poliomyelitis was recorded in Kenya in 1957. With the exception of one local outbreak in Embu district, the epidemic was confined to urban areas. The total number of cases was 552, with 28 deaths. The incidence was estimated to be 80 per 100,000 among Europeans, 14 per 100,000 among Asians and 6.5 per 100,000 among Africans.[111]

In the Republic of Sudan, an epidemic of poliomyelitis occurred in Khartoum in 1959, affecting children aged 4 months to 7 years (mostly between 1½ to 3 years). The most common type recovered was type 1, although other types, as well as Coxsackie and other enteric viruses were also involved.[112]

In Algeria, during the four-year period 1956-59, poliomyelitis accounted for 11.2 per cent of all infectious diseases among children under 12 years of age admitted to the infectious diseases hospital, but only 0.6 per cent of the infectious diseases among adolescents and adults. There were 686 cases, of which 603 were in children under 5 years of age and of these two-thirds were between 6 months and 2 years.[113]

A small number of African children in Northern Rhodesia were surveyed in 1960, including 88 from the urban area of Lusaka and 106 from the rural Mankoya district of Barotseland. In each area one-half or more of the children had been infected with poliovirus by the age of 4 years and almost all by the age of 5-9 years. All three types of virus antibodies were prominent.[114]

In Southwest Asia, poliomyelitis appears to be of little concern in many areas. It is uncommonly reported in Lebanon and Syria and causes little morbidity in Cyprus. However, there are notable exceptions. In Israel, between 1949 and 1957 the polio rate was 2.3 per 10,000 or more. The disease was in the form of infantile paralysis, 85-90 per cent of patients being under 5 years, and 80 per cent under 3 years. Before 1955 it appears that type 1 was the most prevalent of the three types. With the advent of Salk vaccination, changes appear to have been made in the annual pattern but it is at present difficult to discern or assess new trends.[115]

In Turkey, the infant attack rate is high in some of the more inaccessible regions of the eastern part of the country. The disease occurs sporadically elsewhere. In 1960, a report was made of 500 sera which were collected from children living on the Mediterranean coast and the Black Sea coast of Turkey. Antibodies to all three types of poliovirus were present in about 40 per cent of children aged 1-2 years and in 80-100 per cent of children aged 3-9.[116]

Figures are largely absent from the Arabian Peninsula, but poliomyelitis is suspected of contributing importantly to infant mortality in the Aden Protectorate.[2]

Only occasional survey data are available from the countries of South Central and Southeast Asia in recent years. In Indonesia, a survey for poliomyelitis antibodies was carried out in 76 adults, 1,023 school children and 202 pre-school children in Bandung. Type 3 antibody proved to be present in 50 per cent of children aged 1 year, a level attained only at 3 years of age in the case of types 1 and 2. By the age of 6 years, 74 per cent of children had acquired antibody to all three types. After the age of 6, the percentage of persons with antibody to each of the three poliovirus types remained fairly constant.[117]

In Taiwan, a study of adult populations in Taipei, Taoyuan, Taichung and Nantou Counties revealed that 75-90 per cent of adults carried antibodies against poliovirus. On Taiwan, 95 per cent of cases of poliomyelitis occur before the age of 4 years. In 1958, the incidence in the entire island was reported to be 7.7 per 100,000.[46]

The evidence to date would suggest that the underdeveloped countries, well represented by the areas of the survey, are places in which contact with poliovirus of all types is made at an early age, whereas in the economically better developed countries such contact may be postponed. The results of a number of surveys were presented in the Second Report of the Expert Committee on Poliomyelitis of the World Health Organization in 1958.[118] This was done on the basis of the ages at which 50 per cent and approximately 10 per cent of the populations studied showed no detectable antibodies to poliovirus (all three types). Five groups were created as follows:

	Ages at which the stated percentages of the population showed no antibodies to poliovirus	
Group	*50 per cent*	*10 per cent*
I	0-2 years	0-10 years
II	3-5	11-20
III	6-9	21-30
IV	10-15	31-50
V	over 15	over 50

Surveys in various localities falling into the different groups are listed below. Socio-economic groups (upper or lower) are indicated where known.

Group I: Brazil (Rio de Janeiro, lower), Chile (type 2 only), Cuba (Havana, type 2 only), Uruguay (Canelones), Venezuela (Caracas), Belgian Congo, Egypt (Cairo, type 2 only), Eritrea, Liberia, Madagascar, Mauritius, Morocco (Casablanca), Nigeria (Kadandani), Sudan, Aden (type 2 only), Israel, India (Bombay), Turkey, French Oceania (Raiatea and Tahiti).

Group II: Uruguay (Montevideo), Ryukyu Islands (Okinawa).

Group III: Brazil (Rio de Janeiro, upper), Hong Kong, Singapore.

Groups IV and V: Not represented in the survey areas.

Although the above listing is a very small sampling of the total area encompassed in the present survey, it must be apparent that the conditions of Group I are definitive of the situation in the majority of countries sampled.

The available data reinforce the concept that, in the areas included in the survey, poliomyelitis takes the form of infantile paralysis. Exceptions to this generalization are provided wherever the socio-economic level acts to protect children from the conditions under which virus is transmitted. Thus it is seen that in Rio de Janeiro, half of the lower socio-economic group presents antibodies to poliovirus between the ages 0 and 2 years, whereas in an upper socio-economic group, this level of saturation is not attained until the ages of 6 to 9.

Morbidity and mortality

According to the number of cases and deaths reported in 1957, poliomyelitis is the 23rd cause of morbidity and the 17th cause of mortality among the great diseases considered in the survey area (Tables 7 and 8). There were 14,807 cases and 1,560 deaths. It must be kept in mind that in all probability these figures refer to paralytic poliomyelitis. The true number of cases, and perhaps of deaths, due to this disease are not known.

Although 115 of the 169 countries and territories of the survey area classify poliomyelitis as a notifiable disease, cases and deaths were reported in 1957 from only a few more than half. Table 13 summarizes the data. With a general morbidity rate of 1.23 per 100,000, poliomyelitis does not occupy a prominent position as a cause of illness in the tropics. The mortality rate of 0.13 per 100,000 tends to support this conclusion.

The highest morbidity rate per 100,000 was in Oceania (8.79) and the lowest rate in South Central and

Southeast Asia (0.29). The Caribbean, Central and South America presented the highest mortality rate per 100,000 of the survey area (0.3) and Southwest Asia the lowest (0.056).

In general, morbidity and mortality rates were not found to be high in the survey area, although significant rates were presented by some countries.

Highest morbidity and mortality rates per 100,000 in the Caribbean, Central and South America were found in Venezuela (7.73 and 0.72, respectively), Mexico (4.97 and 0.71), Chile (4.68 and nil) and Brazil (1.18 and 0.11).

In Africa the highest morbidity and mortality rates were found in the following countries: South Africa (17.24 and 1.29), Federation of Rhodesia and Nyasaland (14.24 and 0.78), Kenya (12.48 and 0.64) and Uganda (10.85 and 0.21).

Rates in Southwest Asia were low. Iraq had a morbidity rate of 4.6 followed by Israel (3.48) and Turkey (0.78). Mortality rates for these countries were 0.49, 0.31 and 0.03, respectively.

Low rates also characterized the countries of South Central and Southeast Asia. Highest morbidity and mortality rates in this area were found in Ceylon (12.06 and 3.04), Taiwan (3.37 and 1.37), Philippines (1.49 and 0.25) and Malaya (1.53 and 0.13).

Highest morbidity rates for any country or territory were found in Oceania, where the Ryukyu Islands presented a morbidity rate of 24.29 and Papua a morbidity rate of 21.37. Nevertheless, mortality rates for these areas were not high, being 0.25 and 0.85, respectively.

Public health importance

Reported cases of poliomyelitis have reference, generally, only to the paralytic form of the disease. Medical facilities in the most underdeveloped areas do not lend themselves to the diagnosis of inapparent infection, or, indeed, to the accurate identification of milder forms of the disease. It is assumed that the true number of cases must exceed by a wide margin the reported number of cases and deaths. However, environmental conditions in much of the area included in the survey are such as to potentiate transmission of virus at a very early age, with concomitant establishment of widespread immunity in the population. The impression gained from the available literature is that poliomyelitis is not to be included foremost among the major health problems afflicting the tropics as a whole.

TRACHOMA

Distribution, incidence and prevalence

Of the countries and territories in the survey, 90 acknowledged the presence of trachoma (Table 10) but the disease is notifiable in only 58 of these. There were 1,080,354 cases reported in 1957 in the survey areas. Of these, less than half of 1 per cent were in the Caribbean, Central and South America, 48 per cent were in Africa, 45 per cent in Southwest Asia, 7 per cent in South Central and Southeast Asia and less than half of 1 per cent were in Oceania (Figure 1-e). The distribution of trachoma is shown in Figure 4.

In the Caribbean, Central and South America, considerable attention has been paid to this problem, particularly in Brazil, where there are three foci of high concentration. In the northeastern states, Ceará is the most heavily affected, with rates ranging from 21 to 65 per cent in the various districts. In the state of Piauí, 10 to 30 per cent are infected. Neighboring states of Maranhão, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe are heavily involved. This area of involvement also extends as far as Amazonas, Pará, Minas Gerais, Espiritu Santo and Rio de Janeiro. A second focus is reported in the northwestern part of São Paulo and northern Paraná. A third involves the agricultural areas of Rio Grande do Sul. Estimates of the total number of cases in Brazil vary from 250,000 to 1,000,000.

The disease has spread to Paraguay, Uruguay and Bolivia from Brazil but specific figures for prevalence are lacking. In Argentina, an infection rate of 20 per cent in certain northern provinces has been reported, including Tucuman, Santiago del Estero, Salta, Jujuy, Chaco, Misiones, Formosa and Corrientes. Small numbers of cases are reported annually from Peru, Ecuador and Colombia. The coastal regions of Venezuela and the Guianas suffer from higher rates.

In Africa, trachoma is almost universally distributed in the Sudan.[119] It is especially widespread and relatively severe in all the countries of the North African coast. It is common in Ethiopia, is not a problem in Central or West Africa, except for certain foci in Cameroon and Senegal and the Gambia, but is prevalent in South Africa. Figures on prevalence are not available.

In Southwest Asia, no country can be considered free of the disease. It is widespread in Saudi Arabia, Muscat, Kuwait, Qatar and Aden, in all of which it constitutes a major health problem. According to Petrie, 90 per cent of the native population of the Yemen suffers from trachoma.[37] A WHO survey carried out in Jordan showed that 72 per cent of 19,495 persons examined in various provinces were infected, the incidence varying from 94 per cent in Karak Province to 53 per cent in Amman Province. These figures are supported by other

Figure 4. Distribution of Trachoma (Based on Incomplete Data)

Sources: World Population and Production by Woytinsky & Woytinsky
WHO Publications
Public Health Service Records

Map reproduced by permission of the Committee on Government Operations, United States Senate, and its Subcommittee on Reorganization and International Organizations.

estimates of local observers that in the more affected areas of Jordan from 40 to 70 per cent of the population suffers from some form of the disease.[15]

In Lebanon, the disease is most frequent in areas where water is scarce. It has been estimated that the rate of prevalence varies from 15 to 71 per cent depending upon locality.

Trachoma is an important health problem in Turkey, where a survey conducted in 1955 revealed 14.6 per cent of persons examined to be infected. The disease is strongly endemic in the towns of Gaziantep, Urfa, Mardin, Siirt, Diyarbakir and Malatya. In a 1952 report, the number of cases was estimated to be 250,000 in the entire country, with as high as 90 per cent of the population suffering clinical manifestations in certain localized areas.[38]

The disease is widespread in Syria and Iraq, especially in dry rural areas where dust storms are frequent.[17] In Afghanistan, infection rates are highest in the rural areas, trachoma constituting 85 per cent of all cases involving ocular pathology.[120]

With regard to South Central and Southeast Asia, India and Pakistan are badly afflicted, with infection rates almost reaching totality in certain areas of West Pakistan (Baluchistan) and the Punjab. Distribution is less widespread in the moister and more tropical regions of Bengal (East Pakistan) and Southern India.[120] A WHO survey of 15,157 persons in 29 villages in the Aligarh District of Uttar Pradesh showed that 88.5 per cent had clinical signs of trachoma and 21.6 per cent were suffering from active forms of the disease.[121] In Burma, approximately 20 per cent of polyclinical eye cases seen in Rangoon suffer from trachoma. The disease is not serious in Ceylon or Nepal.[120]

Trachoma is widespread in Thailand, especially in the regions bordering on former French Indo-China, but figures for prevalence are rare. A study made in 1954 of 381 inhabitants of a rice farming community northeast of Bangkok showed that 3 per cent had trachoma. However, 11 of these 13 cases were among 237 children 7 to 14 years of age, i.e., an incidence for this group of 4.6 per cent.[122]

Trachoma prevails in Vietnam, especially along coastal areas, where up to 80 per cent of the population are afflicted. The infection decreases toward the interior. It exists in a severe form in Cambodia and in recent years has been carried into Laos by immigrants.[120]

In Taiwan, the disease is common and widespread. A survey among 2,235,895 primary school children carried out from September 1954 to June 1958 showed an average incidence of 50.1 per cent. The infection rate among new school entrants in 1956 was 60.6 per cent and in 1957 new students displayed an infection rate of 55.9 per cent. Rates are similarly high in the families of these children. Examination of 37,561 persons in this category elicited an incidence of 69.1 per cent. In certain fishing and salt mining villages of Taiwan the incidence of infection approaches 100 per cent.[46]

In Oceania, trachoma is found in weak endemic foci in New Guinea, Papua, the Bismarck Archipelago and the Solomon Islands. An incidence of 10 per cent has been estimated for Fiji and for Western Samoa. However, American Samoa is reported infected only to the extent of 2-3 per cent.[120] The disease is found on Tonga. No mention has been made of trachoma as an important infection in other regions of Oceania.

Morbidity and mortality

In 1957 trachoma provided figures for a high overall morbidity rate, 89.7 per 100,000, in the entire survey area. The mortality rate was extremely low, 0.0003 per 100,000, and in three of the five major regions of the survey, no deaths ascribable to trachoma were reported (see Table 13). The disease is listed as notifiable in 58 countries, but reports of occurrence were obtained from little more than one-third of all countries surveyed.

Highest morbidity rates per 100,000 were reached in Southwest Asia (606) and Africa (224) and the lowest rate in the Caribbean, Central and South America (1.37). The two areas reporting deaths due to this disease were the Caribbean, Central and South America and Africa with mortality rates of 0.00053 and 0.0013 per 100,000, respectively.

In the Caribbean, Central and South America all countries presented relatively low morbidity rates. The highest figures for morbidity were found in Argentina, Paraguay and Venezuela (12.74, 0.67 and 0.36, respectively). Only Guatemala in this region reported deaths with a mortality rate of 0.03.

In Africa morbidity rates were higher. Morocco presented a morbidity rate of 1,922.79 and Sudan, Ethiopia and former French West Africa had morbidity rates of 1,767.06, 484.11 and 103.41, respectively.

Only two areas reported deaths, Sudan and former French West Africa, with mortality rates of 0.02 and 0.005 per 100,000, respectively.

In Southwest Asia several countries achieved very high morbidity rates but none reported deaths due to trachoma. Jordan had a morbidity rate of 8,760.36 and Iraq, 1,707.01.

No deaths were reported from South Central and Southeast Asia, the highest morbidity rates being found in Laos (1,450.28), Cambodia (566.73) and Vietnam (96.06).

In Oceania no deaths were reported. The highest morbidity rates were found in Tonga, Fiji and the Ryukyu Islands; these rates were 268.42, 97.65 and 96.59, respectively.

Public health importance

Of the diseases considered, trachoma occupies sixth position in the list of major causes of illness in the survey area (Table 7). A valid estimate of its importance is handicapped by the lack of specific data regarding the extent to which it is responsible for blindness. From the standpoint of the entire area surveyed, trachoma cannot be considered a major cause of illness. However, it constitutes a public health problem of considerable magnitude in many localized areas and continues to be of actual and potential concern as one of the principal causes of blindness in many regions of the survey.

ANCYLOSTOMIASIS

Distribution, incidence and prevalence

Ancylostomiasis is found throughout the warm regions of the world. Figure 5 represents its distribution throughout the areas included in this survey. The imperfect parasitic nature of the worm places it at the disposition of the external environment during its initial larval stages, thus making small localized differences in microclimate or social behavior extremely important in determining its spread. It is favored by warm, moist situations with attendant shade.

In 1957, of the 656,707 reported cases of ancylostomiasis in the entire survey area, 5 per cent were from the Caribbean, Central and South America, 71 per cent from Africa, 4 per cent from Southwest Asia, 19 per cent from South Central and Southeast Asia and 1 per cent from Oceania (Figure 1-a).

Hookworm infection is considered to be a notifiable condition in only 28 of the countries included in the survey. Patients are, characteristically, often unaware that they harbor the parasite. The fact of infection is

Figure 5. Distribution of Ancylostomiasis

Sources: Adapted from American Geographical Society Atlas of Distribution of Diseases
Map reproduced by permission of the Committee on Government Operations, United States Senate, and its Subcommittee on Reorganization and International Organizations.

often discovered as a consequence of examinations performed in connection with other complaints or during epidemiological surveys. Thus, the number of patients receiving medical attention with a specific complaint of ancylostomiasis undoubtedly constitutes a distinct minority of actual cases.

Some epidemiological surveys have shown the parasite to be present in areas in which it had gone unreported by medical authorities.

May[57] has summarized much of the available information of recent years which pertains to hookworm distribution throughout the world. The report which follows will not attempt to recreate this very useful summary, but will be more concerned with reports of the prevalence of hookworm disease.

The distinction between hookworm infection and hookworm disease is seldom made in epidemiological surveys. Quantitative work is required to ascertain the degree of individual involvement which is directly related to disease. Yet the results of most surveys are reported in qualitative terms alone.

In the absence of more reliable data, the experiences of certain heavily infested areas of the tropics in which the problem of hookworm disease has been adequately studied can doubtless be generously extrapolated. Anemia is the main result of heavy infection (3,000 to 10,000 eggs per gram of feces). In pediatric practice, the corollary is often physical and mental retardation. In pregnancy, the debilitation may result in stillbirth and post-parturitional crises. Hookworm has been considered among the most important of retarding influences on community development. It produces apathy toward work. Nagaty has estimated that the reduction in labor efficiency in parts of Syria may be as high as 50 per cent.[123] In view of these facts it is of interest and some concern that ancylostomiasis is generally accorded a position of low importance on the list of great diseases of the tropics.

Caribbean, Central and South America. In Mexico, comparisons of data for the three-year period 1924-1926 and that of 1953-1955 show a death rate from hookworm disease of 0.94 per 100,000 in the first triennium and in the second 0.12 per 100,000. Hernadez Vallados concluded that hookworm disease is not an important cause of death in Mexico. The parasite is distributed mainly along the Gulf Coast and in the more inland parts of Veracruz, Oaxaca, Chiapas and Tabasco.[124]

In Puerto Rico, a survey of six areas representing three different physiographic regions revealed the persistence of hookworm infection in as many as one-third of the individuals examined. The survey was pursued during the triennium 1953-1955 and produced the following data:

	Per cent positive for hookworms in:		
Locality	*1953*	*1954*	*1955*
Comerío	40.5	35.3	26.6
Barranquitas	35.3	40.0	31.2
Utuado	44.0	40.6	36.4
Jayuya	29.2	36.9	29.0
Guayama	21.1	26.4	9.3
Ceiba	18.5	24.0	15.6
Average	31.8	32.4	25.3

These figures are still disconcertingly high in view of the specific control measures which have been introduced and practiced for thirty years. In general, however, infections are light. Moreover, even heavily infected individuals may present no symptoms of hookworm disease due to their improved nutritional status. Maldonado and Oliver-Gonzalez are of the opinion that the hookworm problem in Puerto Rico may presently be evolving into a "dooryard problem" rather than the serious occupational hazard of former years.[125]

In Brazil, Pessôa gives figures on the incidence of hookworm infection in 11 of the northeastern states, the damp areas of which are particularly well adapted for transmission. Figures from 36 separate surveys including a total of 187,913 examinees revealed 90,527, or 48.2 per cent, positive for hookworm ova. The incidence in small children, although based on much smaller samples, was smaller than the over-all figure, but children are reported by several sources to be more heavily infected than adults. Unfortunately, no data are presented with regard to the prevalence of hookworm disease in this heavily endemic area.[126]

In Paraguay, a study was made of 980 cases of hookworm infection out of 14,476 patients seen between 1945 and 1957. Of these, 844 had light involvement with little impairment of health and 136, or 13.9 per cent, suffered from overt hookworm disease with varying degrees of severity and complications. It is reported that the disease affects up to 90 per cent of persons inhabiting rural areas and accounts for a very high incapacity for work. *Necator* predominates in the eastern part of the country and *Ancylostoma* in the Chaco country in the west.[127]

Africa. Hookworms are widely distributed throughout the warm and wet parts of Africa. Infection is particularly heavy among populations of primitive living standards such as constitute such a large proportion of the total population on this continent. Yet here, with certain notable exceptions, hookworm disease is not regarded generally as a major problem. The worm is distributed through all of West and Central Africa south of the Sahara. It extends along the coastal areas of Morocco, Algeria and Tunis. It is not reported from Libya, but in Egypt it is found throughout the delta region and extends the length of the Nile. In East Africa, it is reported along coastal areas from the hook of Somalia to Mozambique, Northern Rhodesia and the extreme northeast corner of South Africa. It is reported from Eritrea. Its distribution in more inland areas tends to follow the wetter localities provided by major rivers. In the Indian Ocean, it is found on Madagascar, Reunion, Mauritius and Seychelles.

Ancylostomiasis constitutes a grave problem in the former Belgian Congo and Ruanda-Urundi, particularly in large and densely populated towns. It has been stated that nearly 500,000 cases were, until recently, recorded annually in a total population of approximately 12 million. It is not possible, however, to secure reliable statistics concerning its importance as a disease. Improved diagnostic facilities in Africa have recently caused an increase in the number of cases reported, but it is certain that these figures do not correspond with an increase in clinical morbidity. Yet Van Oye has stated his conviction that, in the absence of better data, it would be justifiable to place ancylostomiasis foremost among the health hazards of the Congo on the basis of incidence alone.[128] In official reports, however, ancylostomiasis continues to be regarded as a mild complaint. Only about 300 cases involving Europeans were reported annually between 1952 and 1957.[7]

The condition is endemic along the Mediterranean littoral and is an occupational hazard of miners in Morocco and Algeria. In Tunisia, an important focus of ancylostomiasis was discovered at the extreme northern end of Cape Bon, 89 out of 155 persons examined (57 per cent) being found to harbor *A. duodenale*. All the carriers were anemic and showed pronounced emaciation.[129]

Ancylostomiasis extends the length of the Nile, but a survey of 1,408 specimens taken in various localities of the United Arab Republic (Egypt) showed considerable local variation in hookworm incidence in this country. In one seacoast fishing village (El Burg), 10 per cent of persons examined were positive. In the urban areas of Alexandria and Suez, the incidence was, respectively, 12 and 11 per cent. Surprisingly, the same workers were unable to find hookworms in a comparable population in Cairo. The farming communities of Abu Rauwash, Faiyum, Shirbin, Sindbis and Tanash produced incidence rates of 70, 21, 11, 12 and 38 per cent, respectively. The borderline desert communities of Wadi Nassim and Wadi Natroun had rates of 16 and 14 per cent. Finally, a survey of the desert-bordering city of El Arish revealed an infection rate of only 2 per cent, the same figure that was obtained from a group of Bedouins encountered in south Sinai Province. Kuntz *et al.* are of the opinion that hookworm disease is less of a problem in Egypt than is generally assumed. They point out that the prevalence of disease has declined from 23.4 per cent in 1935 to 13.3 per cent in 1957.[130]

In 1956, the official statistics for French West Africa showed that of 8,105,055 patients presenting a diarrheic syndrome, only 64,140, or 0.79 per cent, were positive for ancylostomes. Sénécal noted that intestinal parasites are quite common in African children. He examined 1,690 children, between 1954 and 1958, with a complaint of diarrhea, anemia, eosinophilia or nutritional difficulties, and found hookworms infecting only 242, or 14.3 per cent. He concluded that a variety of infectious organisms are responsible for the occurrence of diarrhea in African children and that the data did not permit singling out any one causative agent for prime responsibility.[10]

Since the eradication of malaria in the Seychelles Islands, ancylostomiasis has become foremost among infectious diseases of importance there. The mean infection rate in Mahe was recently reported to be 26 per cent. In the more rural western side of the island, it was 41 per cent. In Praslin it was 30 per cent and in La Digue, 30-50 per cent. The predominant species in these islands is *Necator americanus.*[131]

Southwest Asia. Reports from the areas of Southwest Asia stress that ancylostomiasis is almost entirely a condition of rural areas, although generally absent from drier and more climatically rigorous parts.

The parasite is rare in the Yemen.[37] It is not considered autochthonous in Saudi Arabia.[13] In Israel, a few foci of very low intensity are found, the parasites being common among immigrants from Iran and India.[132] Data on incidence are lacking from Jordan and Lebanon.

In Turkey, ancylostomiasis is prevalent along the Black Sea littoral in the Riza area near Trabzon and in some areas the incidence has been reported to approach 50 per cent.[38] A taxonomic survey established that *Necator americanus* is much more prevalent than *A. duodenale* in this area: of 1,869 worms, 95.8 per cent were the former and only 4.2 per cent the latter.[133] Although figures on the prevalence of hookworm disease or disability are not available, the seriousness of this problem is indicated by the extent of government preoccupation with it. Control programs, including dissemination of educational propaganda, have been in effect since 1945.

In Iraq, ancylostomiasis is common and one of every four Iraqis is said to have it. The number of reported cases of disease was 23,727 in 1954, 24,035 in 1955 and 24,866 in 1956.[134] The climatic conditions of the areas around Basra and some of the rural areas near Baghdad are particularly favorable to spread.[135] In the northern part of the country, incidence is from 10 to 20 per cent, rising to nearly 40 per cent in the irrigated farm areas of the south. Although hookworm is a serious problem in Iraq, the percentage of those infected who demonstrate clinical signs and symptoms is apparently low.[136]

In Syria, ancylostomiasis is considered to be the most important helminthic infection after schistosomiasis.[137] In one study, the highest rates for the disease were found in Deir Ez Zor Governorate, where the average rate for the whole territory was 47 per cent. In many schools, however, 85-100 per cent of children were suffering from hookworm disease. The following results emerged from this study:[123]

Governorate	*Per cent positive for hookworm*
Deir Ez Zor	47.5
Damascus	0
Hasaka	3.0
Aleppo	2.0
Hama	43.0
Homs	0
Latakia	0
Deraa	0
Sueda	0

South Central and Southeast Asia. In Indonesia, hookworm is probably the most frequent helminthic infection to be encountered. In one study, a survey of 664 autopsies performed in Djakarta between 1952 and 1955 elicited an incidence of 85.5 per cent and an average worm load of 60.8 per person. All age groups were involved, but the peak (90 per cent) occurred in the age group 16 to 25 years.[138]

The inadequacy of specific survey data does not warrant singling out many countries of this region for comment. An exception is provided by Taiwan. Here, hookworm is heavily endemic and there is some evidence that it occurs with greater seriousness in the native Taiwanese than in the Chinese. It is particularly rife in the coal mines, where Hsü *et al.* reported incidences ranging from 65 to 98 per cent.[139] Shambaugh reported that the incidence was as high as 83 per cent in coal miners, whereas infestation in farmers varied from 10.8 to 67.3 per cent.[46]

A study of Chinese troops and of young Taiwanese males revealed that 72.1 per cent of the former and 93.5 per cent of the latter supported hookworm infections. Despite the high incidence, intensities of infection were relatively low. In the absence of blood studies it was considered that the probability of overt disease in both groups was minimal. However, 22.7 per cent of the Taiwanese and only 2.3 per cent of the Chinese were demonstrated to have egg counts per gram of feces as high as those usually associated with disease.[140]

Oceania. The picture of ancylostomiasis in Oceania is of a generally distributed condition with frequent high incidences in the populations but with such low individual involvement that the condition evokes little interest on the part of medical authorities. Surveys for the presence of infection are more numerous than surveys for the presence of hookworm disease.

In Western Samoa, the group incidence for hookworm has been reported to be 15.7 per cent. In the absence of quantitative work, the general impression gained was that the infections were of low degree. This impression was supported by the absence of clinical anemia and other physical signs of hookworm disease. Incidence was at its peak in the age group 10-19 years.[141]

Hookworm disease is not a problem in the Cook Islands although the parasites persist. Most infections are of low degree. In 1959, a survey revealed incidence rates of 12.3 per cent in males and 5.9 per cent in females on Rarotonga and 11.6 per cent in males and 7.4 per cent in females on Aitutaki.[142]

In Tahiti, a survey of 560 individuals produced a figure for hookworm incidence of 38 per cent. The egg counts were low, usually under 2,000 per gram, and little overt hookworm disease was encountered.

Morbidity and mortality

Ancylostomiasis is a notifiable disease in only 28 of the countries and territories of the survey area (Table 9). The morbidity rate (54.5 per 100,000) for the entire area was relatively high (Table 15). It is to be noted that 48.98 per cent of the total estimated population of the survey area inhabited countries in which the disease was reported. The over-all mortality rate was low (0.044 per 100,000).

Morbidity was highest in Africa (202.15 per 100,000) and lowest in the Caribbean, Central and South America (16.8 per 100,000). The rate for Southwest Asia (29.9 per 100,000) assumes special importance when it is considered that only one country in this region reported the disease and that only 8.12 per cent of the total population of the region lived in areas reporting the infection.

Mortality rates may be considered of minor significance even in Oceania, which had the highest rate (0.33 per 100,000).

In the Caribbean, Central and South America the highest morbidity rates per 100,000 occurred in the Canal Zone (2,830.18), Panama (408.54), Trinidad (129.41) and Mexico (76.12). Deaths due to hookworm disease were reported in this area only from Jamaica with a mortality rate of 0.06.

In Africa the countries with the highest morbidity rates per 100,000 were the former Belgian Congo (2,515.07), the Republic of Cameroon (formerly French Cameroun) (764.78), former French West Africa (336.78), Uganda (232.31) and Sudan (94.37). The countries with the highest mortality rates per 100,000 were the former Belgian Congo (1.38), French West Africa (0.08) and Sudan (0.16).

In Southwest Asia only Iraq reported cases and deaths due to ancylostomiasis, the morbidity and mortality rates being 367.62 and 0.05 per 100,000, respectively.

In South Central and Southeast Asia the highest morbidity rates per 100,000 were obtained for North Borneo (665.27), Ceylon (186.14) and Vietnam (99.01). Mortality rates per 100,000 were highest in Ceylon (0.24) and India (0.005).

In Oceania highest morbidity rates per 100,000 were associated with the British Solomon Islands (914.91), Ryukyu Islands (240.89) and Fiji (141.19). Deaths were reported only from the Ryukyu Islands, where the mortality rate was 1.49.

Public health importance

Although having a relatively high rate of morbidity, ancylostomiasis customarily presents a very low mortality.

Table 15. Morbidity and mortality due to parasitic diseases of high endemicity as reported in 169 countries and territories in 1957

DISEASES		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Ancylostomiasis	Relative population[1]	23.03	47.08	8.12	61.39	50.29	48.98
	Morbidity (per hundred thousand)	16.80	202.15	29.90	18.40	97.40	54.50
	Mortality (per hundred thousand)	0.00053	0.12	0.0037	0.034	0.33	0.044
Filariasis	Relative population[1]	0.97	46.20	0.82	62.52	87.95	46.75
	Morbidity (per hundred thousand)	0.64	26.60	0.0025	28.80	33.50	21.99
	Mortality (per hundred thousand)	—	0.0022	—	0.0046	0.44	0.0044
Malaria	Relative population[1]	94.15	75.91	62.80	83.21	52.68	82.08
	Morbidity (per hundred thousand)	84.10	1,236.00	145.00	141.00	571.00	345.00
	Mortality (per hundred thousand)	16.50	2.60	0.28	39.10	5.66	25.80
Schistosomiasis	Relative population[1]	1.19	46.58	8.93	63.10	—	46.32
	Morbidity (per hundred thousand)	0.78	64.10	75.96	0.71	—	21.60
	Mortality (per hundred thousand)	—	0.068	0.0037	0.057	—	0.044
Amoebic dysentery	Relative population[1]	39.43	64.29	81.81	14.98	76.21	31.92
	Morbidity (per hundred thousand)	58.70	83.30	29.80	8.49	18.40	32.30
	Mortality (per hundred thousand)	3.38	0.39	0.041	0.095	0.67	0.67

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

However, many authors have commented upon the role evidently played by the parasite in exaggerating the effects of nutritional deficiencies and anemias of other etiology.

Mass treatment to rid populations of their worm parasites was once an accepted routine in many countries of the survey; the procedure has been abandoned for the most part because of lack of efficacy and disagreeable side effects of anthelminthics and the fact that chemotherapeutic control is but a temporary expedient.

In some areas ancylostomiasis constitutes an important public health problem second only, among helminthic diseases, to schistosomiasis. However, in most areas its prevalence and incidence must still be evaluated. The total picture for the entire survey area is that ancylostomiasis is a disease of secondary importance when compared with most of the others in the list of those considered (see Appendix 18), although its influence on health and productivity in specified localities can be severely detrimental.

FILARIASIS

Distribution

Data on the distribution of filariasis were available from 57 of the 169 countries and territories of the survey. The disease is characterized by the uneven nature of this distribution (Figure 6). Of the 264,872 cases of filariasis reported in 1957, 1 per cent were in the Caribbean, Central and South America, 23 per cent in Africa, less than half of 1 per cent in Southwest Asia, 75 per cent in South Central and Southeast Asia and 1 per cent in Oceania (Figure 1-b).

In the Caribbean, Central and South American region, Bancroftian filariasis occurs among most of the islands of the Greater and Lesser Antilles, including Haiti, Dominican Republic, Puerto Rico, St. Croix, St. Kitts-Nevis-Anguilla, Antigua, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, Barbados and Trinidad. The disease is no doubt on the decline in many of these islands through the influence of many factors.

In Central America, *W. bancrofti* has been reported from Costa Rica and Nicaragua.

In South America, endemic areas of *W. bancrofti* occur in Colombia, Venezuela, British Guiana, Surinam, French Guiana and Brazil. The main foci are along the coast. Autochthonous infections with the parasite have been found in Brazil in Manáus in the state of Amazonas, Vigía, Bragança, Cametá and Belem in Pará, Recife in Pernambuco, São Luiz in Maranhão, Maceió in Alagoas, Salvador in Bahia, Florianopólis, Barra and Ponta Grossa in Santa Catarina and Pôrto Alegre in Rio Grande do Sul. The focus in Belem (Pará) is said to be the most extensive one. A few unimportant foci have been found in other areas.

Bancroftian filariasis is widespread in Africa in the region between the Sahara Desert to the north and the Zambesi River to the south and is also found in Egypt. It occurs in hot damp areas near the coast, along the great rivers and around the great lakes.[143]

Figure 6. Distribution of Filariasis (Wuchereria bancrofti and Brugia malayi)

Source: Adapted from Atlas of Distribution of Diseases—Plate 4, American Geographical Society, 1952.

Map reproduced by permission of the Committee on Government Operations, United States Senate, and its subcommittee on Reorganization and International Organizations.

In West Africa, the disease has been reported from Santiago Island in the Cape Verde group, Gambia, Sierra Leone, Ghana, Liberia, Portuguese Guinea, São Tomé and Principe, Angola, Nigeria, Fernando Po, Senegal, Guinea, Niger, Upper Volta, Ivory Coast, Dahomey and Togoland. In Central Africa, filariasis is found in the Central African Republic, the former Belgian Congo, Ruanda-Urundi and the Republic of Cameroon. Distribution in East Africa includes Sudan, Uganda, Kenya, Tanganyika, Zanzibar, Northern Rhodesia, Southern Rhodesia, Nyasaland, Mozambique and Malagasy Republic. The disease is also found in the Comoro Islands, Reunion and Mauritius.

In Southwest Asia, filariasis is known to be widely spread in Yemen[37] and Felsani reported that the disease is more frequent in Haggiah than elsewhere in the country. *Culex pipiens molestus*, a good vector of the parasite, is common in Israel. A large number of Indian immigrants proved to be infected on arrival, but no autochthonous cases have been reported.[144] *W. bancrofti* in Saudi Arabia is mainly recorded from the western and southern regions.[13]. Autochthonous filariasis is found in the Alanya District, but a case found in Ankara raises the suspicion that other sites may be infected.[145] In fact, a recent report indicates that the disease is present in the village of Eläzig in the upper Euphrates Valley in eastern Turkey between 38° and 40° north latitude.[146]

Filariasis is widely distributed in South Central and Southeast Asia. The disease is common in East Pakistan except for the Chittagong Hill Tracts, but only a few scattered cases have been reported from West Pakistan. Both *W. bancrofti* and *Brugia malayi* are responsible for filariasis in that country.[73]

In India, the disease is present in Andhra Pradesh, Assam, Bihar, Gujarat, Madhya Pradesh, Madras, Maharashtra, Mysore, Orissa, Kerala, Uttar Pradesh, West Bengal and the Laccadive, Andaman and Nicobar Islands. Both *W. bancrofti* and *B. malayi* are present in India; the latter occurs mainly in Assam and Kerala. According to Ramakrishnan *et al.*[147] more than 40 million people live in the filariasis areas and are exposed to the risk of the disease.

Filariasis is found in Ceylon and the Maldive Islands. *W. bancrofti* is the responsible parasite in the latter area but both species occur in Ceylon. The disease is present in Burma, although information concerning its distribution and the species involved is meager. *B. malayi* is said to be present.

B. malayi is responsible for filariasis in Thailand, where the disease is apparently confined to some ten provinces in the southern part of the country. In Cambodia, Tonkinese laborers have been found infected but a survey of Cambodian adults revealed no infections. Infection is present in South Vietnam but little information is available concerning its distribution.

Filariasis has a patchy distribution in Malaya; it is of little clinical concern in some areas but of considerable importance in other regions. *B. malayi* is found in Kedah, Penang, Perak, Kelantan, Trengganu, Pahang and Johore. Endemic foci of *W. bancrofti* occur in Penang, Trengganu, Pahang, Selangor and Singapore.

Infection is spread through many parts of Indonesia. Both species are present in the country, although distribution of each is varied. For the most part they are both present in many of the islands. *B. malayi* is mainly responsible for the disease in Sumatra, although a few foci of *W. bancrofti* exist. Filariasis is not present in all islands of the group but it does occur in the following additional major ones: Boeroe, Flores, Soemba, Timor, Celebes, Ceram, Borneo and Java. The disease is not of great importance on the latter island.

Filariasis is endemic in Portuguese Timor, Sarawak, Brunei and North Borneo. It is widespread in parts of West New Guinea. Infection is distributed throughout many of the Philippine Islands and is found in Hong Kong and China (Taiwan).

Both periodic and non-periodic filariasis caused by *W. bancrofti* are found in Oceania. Non-periodic filariasis is endemic in Fiji, the Ellice Islands and all of the Polynesian islands to the east. Distribution is largely rural and urban areas are usually free. Microfilarial rates, in the absence of control, are 20 per cent or more. Manifestations of filarial disease are common, the elephantiasis rates ranging from 1 to 5 per cent. In the Wallis Islands and the Marquesas, the incidence of elephantiasis is very high; on the other hand, in the Tokelau group, Tuamotu Archipelago and Austral Islands, microfilarial infection is present but elephantiasis is rare.[148]

Nocturnal periodic *W. bancrofti* transmitted by *Culex quinquefasciatus* occurs in the Micronesian area in the Marianas, Carolines, Marshalls, Gilberts, Ocean Island and Nauru. The microfilarial rates are usually low. However, in the more populated islands such as Palau, Truk, and Woleai groups (Carolines), Saipan (Marianas), Tarawa (Gilberts) and Nauru, the rates are relatively high, being 13 per cent or more. Incidence of elephantiasis is low except in Nauru with a rate of 1.4 per cent.[148]

Nocturnal periodic *W. bancrofti* transmitted mainly by *Anopheles farauti* is endemic in the Melanesian Islands of New Guinea, the Bismarck Archipelago, Solomon Islands and the New Hebrides. Filariasis is mainly encountered in the coastal areas; the microfilarial rates vary from 15 to 30 per cent. Manifestations of filarial disease are by no means uncommon and range from 1 to 4 per cent.[148]

Incidence and prevalence

Filariasis is so extensively distributed throughout most of the tropical world that space is not available here to present detailed information concerning incidence and prevalence in the various countries in which the disease exists. Only a limited number of data can be given. It must be kept in mind, however, that both incidence and prevalence of the disease may vary widely in different parts of the same country. For this reason, the material cited here cannot necessarily be taken as representative or typical of the disease pattern for the country or area as a whole. Hawking[143] and Jordan[149] have summarized information for Africa, Ramakrishnan *et al.*[147] for India, Lie Kian Joe and Rees[150] for Indonesia, Wilson[151] for Malaya and Iyengar[148, 152] for the South Pacific. In addition, the World Health Organization has published data on the number of cases and deaths from various types of filariasis for the period 1945-1959, as well as the results of surveys on the incidence and prevalence of the disease.[153] Because the morbidity and mortality statistics were based on notifications or on numbers of cases diagnosed at medical centers, they do not reflect the true magnitude of the filariasis problem.

Caribbean, Central and South America. Rachou[154] reported on the geographical distribution of filariasis in Brazil, based on 259 hemoscopic and 34 entomological surveys in the various states and territories between 1951 and 1955. A total of 269,317 persons were examined and 107,211 mosquitoes dissected. Infection which was found in the following states and territories is stated in terms of the number of individuals examined and the per cent positive: Amazonas (32,393: 0.1), Acre (2,003: 0.3), Amapá (5,754: 0.9), Rondônia (2,003: 0.3), Pará (56,124: 2.5), Paraíba (10,503: 0.03), Pernambuco (23,065: 6.9), Alagoas (6,052: 0.3), Bahia (28,160: 0.7), Santa Catarina (54,723: 0.6) and Rio Grande do Sul (31,590: 0.1). Endemic areas with the highest microfilarial rate included Clevelândia, Amapá (2.9); Belem (9.8), Vigía (5.2) and Cametá (4.5), Pará; Recife, Pernambuco (6.9); Castro Alves, Bahia (5.9); and Ponta Grossa, Santa Catarina (10.9 to 14.5).

In French Guiana, the microfilaria rate seems to be on the decrease. From 27.7 per cent in 1917, it came down to 18.6 per cent in 1934 and 14.3 per cent in 1947. New cases of elephantiasis have been very rare since the latter date.[155]

In surveys conducted between 1949 and 1951, 50,861, or 63.7 per cent, of the inhabitants of the capital city of Surinam were examined and 8,857, or 17.4 per cent, had microfilariae of *W. bancrofti*. There were 2,683, or 5.3 per cent, with elephantiasis.[156] However, in the hinterland the rate is much less. In examinations in the back country,[157] Fros found microfilariae of *W. bancrofti* in only 1 of 881 Lowland Amerindians, 1 of 7 Hindustani, 3 of 823 Bush Negroes and 5 of 208 Creoles. *Mansonella ozzardi* and *Dipetalonema perstans* were of more frequent occurrence among the Lowland Amerindians, the latter species predominating.

Filariasis has constituted an important health problem in the coastal areas of British Guiana. However, improved sanitation and a control campaign have resulted in a marked reduction in microfilarial rates and in clinical cases. The rates in Georgetown City and suburbs in 1955 and 1956 were only about half of those registered in 1947. The incidence of microfilaremia in children under 10 years of age declined from 12.3 per cent to 5.2 per cent in this period.[158]

In Venezuela, Briceño Rossi[159] stated that indigenous cases of filariasis had been recognized in Caracas in the Federal District, Carenero (Miranda) and Puerto Cabello and vicinity (Carabobo). Information indicated that potential endemic foci existed at Humocaro Alto-Anzoátegui (Lara), Cumarebo (Falcón) and Sabana de Mendoza (Trujillo). In Puerto Cabello, 649 individuals were examined and 39, or 6 per cent, were positive for microfilariae of *W. bancrofti*. Nine, or 1.39 per cent, showed clinical signs of filariasis.

Lieske[160] in Costa Rica examined the occupants of 125 houses in one city block in the Jamaicatown quarter of Port Limon. Of 137 persons, 21 were positive. Five of these showed insignificant tumefaction of the inguinal lymph nodes; one patient had a slight edema of the foot. No cases of elephantiasis were seen.

Germán Olivier[161] found 4.8 per cent of 896 patients in a hospital in Santo Domingo City, Dominican Republic, positive for microfilaria of *W. bancrofti*.

In Puerto Rico, there has been a marked decline in incidence and prevalence of filariasis over the past twenty-five years. Clinical filariasis has largely disappeared and the disease is no longer a public health problem.

In Martinique, the microfilarial rate continues to be between 7 and 10 per cent. Involvement of the lower extremities is frequent and about 2 to 5 per cent of the hospital cases have elephantiasis. Acute lymphangitis seems to be on the decline probably because of home treatment with sulphonamides.[155]

The microfilarial rate in Guadeloupe also seems to be stationary. The average rate is about 15 per cent. Approximately 8 per cent of the total attendance in dispensaries is for lymphangitis or elephantiasis of various degrees.[155]

Africa. Endemic foci are frequent along the west coast. In Liberia, Young[162] reported nighttime examinations of 811 individuals in 7 localities with 6 per cent positive for microfilariae of *W. bancrofti.* The highest infection rate was found at Robertsport, in which 23.9 per cent of 155 persons were positive. Burch and Greenville[163] conducted both day and night examinations; in those conducted at night, the highest microfilarial rates were found in coastal localities, the maximum rate being in Marshall Territory, where 33, or 16.4 per cent, of 201 individuals were positive.

In the Republic of Cameroon, Languillon[164] conducted surveys involving 13,772 individuals, of whom 18 per cent were positive for *W. bancrofti.* This parasite was found only in the north between the 9th and 13th parallels and in a small focus in the fishing region of Douala. Other species of filariids encountered were *Dipetalonema perstans* 78 per cent, *Loa loa* 24 per cent and *Dipetalonema streptocerca* 8.7 per cent.

Browne[165] surveyed villages on the banks of the Congo in Orientale Province in the Congo Republic and found microfilariae of *W. bancrofti* in 63 per cent of adult males, 67 per cent of adult females, 4 per cent in children under 16 and 9 per cent in young people between 16 and 20. Elephantiasis was not of frequent occurrence but hydrocele was an important involvement. *D. perstans* was diagnosed in 65 per cent of the individuals.

In Angola, the Sleeping Sickness Control Services examined a total of 423,234 blood smears for microfilariae.[166] The percentage of positives in various districts varied from 0.81 in Malanga to 18.2 in Cabinda. No species diagnosis of the microfilariae was made. Cases of elephantiasis, lymph scrotum, hydrocele and lymphatic hypertrophy are not uncommon.[166]

In a survey of an area south of Koronga township in Nyasaland, an infection rate of 16 per cent was encountered in 200 persons. In the Songwe area 25 per cent were found infected; chronic manifestations were seen in many cases.[167]

In the Mozambique, the microfilarial rate in five districts in the north varied from 5 per cent to 19.3 per cent in day blood and in three districts from 15.8 to 47.4 per cent in night blood.[166]

Examination of 18,384 blood samples from 60 of 83 districts in the Malagasy Republic between 1955 and 1957 disclosed microfilarial rates ranging from 0 to 36.64 per cent. Microfilariae of both *W. bancrofti* and *W. bancrofti* var. *vauceli* were found.[168]

Brygoo and Escolivet[169] conducted surveys in persons over 15 years of age on Mayotte and Mohéli Islands of the Comoro Archipelago. On Mayotte, 26.7 per cent of 736 females and 48 per cent of 706 males were positive. Elephantiasis of the lower limbs was observed in 0.8 per cent of 6,636 individuals; in addition, 61 cases of elephantiasis of the scrotum and 4 cases of elephantiasis of the breast were seen. On Mohéli, 38 per cent of 936 females and 48.7 per cent of 1,060 males were positive. Elephantiasis of the lower limbs was observed in 1.7 per cent of 5,736 persons; 60 cases of elephantiasis of the scrotum were seen also.

In investigations on the island of Pate, Kenya, microfilariae of *W. bancrofti* were found in 32 per cent of 332 persons. Of 142 males, 12 had elephantiasis of the legs and 3 similar involvement of the scrotum. Twenty-two cases of hydrocele were present. There was elephantiasis of the arm in one male. Elephantiasis was also seen in 9 of 190 females.[170]

In Tanganyika, there are three major foci of infection: an extensive area along the coast extending up the river valleys and covering a large portion of the Southern Province; an area at the southern end of Lake Victoria; and an isolated heavily infected focus at the northern end of Lake Nyasa. Jordan[149] surveyed over 20,000 persons in 5 different village groups in Tanganyika. Among 12,300 males, the microfilarial rate was 18.8 per cent and among 6,724 females, it was 12.3 per cent. Clinical studies were carried out on 5 groups of adult males with the following results:

Group	*Number of adult males examined*	*Microfilarial rate in per cent*	*Mean microfilarial density*	*Genital filariasis rate*
I	853	2.9	3.5	2.5
II	1,011	9.3	7.2	5.1
III	1,287	20.9	10.9	13.1
IV	1,463	36.0	18.8	18.3
V	497	52.9	28.5	31.1

It was concluded from the above data that the mean microfilarial density and the genital filariasis rate are directly proportional to the mean microfilaremia rate.

Contrasted to Tanganyika, filariasis is no problem in the Sudan. A few cases have been discovered in the south near Li Rangu and there is probably an endemic area in the Nuba Mountains near Kadugli.[171]

Southwest Asia. Apart from data on Turkey, no information on prevalence and incidence of filariasis was found for this region.

In Turkey, cases of *W. bancrofti* infection have been identified from the vicinity of Alanya (a port on the Mediterranean Sea), where an infection rate of approximately 10 per cent was reported in 1959. An autochthonous case from the vicinity of Cubuk (Ankara) led Sipahioğlu[145] to believe that infection exists elsewhere in the country. Thirteen cases were recently reported from Eläzig.[146]

South Central and Southeast Asia. Filariasis is an important public health problem in many parts of this region. Ramakrishnan *et al.*[147] have provided data on the filaria incidences in the areas surveyed under the National Filaria Control Programme in India. The information is summarized below in the form of the lowest and highest infection and disease rates in the various districts of the states in which the campaign has been pursued.

State	*Infection rates* *Lowest*	*Highest*	*Disease rates* *Lowest*	*Highest*
Andhra	0.60	14.97	0.20	6.30
Bihar	4.33	14.20	4.26	24.95
Bombay	2.70	33.90	0.50	6.33
Kerala	2.04	13.32	1.24	9.04
Madras	0.14	11.20	0.02	8.01
Uttar Pradesh	6.40	11.48	1.96	14.48
Madhya Pradesh	0.007	5.89	0.007	1.24
Orissa	4.51	10.30	5.00	14.90

Numerous surveys have been conducted in India in recent years. In addition to the above, a few may be mentioned.

In a survey in Mangalore Municipality by Krishnaswami,[172] 7,402 individuals provided blood samples, or 6.3 per cent of the population of 117,095. Microfilariae were encountered in 1,112 persons or 15 per cent. The disease rate was 9.5 per cent.

Basu[173] conducted examinations on two tea garden estates in Assam. In Bokakhat, 2,213 persons constituting 15 per cent of the population of the area were examined; the microfilarial rate was 4.5 per cent, of which 74 per cent of the positives represented *B. malayi* infections and 26 per cent *W. bancrofti* infections. The disease rate was 3.3 per cent. In the Chabua estate, 1,739 individuals were examined, or 13 per cent of the population. The microfilarial rate was 7.9 per cent, with 81.3 per cent of the infections *W. bancrofti* and 18.7 per cent *B. malayi*. The disease rate was 1.8 per cent.

In a survey of the Laccadive Islands, Subramaniam *et al.*[174] found six of the nine islands to be endemic foci. The over-all filarial disease rate and infection rate were 15.5 and 11.4, respectively.

Formerly both *W. bancrofti* and *B. malayi* were common in Ceylon. A control campaign for the destruction of *Pistia stratiotes* and other host plants of the mosquito vectors (*Mansonioides* spp.) has materially reduced *B. malayi* to a point where it is no longer any problem. Bancroftian filariasis is endemic in the towns and villages of the west coast of Ceylon over a strip a little less than 150 miles in length. The population of the area is approximately 2 million. In the control campaign, about 120,000 blood films are examined yearly, of which a little less than 2 per cent have been positive. Between September and December, 1959, a total of 27,200 individuals were examined, of whom 3.5 per cent were positive for microfilariae. However, many of these were known positives and others were contact cases.[175]

In Malaya, *B. malayi* is the predominant species.[151] It occurs not only in man, but certain lower animals are naturally infected. Apparently two forms exist in the human host, the distinction being based on the degree of nocturnal periodicity. A third species, *B. pahangi*, occurs in lower animals. In Pahang, infection rates with *B. malayi* rise more steeply and reach a higher level; there is little difference in mean microfilarial counts, the figure in terms of 20 mm^3 being 16.1 in Kedah/Penang and 18.5 in Pahang. Peak infection rates are reached in childhood. From 6 to 15 per cent of the population in endemic areas reported episodes of acute filarial fever with adenolymphangitis. Elephantiasis is mainly confined to the lower limbs and in more than half of the patients both legs were affected; the arms are seldom involved.

In Thailand, Iyengar[176] surveyed 32 villages in the provinces of Pattani, Phathalung, Nakhon-Srithamrat and Suratthani and examined 4,112 persons, of whom 863 were positive for microfilariae of *B. malayi* and 215 had filarial disease. Sandhinand[177] later surveyed 30,202 individuals in 24 villages of the Ron-pibul and Cha-uat Districts. The over-all microfilarial rate was 3.9 per cent, but the rates in the various villages varied from 1.69 to 68.35 per cent. In the Ron-pibul District, 319 cases of elephantiasis were observed, compared to 507 such cases in the Cha-uat District.

A survey in the Rawasari District of Djakarta, Indonesia, disclosed an average microfilarial rate of 7.8 per cent, with variations ranging from 1 to 23 per cent for different localities. Elephantiasis was not found in the area but hydrocele was common, being observed in 14 of 92 adult persons examined.[178]

In Western New Guinea, 1,125 persons were examined in 1958 and a microfilarial rate of 20.9 per cent and a filarial disease rate of 8 per cent were found.[179]

Filariasis is considered an important public health problem in Taiwan and the Pescadores. A mass survey involving 181,478 service men and 58,779 civilians, carried out between 1956 and 1958, revealed that 1.34 per cent of the former carried both *W. bancrofti* and *B. malayi* and 6.63 of the latter were carriers of *W. bancrofti*. In the Pescadores in 1957 to 1959 a similar survey of 58,979 service men revealed 6.01 per cent positive for microfilariae and of 22,038 civilians, 0.66 per cent positive. In Taiwan proper, although much of the island has not been surveyed, it is estimated that filariasis endemic areas include at least 21 townships with a total population of 501,150 and an average infection rate of 4.15 per cent.[180]

Rozeboom and Cabrera[181] examined blood films from 1,970 persons in 36 localities in the Philippine Islands and found 94, or 4.8 per cent, positive. On Luzon, 20 of 69 individuals at Bontoc were positive, 8 of 54 at Legaspi and 14 of 50 at Bulan. At Pimamalayan, Mindoro, only 1 of 50 was positive. A similar finding was made at Bais on Negros. At Tacloban, Leyte, 8 of 149 persons were positive. In various towns in the provinces of Agusan, Lanao, Bukidnon and Davao in Mindanao, the rates varied from 2 to 28 per cent. In Basilan City on the island of Basilan, 4 of 16 were positive and at Sagpangan on Palawan, 10 of 50 were infected. These authors associated the presence of filariasis with the abaca producing areas of the islands. Chronic manifestations of the disease are seldom seen in the Philippines.

Oceania. Filariasis is of great clinical significance in many of the islands of tropical Oceania. As indicated previously, Iyengar[148, 152] has provided excellent summaries of incidence and prevalence in this area.

A survey in Western Samoa[77] disclosed a microfilarial rate of 23.7 per cent in 955 individuals. In 1950 there were 1,309 cases of filariasis and 15 deaths reported in the Ryukyu Islands. By 1958, the number of cases had declined to 28.[182]

McCarthy[183] carried out investigations on nine of the Cook Islands. He stated that there has apparently been little change in the infection rate of *W. bancrofti* during the past 35 years and data on the prevalence of elephantiasis support this view. McCarthy's data for the various islands are as follows:

	Males		*Females*	
Island	*Number examined*	*Per cent positive*	*Number examined*	*Per cent positive*
Rarotonga	390	46.9	446	33.6
Aitutaki	134	53.7	123	47.1
Atiu	77	54.6	73	26.2
Mauke	34	55.8	51	35.3
Manihiki	84	59.5	101	26.8
Rakahanga	71	18.3	66	4.5
Penrhyn	58	15.5	68	5.9
Pukapuka	55	56.4	65	29.2
Palmerston	12	25.0	15	13.3

The incidence of microfilarial infections with *W. bancrofti* in Fiji varied from 6.4 to 15.4 per cent, according to the technique of the examination.[184]

Mills[185] observed 35 cases of elephantiasis of the leg among 6,800 New Hebrideans examined during bush tours between 1952 and 1957. The cases occurred in the northern and central parts of the island group.

In French Polynesia, control programs during the past ten years have been successful in materially reducing the microfilarial rates and the amount of clinical involvement. Examinations carried out in various islands of the group during 1960 produced the following data.[186]

Island groups and islands	*Number of persons examined*	*Per cent of total population represented by persons examined*	*Per cent positive for microfilariae*
Archipel des Iles du Vent			
Tahiti	19,468	47.7	6.45
Moorea	3,517	87.6	8.24
Makatea	1,858	81.5	7.64
Maiao	129	73.3	4.65
Archipel des Iles sous le Vent			
Raiatea	2,859	49.1	3.4
Tahaa	3,014	74.8	5.2
Huahine	1,162	39.7	4.3
Bora Bora	1,541	91.3	4.8
Archipel des Tuamotus	391	4.0	16.4
Archipel des Marquises	152	3.34	7.23
Totals	34,701	39.27	6.22

Morbidity and mortality

According to the data available for 1957, filariasis was the 15th cause of sickness and the 30th cause of death in the list of diseases in the countries and territories of the survey area (Tables 7 and 8). There was a relatively high morbidity rate, 21.99 per 100,000, but a low mortality rate, 0.0044 per 100,000 (Table 15). The disease was notifiable in only 17 of the countries of the survey area (Table 9).

Morbidity rates per 100,000 appeared very low in the Caribbean, Central and South America (0.64) and Southwest Asia (0.0025). Highest rates were registered from Africa (26.6), South Central and Southeast Asia (28.8) and Oceania (33.5). Mortality was reported only from Africa (0.0022 per 100,000), South Central and Southeast Asia (0.0046 per 100,000) and Oceania (0.44 per 100,000).

Few countries in the survey area presented high morbidity rates. In the Caribbean, Central and South America, only five territories reported cases of the disease, four Leeward Islands and British Guiana. Morbidity rates for these areas were 127.69 and 211.02 per 100,000, respectively.

In Africa the highest morbidity rates per 100,000 were found in the Republic of Cameroon (478.78), former Belgian Congo (295.49), Angola (44.68) and Ghana (13.29). In Southwest Asia only Aden Colony, with a morbidity rate of 0.31, reported cases of the disease. The highest rates of morbidity in South Central and Southeast Asia were found in former Portuguese India (202.64), India (49.47) and Vietnam (17.46). Relatively low rates were reported from Oceania, the highest being in Fiji (121.02), U. S. Trust Territory (66.2) and Ryukyu Islands (3.47).

Mortality due to filariasis was reported only from Africa, South Central and Southeast Asia and Oceania, the highest rates per 100,000 found in these regions being in Ghana (0.04), Vietnam (0.01), India (0.008) and the Ryukyu Islands (1.61).

Public health importance

The importance of filariasis varies markedly from area to area and from country to country. The relatively large proportion of people living in areas where the disease was reported (46.75 per cent) points to the relative importance of the disease. On the other hand, the mortality rates are low and this diminishes to some extent its relative significance. The disfigurement and disability resulting from the disease are important aspects which cannot be ignored in any attempt to evaluate its public health importance.

MALARIA

Distribution, incidence and prevalence

Malaria is foremost among the most widely distributed diseases of the tropics (Figure 7) and eradication campaigns are being carried out in many countries of the survey area. Malaria was reported from 125 of the 169 countries and territories included in this survey (Table 10). Except in Oceania, where only 9 of the 23 countries mentioned it, malaria was indicated officially as being present in more than two-thirds of the countries of the other areas and in almost all of South Central and Southeast Asia.

There were 4,153,250 reported cases of malaria in the survey area in 1957. Of these, 4 per cent were in the Caribbean, Central and South America, 69 per cent in Africa, 3 per cent in Southwest Asia, 23 per cent in South Central and Southeast Asia and 1 per cent in Oceania. It is said that malaria "has broad shoulders," a reference to the tendency of clinicians to label any fever malaria, in certain of the survey areas. It is quite possible that there is a disproportion in favor of Africa in the above distribution. (Figure 1-c.)

Caribbean, Central and South America. The Caribbean, Central and South American region presented the following picture with regard to malaria eradication as of early 1960.[187]

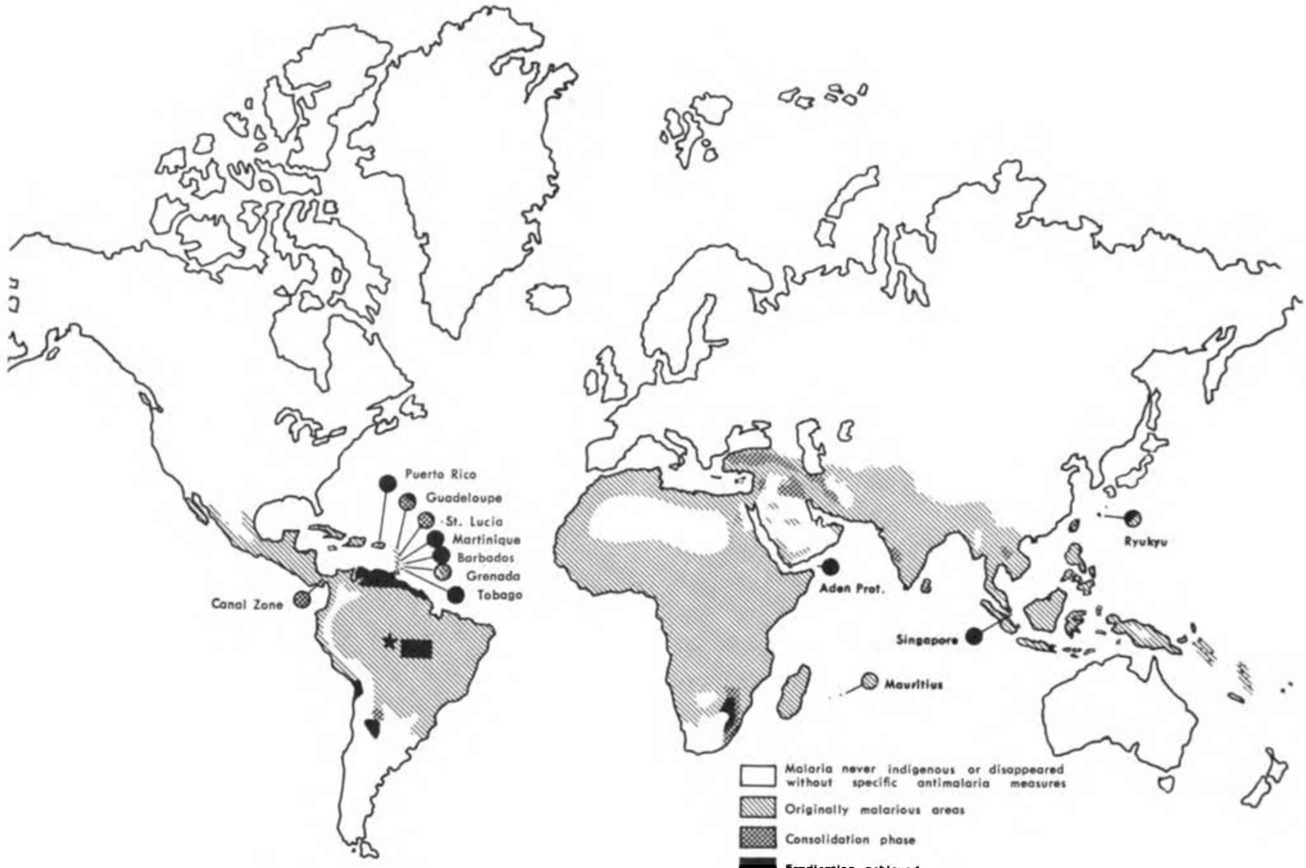
Malaria has never been present in or has disappeared spontaneously from the Bahamas, Turks and Caicos Islands, Bermuda, British Virgin Islands, U. S. Virgin Islands, St. Kitts-Nevis-Anguilla, Antigua, Barbuda, St. Vincent and Uruguay.

Malaria has been eradicated in Martinique, Barbados, Tobago and Chile.

Malaria eradication is advanced, with eradication achieved in some areas in the Canal Zone, Guadeloupe, St. Lucia, Grenada, Argentina, Venezuela and British Guiana.

Total coverage spraying has begun in Jamaica, Dominican Republic, Trinidad, Dominica, Mexico, Guatemala, British Honduras, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru, Bolivia, Paraguay, the Brazilian states of São Paulo, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe, and in Surinam and French Guiana.

Total coverage with chloroquinated salt has begun in the Brazilian states of Pará, Amapá, Rio Branco,



Brazil: malaria eradicated in area with total population of 3,171,000. Information on location of these areas not available.

Map reproduced by permission of The World Health Organization. July/August, 19

Amazonas and Guapore. A plan of coverage has been approved but total operations have not yet begun in the remaining states of Brazil and in Cuba and Haiti.

Malaria still represents a major health problem in this area, although control and eradication measures have reduced incidence to a great extent.[21] In 1956 rates per 100,000 were as follows: Argentina (3.6), Bolivia (33), Brazil (656.8: 1955), Colombia (586.8), Costa Rica (139.6), Cuba (2.1), Dominican Republic (70.2), Ecuador (17.4), El Salvador (201.7), Guatemala (591.9), Haiti (285.1), Mexico (109.2), Nicaragua (14.3), Panama (383.1), Paraguay (27.7), Peru (189.3), Venezuela (26.9), British Guiana (8.7), British Honduras (369.3), Canal Zone (10.7), French Guiana (484.6), Guadeloupe (nil), Jamaica (273.4), Antigua (nil), St. Kitts-Nevis-Anguilla (nil), Martinique (0.4), Puerto Rico (nil), Surinam (233.3: 1955), Trinidad and Tobago (21), U. S. Virgin Islands (nil), Dominica (24.2), Grenada (3,220.4: 1954), St. Lucia (1,255.6) and St. Vincent (nil).

Africa. Malaria is hyperendemic (transmission throughout the year) in the following regions: the West African coastal areas, from about 8° south latitude; the southern part of former French Equatorial Africa and the Congo, the central basin of the latter and the northwestern part of Angola; in Uganda, Kenya and Tanganyika in areas where the altitude is below about 1,400 meters; in Nyasaland and the northern part of Mozambique, at altitudes below about 1,000 meters and in the valleys of the large rivers in the latter territory; along the whole of the east coast of the continent up to Natal; in the low veld of the Transvaal and in the bush veld areas of Swaziland; in certain parts of the coastal zone of Mauritius and also, perhaps, in certain parts of the east coast of the Malagasy Republic.

The endemicity is intense (transmission period longer than six months) in the greater part of the western zone of the continent, particularly in and beyond the regions of north Nigeria, Dahomey, the Ivory Coast, Ghana, Guinea and in the eastern part of Portuguese

Guinea; in the greater part of Rhodesia and in Kenya and Tanganyika at altitudes below 1,400 meters; in the greater part of Mozambique and in the central and eastern parts of Angola; in some parts of the west coast of Malagasy and in Mauritius at altitudes below 300 meters; from the Transvaal to Swaziland, wherever the altitude is between 300 and 800 meters, and in Natal; in the northern part of South West Africa (Ovamboland) and in the Okawongo Swamps in Bechuanaland; in the coastal zones of southwest Mauritius and in the western coastal zone of the Malagasy Republic.

The endemicity is less intense (transmission regular but of short duration) in Rhodesia wherever the altitude is greater than 1,400 meters; in the southern part of Angola and in the highlands of Angola and Mozambique, above 1,500 meters; in the higher parts of the middle veld in Swaziland and in the Transvaal above 1,000 meters; in the higher parts of Malagasy and in Mauritius, above 300 meters but below 700 meters.[188]

Plasmodium vivax and *P. malariae* are irregularly distributed in tropical Africa; with rare exceptions, it is *P. falciparum* which is encountered in the greatest numbers and which causes the most severe forms of the disease. The other species are frequently found in children.[188]

Eradication has been attained only in French Somaliland and near eradication has been achieved only in Swaziland and South Africa.[189, 190] As of January 1960, eradication programs were in force in Algeria, Libya, Mauritius, Reunion, Swaziland, Republic of South Africa, and Zanzibar and Pemba. Pilot projects were operating in the Cameroons, Republic of Dahomey, Ethiopia and Eritrea, Liberia, Nigeria, Senegal, Somalia, Somaliland, Southern Rhodesia, Sudan, Togo, Uganda and the Voltaic Republic.[189] A pre-eradication program was being conducted in Bechuanaland. Some areas that in the past have shown no infection, such as the Nandi district of Kenya, are now reporting cases and sometimes epidemics.[191] Eradication programs were to be inaugurated in Egypt (UAR) and Tunisia in 1962.

As of 21 October 1960 in the WHO Region in Africa, the original malaria areas had a population of 141,266,000, of which only 2,679,000 resided in regions where the disease had been eradicated. Eradication programs were not under way in regions with a total population of 131,379,000.[192]

In Spanish Morocco during the ten years from 1946, there was a steady decline in the number of malaria cases from over 17,000 to 300-500 annually. All three common species were involved but *P. vivax* was predominant.[193]

In Algeria, approximately 3,500,000, or about half of the total population, lived in malarious areas. By 1954, 1,407,478 were under some degree of protection against the disease. Malaria is not a notifiable disease and morbidity and mortality data are no doubt incomplete. However, there was a steady decrease in number of reported first infections from 1948 to 1954; in the latter year the mortality was practically nil.[194]

In Tunisia, as of 1960, of a total population of 3,783,000, some 1,835,500 were at malaria risk but were under protection by various control measures. The eradication program which was scheduled for inauguration in 1962 was to be completed within ten years.

The eradication program in Libya was started in 1960 with a completion goal as of 1963. Some 31,000 inhabitants are under risk but are being protected. The population is 1,340,000.

Malaria is widely distributed in the watered areas of Egypt and 18,355,000 persons are at risk out of a total population of 26,080,000. As of 1960, a total of 5,433,000 were under protection. The eradication goal is set for 1972.

Recent data on incidence and prevalence of malaria in most African countries are not available. However, since only limited success has been achieved in control of the disease in most countries and territories, citation of past information may be of interest.

In former French West Africa, the total number of malaria cases reported from the various territories in 1948 was 346,080. At M'Bour, south of Dakar, the splenic index in school children was 18.8 per cent and the parasite index 57.37 per cent. At Bamako in the Soudan, malaria has been a grave problem. The splenic indices ranged from 45 to 66 per cent; *P. falciparum* was chiefly responsible. In urban areas in the Ivory Coast, parasite rates varied between 45 and 57 per cent.[195]

In Conakry, Republic of Guinea, malaria is a mild disease during the dry season. Prevalence increases in the Kaloum peninsula with increasing distance from Conakry, where a parasite rate of 30 per cent can be found in the outskirts of the city. Farther into the country more than 50 per cent of the population are *Plasmodium* carriers but infection is moderate. It can therefore be seen that the degree of malaria infection varies greatly from locality to locality.[196] In the Rio-Nunez estuary of Lower Guinea, the parasite rate in a small population was up to 71.9 per cent in children and up to 26.2 per cent in adolescents and adults.[197]

A malaria survey of Liberia in 1948 comprised the examination of 10,128 blood smears from representative population centers; of these 30.65 per cent had malaria parasites. Malaria was most prevalent in the 1-4 years age group, 64.45 per cent of which were positive. *P.*

falciparum was the dominant species.[198] Some progress has been made in control, especially around Monrovia and in a few other areas up country. The coastal region is less infected than is the interior.

Malaria is hyperendemic in the coastal regions of Ghana and endemic in the hinterland. It is said that the first attacks of the disease are fatal to about 5 per cent of children.[199] In 1948, malaria accounted for 10.15 per cent of all deaths.[195] Local control efforts have been attempted but an eradication program has not been inaugurated.

In Angola, malaria is present throughout the country; it is more intense in the districts of the north and in the zones along the water courses; it is less intense in the higher regions and in the dry areas of the south.[195] A survey in 1959 in northeast Angola in an area comprising over 45,000 km.^{2} revealed a splenic index of 55 to 91 per cent in children 2-4 years of age; the parasitemia varied from 35 to 60 per cent.[200]

Malaria is distributed throughout the former French Equatorial Africa. The disease is hyperendemic in the south and endemic in other regions. In 1948, 414,000 cases were reported from Gabon, 35,332 from Middle Congo, 9,137 from Ubangi-Shari, and 12,519 from Chad.[195] While some localized control efforts are no doubt being made in certain parts of the republics formerly constituting French Equatorial Africa, eradication programs had not been initiated in any of them as of the close of 1961.

Malaria is hyperendemic in the former Belgian Congo lowlands and frequently epidemic in the higher altitudes. It is estimated that 100 per cent of the children in the endemic areas acquire malaria before the age of ten years. The average infection rate in the Congo is believed to be 75 per cent for children under 3 years of age and slightly under 50 per cent for children 3 to 15 years. Blackwater fever appears sporadically among the white population.[7]

In São Tomé and Principe Islands, a spleen rate of 42.8 per cent and a parasite rate of 21.7 per cent were found among children.[201]

In Lagos, Nigeria, malaria in 1955 was the most common single cause for hospital attendance, being responsible for 6.2 per cent of all inpatients and 10.2 per cent of all outpatients.[68] At Ibadan, malaria is considered only second to malnutrition as a cause of severe anemia.[202]

In Northern Rhodesia a survey of isolated villages in the Bangweulu Swamp in 1958 showed a prevalence rate of 40 per cent. At Fort Rosebery, examination of 640 children revealed 28.9 per cent to be positive. At Matanda, malaria is considered hyperendemic.[28]

In Mozambique malaria is hyperendemic throughout most of the country. No control measures have been practiced except in the main towns and at the Irrigation Scheme of the Limpopo River. In Lourenço Marques and at the irrigation scheme in question, transmission rates are approximately 6 per cent.

In Swaziland, during the non-transmission season in 1956, parasite rates were 0.25 per cent in the bushveld, nil in the middle veld, 3.9 per cent in a strip of land separated from Mozambique and Maputaland by the Usutu River, and 3.8 per cent in the irrigation schemes.[80] As stated, eradication is far advanced in Swaziland.

In Kenya, few areas below 5,000 feet are completely free of malaria. There is a low endemicity in the semiarid portions of the northern part of the colony. The disease is highly prevalent in the lake region where the rainfall is heavy and is hyperendemic in the coastal areas and around Nairobi.[203] Various control measures have been applied for some years and the disease has been reduced in some areas; no over-all eradication program has yet been attempted.

In Zanzibar a WHO survey of 1,460 individuals revealed 65.6 per cent to have plasmodia in the blood; 83 per cent of children aged 2 to 9 years showed spleen enlargement; and 5.3 per cent of infections presented gametocytes.[28]

All provinces of Tanganyika report malaria as a major cause of morbidity and, in younger ages, of mortality. The true incidence cannot be determined from hospital returns, due to the tendency of attributing most febrile illnesses to malaria. Blackwater fever is rarely reported. Holoendemic conditions prevail in swamp areas (Pare District), where *A. funestus* is the chief vector.[204]

A WHO survey of the Kigezi District of Uganda in 1957 revealed virtually no malaria in regions higher than 5,000 feet. Endemicity increased with decreasing altitude and reached hyperendemic proportions on the shores of Lake Edward, where a spleen rate of 82 per cent and a parasite rate of 42 per cent for all ages were found.[28] After 10-12 months of DDT protection in the Kigezi District, over-all spleen rates fell from 39.3 per cent to 10.7 per cent and parasite rates from 16.6 per cent to 0.3 per cent.[205]

A malaria epidemic which occurred in Ethiopia between June and December 1958 covered some 100,000 square miles in four central provinces and portions of five other provinces in the highlands. The number of cases was said to be not less than 3 million; the number of deaths may have exceeded 150,000.[206] It is estimated that half of the population of the country is at risk from malaria. An eradication program began in 1961 with a completion goal for 1973.

Malaria is still the major endemic disease in Sudan, even though a marked improvement has taken place after the application for several years of residual spraying in all provinces. In 1956-57 the total number of malaria cases and deaths reported were, respectively, 499,950 and 373. Highest morbidity rates were in the south and the lowest in the north.[207] As of early 1961, the total population of 11,390,000 was at malaria risk but 4,035,275 were under protection. An eradication program is scheduled for initiation in 1963, with a completion goal of 1972.[190]

Malaria is unstable in the former British Somaliland; the disease is hypoendemic throughout most of the country, with hyperendemic foci in certain areas. *P. falciparum* is the species chiefly involved and gives rise at times to epidemics of great severity.[208] In Somalia, as now constituted, 1,776,000 individuals out of a total population of 1,980,000 are at risk; of these only 247,500 are under some sort of protection. An eradication program will be attempted in 1963.[190]

Eradication programs are under way in Reunion and Mauritius. While the disease has not been eradicated from the latter island, a remarkable degree of control has been attained so that the condition is no longer of public health importance.[209]

Southwest Asia. WHO reports on the status of malaria in the Eastern Mediterranean Region indicate that malaria still poses a major health problem. Of a total of 191 million persons in the area, about 70 per cent are still exposed to malaria infection. The number at present protected by control programs is approximately 31 million, or only 19 per cent of those living under malaria risk. Malaria has, however, been eradicated from the Aden Colony, Cyprus and the Gaza Strip.

As of January 1960 malaria eradication programs were operating in Afghanistan, Iran, Iraq, Israel, Jordan, Lebanon, Turkey and Syria. Pre-eradication surveys were being conducted in Saudi Arabia,[189] where the eradication program got under way in 1961.[190]

In the Aden Protectorate, *P. falciparum* and *P. vivax* are the most important agents and *P. malariae* is rare. Trucial Oman has extensive outbreaks of malaria from time to time; the disease is endemic not only in towns but also in rural areas; *P. falciparum* predominates.[14] In Saudi Arabia malaria is considered endemic in towns and in the oases;[13] the areas most affected are around the Red Sea, Hejaz and al-Hasa.[14] The disease has constituted a special health problem in the Qatif and al-Hasa oases. In the former area the parasite rate in the 2-14 year age group was reduced from 85 per cent to 6.4 per cent after the application of control measures, with a reduction in the over-all spleen rate from 94 per cent to 3.8 per cent.[210] The government hospital in Jedda reported that 44 per cent of patients were malaria cases. Spleen indices in children in the area were around 88 per cent.[14]

In Bahrain the main malarious areas have been Manama and Muharraq but the disease has been considerably reduced and is under control. In Muscat, all three common malaria parasites occur but *P. falciparum* is the predominant form. Kuwait is free of malaria but in Qatar the disease is endemic in oases.[14]

Malaria is an important health problem in Yemen, occurring even up to elevations of 8,000 feet. Serious foci are reported at Zabid, Baital Faqih and Hais in the lowlands and around Taiz and Madinat-Abid in the middle heights. *P. falciparum* prevails in the lowlands, *P. vivax* in the plateau region but *P. malariae* is relatively infrequent.[14]

The infant parasite rate in Jordan in 1958 was around 0.18 per cent.[132] About 50 per cent of the population is under malaria risk but the disease has been curbed in the Yarmuk and Jordan valleys.[15] Nearly all of the population at risk was under protection in 1961 and the eradication goal is set for 1965.[190]

In 1955 the incidence of new cases in Israel was about 0.05 per 1,000. By 1957 the morbidity had declined to 0.02 per 1,000.[211] Most malaria in the country is being currently diagnosed in recent immigrants. Total eradication is expected by 1963.[212]

In Lebanon approximately 10 per cent of the population lives in malarious zones. A WHO survey in 1951-1953 indicated that the disease was endemic in the coastal plains, along river courses and in the northern portion of the Al Biqa valley. The An Nahr al Kabir valley was a hyperendemic area. The peak of the malaria season in Lebanon is in July-August.[16] By 1960, 683,000 at risk of a total population of 1,627,586 were under protection by various control measures.[190]

In Syria, *P. vivax* predominates in early summer and *P. falciparum* later in the season. *P. malariae* is uncommon and *P. ovale* extremely rare.[17] Of a total population of 4,561,000, 1,570,196 are under malaria risk. However, by 1961 malaria eradication procedures had been extended to cover the total at risk.[190]

As of late 1961, transmission was still taking place in Turkey. The hyperendemic areas have been located in the southeastern section of the coastal plains and littoral and along the valleys of the larger rivers. The rice producing sections have shown a high incidence in the past. All three common species of malaria parasites occur.[38] As of late 1961, over nine million of the population were still exposed to the disease.

In Iraq, only a few limited and uninhabited desert areas are free from malaria. The most highly malarious areas border the Shatt al Arab and the lower Euphrates, followed next in intensity by the valleys of the Kurdish Mountains adjacent to Iran and Turkey, the northeastern provinces and the lower Diyala basin. The disease is also endemic in the southern marsh lands.[213] Of a total population of 6,500,000, 4,514,000 are under malaria risk but are now being protected under the eradication program which was instituted in 1957 and is expected to be completed by 1964.[190]

In Iran, malaria occurs throughout the year in the south and in the alluvial plain regions from March to November, with a peak in May-August and a secondary rise in October and November. *P. vivax* is predominant; *P. falciparum* is encountered in epidemics; *P. malariae* occurs sporadically; while *P. ovale* has also been reported. A total of 13 million inhabitants are under malaria risk out of a population of 21 million. However, 10,068,400 are under protection in the eradication effort which was inaugurated in 1957 and which is expected to reach completion in 1971.[190]

The distribution of malaria in Afghanistan is closely linked with the river valleys where rice cultivation is common. The incidence declines away from the streams. The chief vector is *A. superpictus* with *A. culicifacies* a secondary vector in the eastern province of Mashraqi. The transmission season lasts only three months. Marked reduction in spleen and parasite rates followed initial control efforts with residual insecticides. Spleen rates, which had been as high as 76 per cent in certain localities, were reduced to 9 to 11 per cent. In Sarobi in Kabul Province the parasite rate dropped to 1.6 per cent from 22.5 per cent and in Nijrab in the same province from 27.7 to 0 per cent.[214] The annual parasite incidence has fallen from 3.3 to 0.36 per 1,000.[215]

South Central and Southeast Asia. Eradication programs were being carried on in a number of countries as of January 1960. These included Burma, Cambodia, Ceylon, China (Taiwan), India, Indonesia, Laos, Nepal, Philippines, former Portuguese India, Thailand and Viet-nam. A pre-eradication survey was in progress in Pakistan. A pilot project was in operation in West New Guinea. Sarawak and North Borneo launched eradication programs in 1961. Malaria has been eradicated from Singapore.[189]

In Pakistan, malaria is widespread and is especially important in the riverine plains. The disease has been accentuated by the construction of irrigation systems and dams and extension in some areas of rice cultivation. In the Punjab and North West Frontier Province, regional epidemics occur from time to time. Many areas in West Pakistan, particularly in Sind, Bahawalpur and Punjab have become water-logged, with an increase in the incidence of malaria.

The annual death rate from malaria in Pakistan is almost 5 per 1,000 inhabitants. The disease causes more sickness and loss of working time than any other illness. It has been estimated that 24 million Pakistanis suffer from malaria every year. Of these, 500,000 die and another 6 million become susceptible to other diseases through the debilitating effects of malaria. *Plasmodium vivax* is the most common parasite in the northern Punjab and in North West Frontier Province. All three species occur but *P. malariae* is rare. Malaria is a serious problem in East Pakistan, where *P. falciparum* is the species most frequently encountered.[73] Of a total population of 86,823,000, 83,951,000 individuals are under malaria risk. An eradication program is in the preparatory phase.[207]

Malaria was long one of the major health problems in India, where it has been studied intensively for more than half a century. In 1950, prior to the institution of other than a few local control efforts, the distribution of the disease, as indicated on maps produced by the Malaria Institute of India, was substantially as follows:

The only non-malarious area consisted of most of Jammu and Kashmir. The healthy plains (spleen rate under 10 per cent) were limited to coastal areas around Madras City, Vizagapatam and southeast of Calcutta.

Areas of moderate to high endemicity of more or less static character, the intensity of which depended on local surroundings, with seasonal variation moderate, and in which fulminating epidemics were unknown, included the following: Southern Kashmir, the west coast from Baroda south to the southern tip of the country, the east coast northward through Madras State, most of the eastern half of the country and central Assam.

Areas of variable endemicity associated with dry tracts, usually showing autumnal rise in fever incidence and with low spleen rates, except in years following epidemics or in special local situations with irrigation, included most of Mysore, Hyderabad and Madhya Bharat, Saurashtra and western Rajasthan.

Areas of hyperendemicity in jungly hill tracts and terai land comprised hill tracts paralleling the western coastal plain from Bombay south, areas in Orissa, Madhya Pradesh and Bihar, and northern and southern Assam.

Known areas liable to fulminating epidemic (diluvial) malaria, with spleen rates dependent on the occurrence of epidemics, with high rates during and immediately following such, and falling to a low level in the course of half a decade or so, were located in northeast Rajasthan and western Vindhya Pradesh northeast of Bhopal.

The above data are based on the political constitution of India prior to the realignment of the various subdivisions.

At the close of the year 1952-53, after the institution of the National Malaria Control Program, it was roughly estimated that in India 75 millions still suffered from malaria each year. Out of about 5.5 million annual deaths from all causes, just over 50 per cent were due to fevers, of which 0.8 million were directly attributable to malaria. In 1952, of a total population of 356.65 million, 202.78 million were at malaria risk.[216] Since that time, the eradication program has made great strides and the disease no longer is responsible for the huge number of cases and the considerable number of deaths that it once was. In 1959-60, compared to 1953-54, the spleen rate had been reduced 91 per cent, the child parasite rate 95 per cent, the infant parasite rate 94 per cent and the proportional case rate (i.e., number of malaria cases per 100 patients) 78 per cent.[217]

In Ceylon, some two-thirds of the total population of 9,612,000 are under malaria risk. However, the eradication program is making considerable progress so that some 4,902,000 of the inhabitants are under protection.[207] In 1960, examination of 441,210 blood smears revealed an incidence of 0.08 per cent.[60]

The Terai is the most highly malarious area in Nepal, with spleen and parasite rates as high as 100 per cent in adults and 30 per cent in children. The disease is always present in the Katmandu valley. The Rapti valley is said to have been recently cleared of malaria. The Pokhara area is malarious but control efforts have limited the disease in the Biratnagar district.[218] As of October 1961, over 2 million people out of some 5 million under malaria risk were under protection.[207]

There are four malarious zones in Burma, viz: hill tracts with perennial hyperendemic malaria, the chief vector being *A. minimus;* the plains, largely free of infection except in the foothills and where irrigation is practiced, the vectors in the former being *A. minimus* and in the latter *A. culicifacies;* the delta, with patchy distribution and irregular local epidemics, the vectors being unknown; and the coastal regions, where malaria is widely prevalent with perennial transmission, the most important vector probably being *A. annularis,* although others may be involved.[219] As of October 1961, about two-thirds of the population of 19 million at malaria risk were under protection.

In Thailand, as of early 1960, about 1 million persons inhabited areas where virtually no anti-malaria work had been done and about 8 million other areas where malaria rates were still high, while some 7 million lived in areas with a low malaria rate. In all, 16 million persons in Thailand lived in malarious areas. The only non-malarious areas in Thailand are around Bangkok and several scattered pockets.[60] Since that time, considerable progress has been made in the malaria campaign.

In Vietnam, some 12 million persons live under malaria risk; about half are covered in the preparatory phase of the eradication campaign and the other half in the attack phase.[207]

Malaria is widespread in Laos and all of the 3 million inhabitants are under malaria risk. At the end of 1959, it was estimated that local control activities were protecting about a third of the population.[217]

In Cambodia, some 1 million out of a total population of 4.8 million are at malaria risk. Local control campaigns were providing protection.[217]

In Malaya, malaria is widespread and all of the 6.5 million inhabitants are at risk. At the end of 1959, it was estimated that 3 million were receiving protection.[217]

In Brunei in 1959, as a result of the control campaign, there were only 50 malaria cases as compared with 3,000 or more in 1953.[220]

The disease is widely distributed in North Borneo.[221] Some 400,000 out of a total population of 454,000 are at malaria risk. However, protection is now being afforded through the eradication campaign.

In the past malaria was the most important disease in Indonesia and was responsible for more deaths than any other malady. It was extremely prevalent in the rice growing localities and was especially notorious along the coasts of Java and Sumatra, the southern coast of the Celebes, Nias Island and Buton Island. All three common species were involved but *P. malariae* was less frequent than the others. It was estimated that the morbidity rate comprised about 40 per cent of the total population, with a mortality rate of 15 to 20 per 1,000. Some 120,000 deaths a year were attributed to malaria.[43] Spraying programs were instituted in the early 1950's but progress has been slow and it is estimated that eradication cannot be attained before 1969. The disease has been checked in a few large cities. About half of the population is under protection.

Most malaria cases in Hong Kong originate in the unprotected areas of the New Territories, especially the Sai Kung peninsula.[108] However, malaria has been eradicated in a large part of the colony.[207]

A large part of China (Taiwan) is free of malaria and only some 800,000 out of a total population of 10.8 million are still at risk.[207] The remaining endemic areas are situated along the foothills of the Central and Taitung Mountain ranges, malaria cases generally being found along the upper reaches of the rivers.[222] Only 84 blood smears were found positive of a total of 584,583 examined during the fiscal year 1961. Seventeen hsiens and cities comprising 41 townships had parasite carriers; there were five foci of transmission. Examination of 13,885 school children in 139 townships in 1951 disclosed a parasite rate of 8.63. In 1959, no positives were found in the examination of 14,843 children in schools in 148 townships, the last positive in this group having been encountered in 1958.[223] *P. falciparum* was the predominant species in Taiwan.

In western New Guinea, malaria is hyperendemic in the coastal areas and plains except in a well-defined area around Merauke, where it is mesoendemic. It is also hyperendemic along the Diguel River but disappears above an altitude of 1,000 meters. *P. vivax* is the predominant species. In 1952 there were 4,046 cases and 35 deaths from malaria in patients in government and auxiliary hospitals. In many villages with perennial transmission, spleen rates in children range from 80 to 100 per cent.[224] Metselaar[225] surveyed the Nimboran valley, situated about 60 km. southwest of Hollandia, where the disease was considered to be holoendemic even though the spleen rates were low. The absolute parasite rate in 315 children 0-11 months of age was 70 ± 2.6 per cent. Between 1 and 8 years, the rates were from 92 ± 1.6 to 83 ± 1.8 per cent. In 1,248 adults, the rate was 34 ± 1.3 per cent. It was estimated that the number of infections per adult per year averaged 150 or more. At Inanwatan on the Vogelkop peninsula, de Rook[179] examined 130 school children and found enlargement of the spleen in 66 per cent and plasmodia in 27 per cent.

Residual spraying was started in West New Guinea in 1954, and early in 1960 some 180,000 persons of a population of 700,000 were being protected by this method.[224]

Prior to the institution of control measures, malaria was widely distributed in the Philippines. The intensity of the disease varied from mildly prevalent to hyperendemic. It was not found along the flat coastal plains—Manila and Cebu, for example, were free—nor was the disease encountered above 2,000 feet. In general, there were two malarious zones, one between the coastal plain and the foothills and the other between the plateau behind the first foothills and the mountains beyond. All three common species of parasites were found, although *P. vivax* was most prevalent. Russell estimated that in 1932, there were about 2 million cases of malaria a year in a population of 12,600,000. The mortality rate was about 0.36 per cent.[226] In 1958, a total of 69,334 cases and 2,104 deaths were reported in the provinces, with morbidity and mortality rates per 100,000 of 347.82 and 10.55, respectively. The disease was far less prevalent in the cities. High rates characterized the disease on the island of Mindanao, which witnessed epidemics of malignant tertian malaria during and following World War II.[227] Nation-wide residual spraying began in the Philippines in 1954.[228] As of 1 October 1961, the eradication program was far advanced. Of a total population of 27,456,000, 8,956,000 resided in the original malarious areas. Of these, 8,256,000 were under protection.[207]

Oceania. In Oceania, malaria is endemic in Papua and New Guinea, Melanesia and the Ryukyu Islands. Micronesia and Polynesia are free of infection. The endemic area in Melanesia is bounded on the north by the equator and on the east by the 170° E. meridian of longitude. The main island chains included in the endemic zone comprise the Admiralty Islands, the Trobriand Islands, the D'Entrecasteaux and Louisiade groups, the Solomons, the Bismarck Archipelago and the New Hebrides. However, within this area the disease is absent from the Loyalty Islands, New Caledonia, Futuna, Ticopia, Nauru, Ocean Island and Bellona, and some of the islands of the Torres Strait.[229]

As of the end of 1961, an eradication program was in progress in the Ryukyu Islands and pre-eradication surveys were being conducted in the Solomons.

In Papua and New Guinea, the upper limit of malaria appears to lie between 1,800 and 2,000 meters. Malaria in the highlands is an unstable type and epidemics occur from time to time in marginal areas. In the highlands spleen rates in children have varied in different surveys from 0 to 43.7 and parasite rates from 0 to 6.1 per cent; the corresponding figures for adults are 0.5 to 51.6 and 0 to 21.4 per cent.[230] Malaria was responsible for 15.03 per cent of all hospital admissions and 12.64 per cent of all deaths in hospitals between 1952 and 1957.[231] Surveys in the Mount Hagen area of the New Guinea highlands revealed parasite rates of 78 per cent at Kogi and 46 per cent at Rugi.[232] Spleen rates exceeding 75 per cent below the age of 20 years and 90 to 100 per cent below 4 years were found in the Sepick District.[233] A survey of the coastal and inland areas of the Western District of Papua revealed a high endemicity of malaria.[234]

In the New Hebrides, Black[235] conducted a survey of Northern Malekula Island, Southern Espiritu Santo Island and Efate and the adjacent islands. Malaria was found to vary in the degree of endemicity from hypo- to holoendemic proportions. The parasite rates varied from 0 to 43 per cent.

In the British Solomon Islands, Black[236] was able to secure few data on the incidence of malaria but his surveys showed the disease to be hyperendemic on Ontong Java, hyper- and holoendemic in the Tetere area of Guadalcanal, holoendemic on Savo, and mesoendemic on Sikaiana and Rennell. No evidence of the disease was found on Bellona Island. The same investigator[237] found the disease to vary widely in the Trobriand Islands from hypoendemic to holoendemic proportions throughout the group. A native control project was instituted in 1953.

Malaria has been a serious health problem in the southern Ryukyu Islands. The disease constituted an active deterrent to the resettlement of Ishigaki and Iriomoto Islands. Failure of earlier attempts by the Japanese to carry out a resettlement program in these islands was attributed directly to malaria. An eradication program has been in operation in the Ryukyus since 1957. In 1946, there were 160,098 cases and 660 deaths from malaria. In 1959, there were 47 cases and no deaths, up to 31 July.[182] Of the total population of 868,000, 68,000 lived in the original malarious areas; all of these people are now under protection.[207]

Morbidity and mortality

The data obtained concerning malaria cases and deaths in 1957 revealed that in spite of widespread control and eradication campaigns the disease is still highly prevalent and constitutes as always one of the most significant health hazards in the survey area. Of the diseases listed in the survey, Tables 7 and 8 show that in the list of great diseases, malaria in 1957 ranked in fourth place as a cause of morbidity with 4,153,250 cases reported and third as a cause of mortality with 310,842 fatalities attributed to it. However, the disease is notifiable in only 67 of the 169 countries and territories of the survey area. In addition, it is a common practice in many areas to label all febrile illnesses as malaria. A number of virus and bacterial diseases are probably reported as malaria. Under such conditions it is impossible to evaluate the extent to which under-reporting and over-reporting of cases, because of lack of differential diagnosis, may be mutually compensatory.

Table 15 summarizes the information obtained. It can be seen that 82.08 per cent of the population of the entire survey area resided in regions in which the disease was reported in 1957. Thus, 988,693,000 people were exposed to the risk of malaria infection or more than 35 per cent of the total population of the world.

Malaria in 1957 presented a morbidity rate of 345 per 100,000 and a mortality rate of 25.8 per 100,000 for the entire survey area.

By regions, Africa with a morbidity rate of 1,236 and South Central and Southeast Asia with a mortality rate of 39.1 were the regions in which these rates were highest. However, 11 countries in the area reported only deaths of which 4, including India and Pakistan, were in South Central and Southeast Asia. The lowest morbidity rate was found in the Caribbean, Central and South America (84.1). However, this is a relatively high rate when it is considered that in this region eradication programs are most advanced. The lowest mortality rate was found in Southwest Asia (0.28). Differences between morbidity and mortality rates of the five major areas are considerable. The predominance of malignant tertian malaria in some areas may partially explain these differences.

By areas, the highest morbidity and mortality rates per 100,000 respectively, were as follows:

Caribbean, Central and South America: Panama (742.71 and 19.38), Colombia (571.53 and 11.88), Haiti (449.73 and 0.53), El Salvador (381.87 and 30.6) and Peru (89.43 and 1.13). Three countries with very high mortality rates did not report morbidity, namely, Guatemala (191.55), Nicaragua (135.61) and Honduras (107.48).

Africa: More than 10 countries surpassed the 1,000 per 100,000 rate of morbidity. The five highest morbidity rates were for Togo (17,281.25), Republic of Cameroon (7,549.21), former Belgian Congo (6,418), Ruanda-Urundi (4,643.38) and Sudan (3,607). Mortality rates were comparatively low, the five highest ones being the former Belgian Congo (16.06), Togo (9.38), former French West Africa (6.05), Uganda (5.32) and Tanganyika (4.95).

Southwest Asia: The highest morbidity and mortality rates, respectively, in this region were in Iraq (1,639 and 3.29), Aden Colony (108.38 and 1.37), Jordan (81.65 and 0.07) and Turkey (22.33 with no mortality reported).

South Central and Southeast Asia: Two countries with high mortality, India and Pakistan, did not report morbidity; the mortality rates were 55.57 and 57.7, respectively. Other high mortality rates were found in North Borneo (223.5), Laos (17.52) and Philippines (10.47). The countries of this region with highest morbidity rates were Laos (18,714.34), North Borneo (13,087.98), Malaya (1,904.33), Vietnam (560.04) and Ceylon (471.33).

Oceania: High morbidity and mortality rates, respectively, were recorded for the following areas: New Hebrides (6,382 and 17.31), Papua (3,041 and 41.24), British Solomons (1,539 with no mortality reported) and Ryukyu Islands (156.38 and 0.25).

Public health importance

Wide distribution coupled with high incidence and prevalence as well as high morbidity and mortality rates makes malaria one of the most important public health problems in the survey area.

That this is indeed the consensus is reflected in the action currently being taken on an international basis through the auspices and efforts of WHO to eradicate malaria from the world.

SCHISTOSOMIASIS

Distribution (Figure 8)

With the exception of a small focus in southern Portugal and the several foci in Japan, schistosomiasis is confined to the area under survey. *Schistosoma haematobium* has been found only in Africa and Southwest Asia with the exception of a small focus of infection in Maharashtra State in India, which appears to be due to *S. haematobium*. *S. mansoni* occurs in the Caribbean, South America, Africa and Southwest Asia. *S. japonicum* is confined to the Far East.

Of the 216,183 cases of schistosomiasis reported in 1957, 1 per cent were from the Caribbean, Central and South America, 69 per cent were from Africa, 28 per cent were from Southwest Asia and 2 per cent were from South Central and Southeast Asia (Figure 1-e).

Considering in order the five regions of the survey area, in the Caribbean *S. mansoni* is endemic in the Dominican Republic, Puerto Rico, Vieques, French St. Martin, Antigua, Guadeloupe, Martinique and St. Lucia. In Venezuela *S. mansoni* is distributed in the States of Aragua, Carabobo, Miranda, Maracay and the Federal District. It is found in Surinam and occurs in Brazil in the States of Pará, Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia, Minas Gerais, Espirito Santo, Rio de Janeiro, São Paulo, Paraná and the Federal District.

S. haematobium and *S. mansoni* are widely distributed in Africa. *S. intercalatum* is more localized. In North Africa, *S. haematobium* is found in Morocco, Spanish Morocco, Algeria, Tunisia and Egypt; *S. mansoni* is also endemic in Egypt. The former species occurs in Mauritius. Both species are found in almost all other countries of Africa, although *S. haematobium* is more widely distributed.

In Southwest Asia, *S. mansoni* occurs in Israel, Yemen, Aden and Saudi Arabia, while *S. haematobium* has been reported from Aden, Saudi Arabia, Yemen, Israel, Lebanon, Syria, Turkey, Iraq and Iran.

The focus of schistosomiasis in Maharashtra State in India apparently due to *S. haematobium* represents the only occurrence of this species in South Central and Southeast Asia, although it is possible that other foci may be found in India.

In Southeast Asia, *S. japonicum* has recently been discovered in Thailand. An autochthonous case has been reported from Laos. A focus of long standing is in the Celebes. In the Philippines schistosomiasis occurs in the islands of Luzon, Leyte, Samar, Mindoro and Mindanao. *S. japonicum* is found in lower animals in Taiwan but human cases have not been discovered.

Schistosomiasis is not known to occur in the portion of Oceania considered in this report.

It will be noted from Table 10 that schistosomiasis was reported from 52 of the 169 countries of the survey area. Reports included 5 countries in the Caribbean, Central and South America; in addition *S. haematobium* was reported from Antigua, which no doubt represented an imported case or an error in diagnosis. The disease was reported from 29 of the 58 countries and territories in Africa and 8 of 18 countries in Southwest Asia. Eight of 24 countries in South Central and Southeast Asia were represented in the reports. Cases reported from Vietnam were probably not indigenous and the same reservation would apply to the report of *S. haematobium* from Hong Kong.

Incidence and prevalence

Caribbean, Central and South America. There has been intensive study of the disease in Brazil, Puerto Rico and Venezuela. In the latter country, a control program has been carried out with some success.

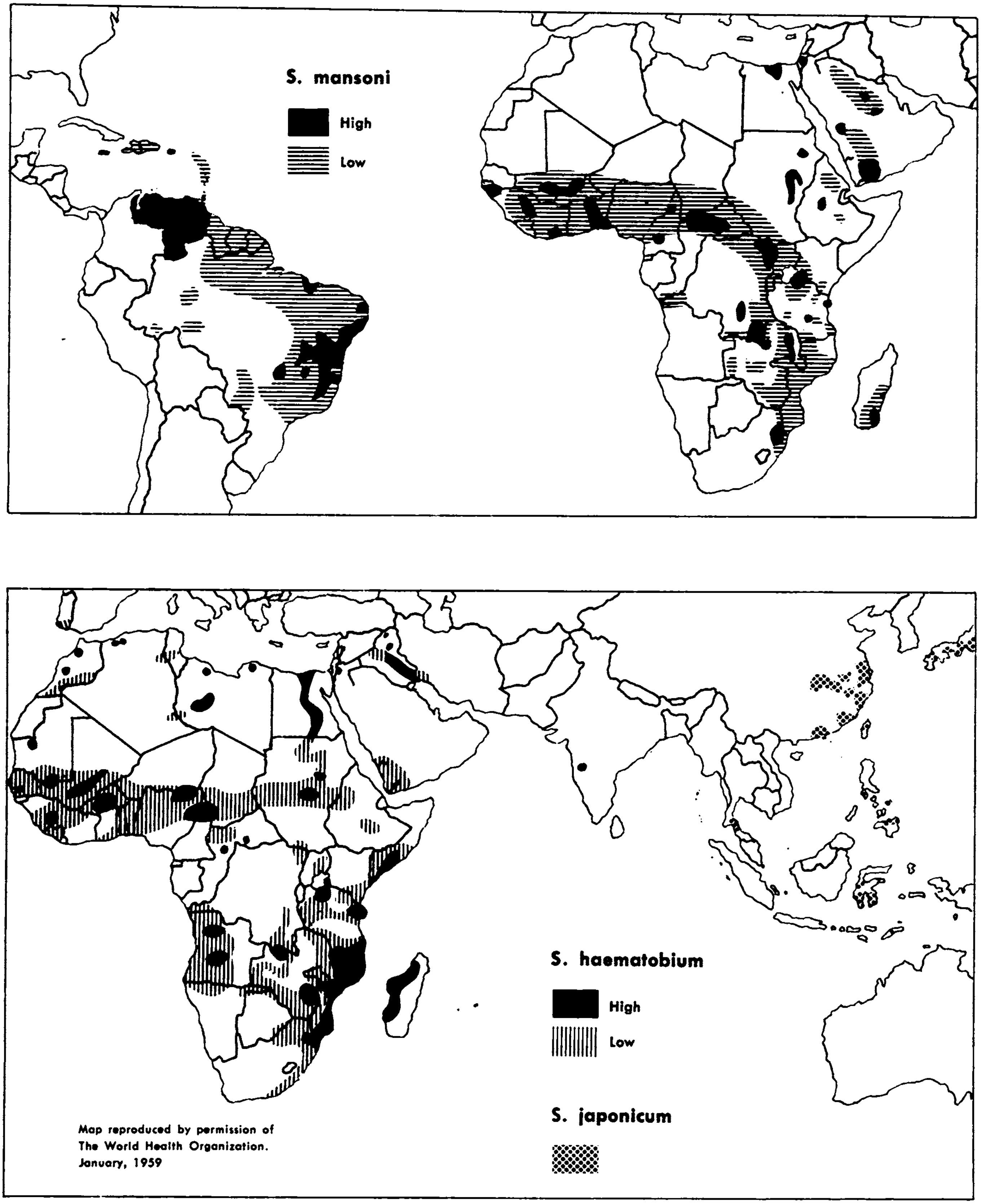
In Brazil, the following prevalence rates in seven states were reported in 1950 as follows:[126]

State	*Number of persons examined*	*Number positive for S. mansoni*	*Per cent positive for S. mansoni*
Maranhão	12,733	59	0.46
Piauí	10,424	4	0.04
Ceará	41,218	387	0.94
Rio Grande do Norte	18,808	436	2.32
Paraíba	21,715	1,629	7.50
Pernambuco	50,971	12,726	24.97
Alagoas	17,668	3,327	18.83

Other studies have been reported on the prevalence of the disease in some states, including Pernambuco, Paraíba, Alagoas and Sergipe. A survey of 814 stool specimens in the town of Gameleira, Pernambuco, revealed 370, or 45.45 per cent, positive for *S. mansoni*, of which 7.5 per cent presented hepatosplenomegaly.[238] In Paraíba, the number of persons positive ranged from 0.7 to 40.7 per cent depending on the age group. In other studies in northeastern Brazil, the percentage of positives ranged as high as 81.3 per cent in persons aged 10-19 years.[239] In one survey the difference between the incidence in a rural and an urban zone was 40 and 26 per cent, respectively.

In a survey covering 600 km.^{2} situated northwest of Paramaribo, Surinam, with a population of about 20,000, 12.7 per cent of 10,356 persons examined in a

Figure 8. World Distribution of Schistosomiasis



house-to-house canvass were found to harbor *S. mansoni.* The infection rates increased proportionally to the distance from the capital city.[240]

In 1956, it was estimated that 70,000 persons in Venezuela were infected with *S. mansoni.* The rate of infection in endemic areas varied from 5 to 100 per cent. Intradermal tests revealed positive reactions in 68 per cent of persons in endemic areas and fecal examinations in the rural areas of Maracay produced a prevalence rate of 62 per cent.[241]

In Puerto Rico, the incidence of *S. mansoni* declined from 22 to 11 per cent during the period 1953-1955 in six endemic foci without definite control measures having been applied with the exception of limited molluscíciding in one.[242]

Africa. Schistosomiasis is widely distributed in Africa and constitutes an important public health problem in many countries. Besides *S. haematobium* and *S. mansoni,* and in limited foci *S. intercalatum,* the presence of human infection with the animal species, *S. bovis* and *S. mattheei,* complicates diagnosis in some regions. Africa has not been thoroughly surveyed but much information is available concerning incidence and prevalence in many countries. Space is not available in this report to record all of these data but representative citations are included.

Both Gaud[243] and Deschiens[244] have reported in detail on the occurrence of the disease in former French West Africa and French Equatorial Africa. The information in Tables 16 and 17 has been summarized from their papers.

In the Upper River Division of Gambia, *S. haematobium* showed prevalence rates as high as 60 per cent. The parasite is widespread in the territory except along the coast and at Bathurst. *S. mansoni* is also prevalent.[245]

S. haematobium is widely distributed in Sierra Leone but *S. mansoni* also exists in localized foci.[246]

In Liberia, infection rates of 50 per cent for *S. haematobium* in the upper part of the Central Province are reported; the coastal area is free of infection. *S. mansoni* is present but has a focal distribution.[247]

Both species are present in Ghana; incidence and prevalence rates vary widely from place to place, although the disease is considered to be widespread. *S. haematobium* is the predominant species but *S. mansoni* is also endemic.[28]

In Portuguese Guinea, *S. haematobium* infection occurred in 18 to 54 per cent of individuals examined in four endemic areas.[248] This species is widely distributed in Angola where *S. mansoni* had not been identified.[249] Urinary schistosomiasis was diagnosed in 32.4 per cent of 739 inhabitants of one region in southern Angola.[250]

Both *S. haematobium* and *S. mansoni* are present in Nigeria. Infection rates approaching 95 per cent have been reported for the former species in children at Katsina in the northern part of the country. In the Epe area on Lagos Lagoon, *S. haematobium* has been found in 76 per cent of individuals examined. *S. mansoni* is found in the Western Region of Nigeria but infection is mild. Of 14,000 specimens examined in Lagos between 1951 and 1955, only 4.7 per cent were positive for *S. haematobium.*[246]

In the former Belgian Congo, half of the African population of Jadotville (Katanga) is considered infected about equally by *S. haematobium* and *S. mansoni.*[251] In Katanga Province the incidence of *S. mansoni* infection in the southern and western districts ranges from 5 to 80 per cent but *S. haematobium* is largely restricted to

Table 16. Percentage of *S. haematobium* infection in former French West Africa and French Equatorial Africa

TERRITORY	RANGE (MOSTLY AFTER GAUD)	ESTIMATED AVERAGE GAUD	ESTIMATED AVERAGE DESCHIENS
Mauritania	15-20	40	31
Senegal	2-40	15	8
Guinea	3-57	20	28
Soudan	2-85	35	47
Ivory Coast	32	5	37
Upper Volta	6-85	30	46
Togo	4-80	5	4
Dahomey	4-60	2	27
Niger	21-74	20	22
Chad	16-87	30	43
Ubangi-Shari	4-64	—	22
Northern Cameroons	4-13	15	—

Symbol: — no data

Table 17. Percentage of *S. mansoni* infection in former French West Africa and French Equatorial Africa

TERRITORY	RANGE (AFTER GAUD)	ESTIMATED AVERAGE GAUD	ESTIMATED AVERAGE DESCHIENS
Senegal	5-10	—	0.3
Guinea	6-8		6.3
Soudan	0-7		12.0
Ivory Coast	—	0.5	1.6
Upper Volta	8		8
Togo	—		1
Dahomey	—		0.2
Niger	—		0.8
Chad	—	0.3	0
Middle Congo	—		0
Ubangi-Shari	3-77	35	40
Gabon	—	3	0
Cameroons	—	—	0.4

Symbol: — no data

two foci, one in southwest Katanga and another in the Lower and Middle Congo.[7]

A survey of schistosomiasis in Mozambique has shown *S. haematobium* to be present in 421 localities in 9 districts with a general prevalence of 66.17 per cent in the age group 3-24 years. *S. mansoni* has a patchy distribution and is absent from many areas. The over-all prevalence of *S. mansoni* infection is 9.33 per cent in the 3-24 year group, but in many places prevalence rates for *S. haematobium* and *S. mansoni* reach 100 per cent based on a single urine or stool examination.[252]

Both *S. haematobium* and *S. mansoni* are found in the Malagasy Republic but the incidence is low in many areas. In the Ambositra area, however, the number of cases has increased since 1951 and the inhabitants of peri-urban areas seem to present a higher degree of infection than the town dwellers. Surveys carried out in this area showed that in children in different localities the infection rate for *S. mansoni* ranged from 4.22 to 58.66 per cent and among adults from nil to 53.66 per cent.[253]

In Durban, South Africa, 46.8 per cent of 517 Bantu school boys and 20.2 per cent of 356 Bantu school girls examined were found infected with *S. haematobium*.[254] In the Transvaal the incidence of *S. haematobium* is generally high and little related to living conditions, whereas the incidence of *S. mansoni* is closely related to the nature of the environment. Infection rates with both species appear to be highest in the Eastern Transvaal and lowest in Western Transvaal, where only the Rustenburg area was investigated but where *S. mansoni* was not found.[255] In a survey of 263 school boys in Eastern Transvaal, 85 per cent were found infected on rectal biopsy.[256]

In Bechuanaland, the disease is confined to the eastern districts. The number of cases reported has been low in past years (41 in 1955, 204 in 1956 and 230 in 1957).[36]

S. mansoni was found in up to 49 per cent of school children in some areas in Swaziland and *S. haematobium* in up to 75 per cent.[257] Rectal biopsy produced rates of 29 per cent in school children infected with *S. haematobium*, 3 per cent infected with *S. mansoni* and 4 per cent infected with both parasites in this country. In older age groups, *S. haematobium* was diagnosed in 51 per cent of rectal biopsies and 6 per cent of urine examinations.[258] A decrease of 27.5 per cent in the number of persons treated for schistosomiasis at district hospitals was recorded in Swaziland in 1956 compared with 1955.[80]

A survey of children in isolated villages in the Bangweulu Swamp of Northern Rhodesia showed an apparent absence of schistosomiasis. A fairly high incidence of *S. haematobium* was found at Fort Rosebery, but *S. mansoni* is probably not endemic. At Matanda, *S. haematobium* showed a prevalence of nearly 100 per cent among school children, and not much less among adults.[28] In Southern Rhodesia an incidence of 4.2 per cent was found among 10,019 European school children.[259] It is estimated that schistosomiasis affects more than 1 million persons in Southern Rhodesia.[260]

In Tanganyika, schistosomiasis is widespread but prevalence rates vary greatly from region to region. In Tanga Province, urinary schistosomiasis has been found in up to 51 per cent of Africans. In the Usumbara foothills and the plains below, *S. haematobium* was diagnosed in 38.8 per cent of individuals of all ages, yet *S. mansoni* was rare.[261]

It is estimated that 1 million persons of a total population of 6.5 millions in Kenya have schistosomiasis.[260] Along the coast and up the Tana River, only *S. haematobium* was found with a prevalence rate of about 50 per cent. Other foci of infection with this species exist. *S. mansoni* is found in the western part of the country.

Both species are encountered in Uganda. *S. haematobium* was not found in an area in the West Nile District but the incidence of *S. mansoni* in this area is probably 31 per cent.[262]

In a comparative study in Egypt, *S. haematobium* was found in 1 to 4 per cent of individuals in urban communities and in 4 to 18 per cent of those surveyed in rural areas. The species was absent from fishing and desert communities. *S. mansoni* was present in all types of communities investigated. The species is prevalent in the Nile Delta and in recent years has invaded Middle Egypt. Urban infection rates of 1 to 7 per cent were strongly contrasted with rural rates of 4 to 59 per cent.[130]

Both types of schistosomiasis are endemic in various parts of the Sudan. Development of irrigation schemes have served to intensify the infection. In 1949, infection rates for *S. haematobium* in the various provinces varied from 0.25 per cent in Bahr el Ghazal Province to 22.8 per cent in Kordofan. *S. mansoni* is not as widely distributed. For the same year, infection rates ranged from 0.2 per cent in Darfur Province to 44.3 per cent in Equatoria.[263] Since the above date, some efforts at control have been exercised, especially in the Gazira irrigation scheme, where some success has been achieved. In 1957, examination of 902 school children in the area revealed an infection rate of 28.3 per cent with *S. haematobium*. The incidence of *S. mansoni* is about 9 per cent.

Both *S. haematobium* and *S. mansoni* are endemic in the northern highlands of Ethiopia, as well as in the western borderlands of the central part of the country.

In addition, a localized focus of *S. mansoni* exists in Harar in the east. Urine and stool examinations conducted in various population groups indicated lack of *S. haematobium* infection in Addis Ababa, at Bahrdar in Gojjam Province and in Harar Province. However, *S. mansoni* was found in the latter two areas.[263] A survey of 52 localities revealed an infection rate of 3.1 per cent for *S. mansoni*.[264]

The disease has long been recognized in Eritrea. However, autochthonous cases of *S. haematobium* are extremely rare and apparently have been recognized only in eastern Tigre, which was formerly, but not now, included within the country. Studies conducted by Ayad[263] indicated *S. mansoni* in various population groups in Asmara, Decamere and Ma'araba in Hamasien Province; Saganeiti in Achele Guzal Province; and Adi Ugri in Serae Province. The incidence, however, in all of these areas was very low.

Vesical schistosomiasis is endemic in the valleys of the Juba and Webi Shebeli Rivers in Somaliland. In the Juba Valley, Ayad[263] found infection rates of 20 and 55 per cent, respectively, in two locations; in the Webi Shebeli Valley the rates in two villages were 35 and 55 per cent, respectively.

In French Somaliland and former British Somaliland, schistosomiasis is either absent or extremely rare.

S. intercalatum infection should be mentioned. This parasite occurs mostly in areas with high rainfall and in tropical forest zones, mainly along the Congo River basin. One study at Yakusu, near Stanleyville, found 72 to 79 per cent infestation in males 3 to 30 years old and up to 4 per cent in males over 30 years of age. In Stanleyville, 3.5 per cent of school children had the infection in 1928-1929 and 3.5 per cent in 1951. In Ponthierville, the rate of *S. intercalatum* infection in boys was 15 per cent and in adults 6.2 per cent. At Lokandu, 0.6 per cent of 2,900 examinations revealed *S. intercalatum* infection, and at Kindu 8.9 per cent of 145 boys were positive. In the Ogowe area of Gabon, 4.2 per cent of 6,560 hospital patients and 38.8 per cent of school children had the infection, and among Pahouin school children the infection rate for this parasite was 40.7 per cent, but among other tribes it was only 20.4 per cent. Infection by *S. intercalatum* has also been reported from Nigeria, Republic of Cameroon, Senegal, Republic of Guinea, Mali, Liberia, Central African Republic and Angola. These reports need confirmation.

Human infection with *S. mattheei* has been reported by Pitchford from South Africa.[241]

Southwest Asia. Reports on the incidence and prevalence of schistosomiasis in this area are not common. The disease is endemic in scattered areas of the western portion of the Aden Protectorate, especially in the highlands, the districts of Jebel Jeahf and Dhala, plateau country in the Wadi Tiban area and in the vicinity of Tor Am Baha, Huwemi and Khor Umeira. *S. haematobium* and *S. mansoni* are present, the latter being the more restricted.[14] Only imported cases of schistosomiasis are known from Aden Colony and Jordan.[2] In Lebanon, a focus of *S. haematobium* infection has quite recently been discovered in the southern town of Sarafand, where approximately 15 per cent of the population is infected.[265]

Schistosomiasis is characterized by a focal distribution in Saudi Arabia and is mainly confined to the oases. *S. mansoni* is prevalent in the central group of oases in Nejd. Foci have been found at Solimiah and Taif but apparently this species does not occur in Hejjaz north of Taif. However, areas of high endemicity of vesical schistosomiasis are reported in the Rabigh area. This infection is also rampant in Tabuk and is reported from Taima in the northern reaches of Hejjaz. For the years 1957 to 1959 and four months of 1960, stools examined at the King Saud Hospital in Riad for *S. mansoni* totaled 10,084, of which 692, or 6.8 per cent, were positive. During the same period, 17,707 urine specimens were examined for *S. haematobium*, of which 603, or 3.4 per cent, were positive.[266]

Vesical schistosomiasis occurs in the Province of Nusseibin in south central Turkey, where the endemic area is confluent with that in the Jezireh district of Syria. The Nusseibin focus was first discovered in 1956 and lies along the River Sublak. It covers an area of 10 km^2 and a total population of 1,300 in three villages are exposed to infection. The infection rate, however, is only 0.8 per cent.[267]

S. haematobium is more extensively distributed in northern Syria. There are four main foci situated along the Jarah, Sublak Jagh-Jagh and Ramila Rivers, as well as including a small tributary of the Balekh River and an irrigation canal from the Euphrates and three lakes in the Salu-Tobe Zone. The extent of the endemic areas is 708 km^2, in which are located 111 villages and 1 city. Of a total population of 73,810, 3,253 are infected, or 4.4 per cent.[267]

Both species are known to be present in Yemen. In 1955 and 1957, prevalence rates of 24.6 and 8.4 per cent for *S. mansoni* and 3.1 and 1.4 per cent for *S. haematobium*, respectively, were recorded. The *S. mansoni* cases came from 19 different areas and the *S. haematobium* patients from 12 areas. The latter species is highly endemic around the city of Haggia in the extreme north.[268]

In Israel, immigrants have been blamed for introducing both species of parasite. A survey revealed that 30 to 40 per cent of Yemeni immigrants carried the disease, as well as 5 to 12 per cent of Iraqi immigrants. About 7 per cent of those from Iran were affected. To date the disease has become endemic in Israel only in small, localized foci.[132]

One of the early surveys in Iraq indicated that *S. haematobium* affected approximately 20 per cent of the population. While the sample was limited, the percentage is still approximately correct even though more recent surveys have indicated that in some localities up to 80 per cent of the population is infected.[269] In Basra, 8 to 36.9 per cent of 3,477 children in various schools were found positive, as well as 40 per cent of 775 inhabitants of the hut settlements in the poorer parts of the city.[270] The highest rates of incidence in Iraq have been recorded in the following liwas: Baghdad, Muntafiq, Kutal, Imara, Basra, Diwaniya, Karbala, 'Amara and Hilla. The least affected liwas are Erbil and Mosul.[213]

S. haematobium is endemic in Iran. The known endemic areas lie within the province of Khouzistan in the southwestern part of the country. The land area of the province is approximately 50,000 km.^{2} and has a population of 1.5 million. The chief water courses are the Karoun and Karkheh Rivers. Irrigation is practiced in a few localities and extensive schemes are planned. In 1952, surveys were carried out in several localities within the endemic zone. The results indicated foci of infection at Ahoudasht, Seid Khazer, Chahour, Maravane, Almoghatef, Albarvaneh and Kheir-Abad. Infection rates varied between 25 and 78 per cent.[271]

South Central and Southeast Asia. In India a tiny focus of infection, tentatively identified as *S. haematobium*, has been reported[272] in the village of Gimvi in the Ratnagiri District of Maharashtra State, where 20.9 per cent of 191 school children were found infected.

Recently confirmation of a focus of infection in southern Thailand has been made.[273] An infection rate of 6 per cent was found on skin tests. Rectal biopsies were performed on 63 of 92 persons who reacted positively to the intradermal test and of these schistosome ova were recovered from 15.

In the Philippines, it has been estimated that approximately 1 million persons inhabit areas infested by *S. japonicum* and that some 250,000 persons have the disease. In a random sample of 278 infected individuals on Leyte, 38 per cent exhibited symptoms of the disease; mild cases constituted 57 per cent, moderate cases 39 per cent, and severe cases 4 per cent of the total.[274]

In Taiwan, where the local strain of *S. japonicum* is apparently limited to animals, cases of human schistosomiasis occur only in immigrants who were infected on the Chinese mainland.[46]

Morbidity and mortality

Because schistosomiasis is characterized by a delayed onset of symptoms which are often mild and unnoticed, and which in many cases do not attain serious proportions, the disease suffers from lack of notice and from under-reporting. Indeed, a controversy exists whether infection invariably produces disease. Intensity of infection is extremely variable and diagnosis is often made in connection with routine examination for some quite different complaint. In most endemic areas it may be assumed that large numbers of infections go undetected throughout life. This explains the very large differences between the prevalence and incidence rates, which result from epidemiological surveys, and the official morbidity rates. Schistosomiasis is rarely established as a direct cause of death and official mortality rates are correspondingly low. It is thought that they represent a fraction only of the hypothetical true rates.

According to the figures reported in 1957, schistosomiasis was in the 16th position as a cause of illness (Table 7) and in 24th position as a cause of death (Table 8) in the list of diseases considered in the survey.

The total morbidity rate for the survey area was 21.6 per 100,000. The total mortality rate was 0.044 per 100,000 (Table 15). These must be accepted as extremely minimal rates.

In Southwest Asia and Africa, relatively high morbidity rates of 75.96 and 64.1 per 100,000, respectively, were found. The Caribbean, Central and South America reported a morbidity rate of 0.78 per 100,000 and South Central and Southeast Asia reported a similar rate of 0.71. Oceania did not report the disease.

With regard to the known endemic areas, it is reasonable to estimate that approximately 200 million persons (10 per cent of the population of the world) inhabit regions of schistosomiasis risk.

Schistosomiasis is considered a notifiable disease in only 19 of the 169 countries and territories of the survey area (Table 9).

It may be estimated that 46.32 per cent of the population of the areas included in the survey inhabit areas in which schistosomiasis was reported in 1957.

Mortality rates were negligible in the majority of countries reporting the disease. The areas in which morbidity attained its highest figures were the following:

Caribbean, Central and South America: In 1957 only Puerto Rico reported the disease, with a morbidity rate of 65.33 per 100,000 and no deaths.

In Africa the highest rates, per 100,000, were found in Sudan (427.39), the former Belgian Congo (420.83), Angola (237.87), Republic of Cameroon (182.94) and former French West Africa (83.38).

In Southwest Asia only three countries reported cases of schistosomiasis, Iraq, Aden Colony and Protectorate. The rate for Aden Protectorate cannot be evaluated since data concerning population for 1957 were lacking. Iraq presented a morbidity rate of 321.77 and was the only country to report deaths, the rate per 100,000 being 0.02.

In South Central and Southeast Asia, only five countries reported cases of schistosomiasis in 1957. Macao reported that the cases were among African soldiers stationed in the colony. The rate for India was negligible since the disease was localized in one small focus. The Philippines reported a morbidity rate of 19.18 and a mortality rate of 1.75 per 100,000. Hong Kong and Vietnam showed morbidity rates of 0.35 and 0.21, respectively, the mortality rate in Hong Kong being 0.04 per 100,000 population. No deaths were reported from Vietnam.

Public health importance

Attention has been called only recently to the importance of schistosomiasis as a public health hazard in certain areas of the tropics. Its importance has hitherto been masked by the insidious and chronic nature of the disease and by the lack of evidence concerning its true incidence. To date, little information is available to permit a true evaluation of this disease as a public health problem. It has been accused of predisposing to hepatic and cystic carcinoma. Its high localized prevalence rates cannot be ignored. It has been shown capable of producing lesions in practically all the organs of the body. Nevertheless, the extent to which these lesions constitute a handicap has not been conclusively demonstrated. The extent to which the disease is responsible for mortality in childhood and disability in adults is not known. In general it constitutes an entity on which much basic research is needed before an evaluation of its true public health importance can be approached.

At present schistosomiasis cannot be considered a controllable disease, although progress is being made in developing more effective methods. The problem of control is one of great magnitude and with presently known methods any effort toward this end would be exceedingly costly. With opinion divided concerning the public health importance of the disease, it is difficult to secure necessary support in most countries for substantial control campaigns.

AMOEBIC DYSENTERY

Distribution

Examination of the available data shows that amoebic dysentery was reported from 65 of the 169 countries and territories in the survey area (Table 10). The greatest representation was from South Central and Southeast Asia where 15 of 24 countries reported its presence. The fewest reports were from Oceania in which only 5 of 23 health jurisdictions acknowledged its existence. The disease was reported from 17 of 46 countries in the Caribbean, Central and South America, in 22 of 58 countries in Africa, and in 6 of 18 countries in Southwest Asia.

In 1957, it was possible to find reports of 388,714 diagnoses of amoebic dysentery in the survey area. Of these, 29 per cent were in the Caribbean, Central and South America, 50 per cent were in Africa, 6 per cent were in Southwest Asia, 15 per cent were in South Central and Southeast Asia, and less than half of one per cent were in Oceania (Figure 1-a).

Detailed information regarding the distribution of the disease is lacking, but there is good reason to believe that it occurs throughout the entire survey area.

Incidence and prevalence

The reporting of the dysenteries presents many puzzling characteristics. A compilation of the data supplied by WHO[275] indicates that many countries consistently report only a relatively few cases of dysentery and that others routinely report relatively large numbers of cases. Reports are classified by WHO into unspecified, amoebic and bacillary dysenteries. The total number of cases reported to WHO for the 11 years from 1950 to 1960 in the countries comprised in the present survey was 19,034,513, of which 48.2 per cent were unspecified as to etiology, 33.2 per cent were amoebic and 18.6 per cent were bacillary. These data would seem to indicate that amoebic dysentery is far more prevalent than is bacillary dysentery, a conclusion which is open to considerable doubt. The unspecified cases, which predominate, cannot be classified as to etiology. Some of the pitfalls in the diagnosis of amoebic dysentery are mentioned below. It is questionable whether many of the cases reported as bacillary dysentery are based on bacteriological examination of the stool and identification of the etiological agent. No doubt some, if not many, cases of dysentery are of viral origin. The term is in itself confusing and one is inclined to presume that the reported cases include diarrheas and do not truly represent dysentery in the strict sense of the word.

With respect to reported deaths from dysentery for the above-mentioned period, there was a total of 1,705,-242, of which 97.4 per cent were ascribed to disease of unspecified etiology, 1.3 per cent to amoebic dysentery and 1.3 per cent to bacillary dysentery.

The question of the relative pathogenicity of *Endamoeba histolytica* has long been debated. Some authorities have held that the organism is invariably so. Others have believed that only the so-called large race is capable of producing disease and that the small race (now thought by some to be a separate species designated as *E. hartmanni*) is nonpathogenic. Even with the large race of *E. histolytica* strain differences as regards viruience are recognized. The name *E. dispar* has been applied to the nonpathogenic strain. More recent views have been summarized by Hoare[276] who is of the opinion that clinical manifestations are caused only by a race of *E. histolytica* which is endemic in countries with a hot climate.

Unfortunately, from the standpoint of this report, those who have conducted and published the results of surveys in parts of the world here considered have not always designated the type of organism which they have diagnosed. Furthermore, the best of authorities are not in agreement concerning the criteria for laboratory diagnosis of the infection. In the information cited below, it is highly probable that different techniques for stool examination have been employed and that there have been some differences in the competency of the various individuals who made the determinations.

With the above facts in mind, it is apparent that the data on incidence and prevalence of amoebic infection may not refer to clinical disease or potential disease, and in many, if not in most cases, are not comparable.

Some surveys have been performed in the area of the Caribbean, Central and South America. In Mexico, a study of 385 children with bloody diarrhea disclosed *E. histolytica* in 18 per cent of the cases.[277] An analysis of pathological material at the Children's Hospital in Mexico City, collected between 1949 and 1957 and representing more than 75,000 admissions and 951 necropsies, revealed only 41 necropsy cases that could be diagnosed as amoebiasis.[278] The incidence of *E. histolytica* infection in Costa Rica was reported to be only 4.6 per cent.[279] In Cuba, amoebic dysentery would seem to have ceased to be a serious problem.[280] In more than 300,000 examinations performed in different parts of the island, a rate of 5 per cent was found. In selected groups the prevalence rose as high as 29 per cent. A survey at the University of Habana involving 120,000 examinations during the years 1937-1956 produced a rate of 6.5 per cent.[281]

In Colombia, where clinical manifestations of amoebiasis are rare, examination of persons belonging to an underprivileged group revealed that 40 per cent were carriers of *E. histolytica;* of these, 80 per cent were carrying the large race of the parasite.[282] In the state of São Paulo, Brazil, *E. histolytica* was found on a survey to be present in 23.8 per cent of the urban population and in 26.1 per cent of the rural population.[283]

In Africa, single stool examinations of 315 persons in six northern villages in Sudan produced evidence of *E. histolytica* infection in 48.[119] In Ethiopia, large race *E. histolytica* was found in 28.4 per cent of 320 specimens examined in 52 localities; small race was found in 44.1 per cent of these specimens.[264]

The incidence of amoebic infection in former Spanish Morocco was reported in a survey done in 1954; 1,080 "normal" persons suffering from no complaints were examined and 71, or 6.57 per cent, were found to be carrying *E. histolytica.*[284] In Liberia, a survey of 100 persons at Harbel disclosed an infection rate with *E. histolytica* of 52 per cent.[285] In former French West Africa in 1956, 43,671 cases of amoebiasis without liver abscess and 3,386 cases with liver abscess were diagnosed.[10]

Amoebiasis is endemic throughout the former Belgian Congo, with particularly high incidences in Kivu, Leopoldville and Orientale Provinces. Liver abscess is reported infrequently.[7] A survey of the Bangweulu Swamp in Northern Rhodesia revealed amoebiasis to be rare among 326 school children examined. On the other hand in Durban, South Africa, amoebiasis is extremely common.[286] In 1957, 1,247 African patients were admitted to medical wards with acute amoebic dysentery and a larger number was treated in outpatient clinics. Of 77 cases of liver abscess admitted during 1957-1958 to a single medical unit, 22 had concomitant amoebic dysentery. An average of at least 50 autopsies are performed each year in fatal cases of this disease.

A survey of stools in Tananarive, Malagasy Republic, failed to discover any quadrinucleated cysts, and trophozoites of *E. histolytica* were identified in only 19 of 1,697 specimens.[287] The Pasteur Institute in Tananarive diagnoses between 5 and 10 cases of amoebiasis each year. Amoebiasis in the Malagasy Republic is considered rare and exhibits a mild course. The disease is endemic on St. Helena, but few cases are seen and amoebiasis is not considered an important problem.[79]

A comparative study of incidence in different types of communities in Egypt revealed relatively high incidences in all those studied. One fishing village showed an incidence of 56 per cent infection with both races. Incidence was 30 per cent in one urban community and 37 per cent in two others. Five rural communities revealed infection rates varying from 26 to 51 per cent. Two communities classified as intermediate between rural and desert had incidences of 49 and 52 per cent, while two desert communities had infection rates of 56 per cent.[130] Other studies have produced similar rates, with occasional higher figures, approaching 90 per cent in one community. Here, the small race of amoeba was found.[132]

In Syria, a survey of 860 persons of all age groups revealed 3.49 per cent to be carriers of cysts of *E. histolytica*.[132] In another study no amoebae were found in persons examined in the towns of Aleppo, Hama, Homs, Latakia, Deraa and Sueda; 1.61 per cent of persons in Hasaka were infected with *E. histolytica*, 0.87 per cent in Deir ez Zor and 9.44 per cent in Damascus.[137]

In Turkey, rates of 9 per cent were found in 1956. These figures were exceeded by those of a study done in 1958, in which incidence rates of 15 to 42 per cent were reported.[132] The general incidence of amoebic dysentery has been estimated to be 14 per cent in Iran, with local figures rising to 30 per cent.[132] The over-all incidence of infection in Israel was estimated at between 10 and 20 percent in 1956.[144] In Lebanon, it was around 17 per cent.[132] In Saudi Arabia, the Eastern Province was reported to have an incidence of 2 per cent, the disease being largely asymptomatic but severe among immigrants.[132] In Yemen, examination of 912 patients at the Hodeidah Hospital showed an incidence of 26.5 per cent.[37] However, amoebiasis is chiefly prevalent in the lowlands from which many of the patients probably came.

Few data on surveys are available from South Central and Southeast Asia. In Upper Burma, where incidence of amoebic infection is considered heavy, one study of women attending antenatal clinics produced an infection rate of 46 per cent.[288] Laboratory records from Vietnam showed the incidence of *E. histolytica* to be approximately 21 per cent in 1953 but only 2 per cent in 1958.[289] In Taiwan, examination of more than a thousand immigrants from the Chinese mainland showed an incidence of amoebic infection in 23.9 per cent and a similar study of natives produced a figure of 27.7 per cent.[140] Another study recorded a prevalence of approximately 20 per cent in various population groups.[46]

In Oceania, examination of Marshall Islanders, in the U. S. Trust Territory, showed an over-all incidence of 18.2 per cent.[290] A survey done in Western Samoa in 1953 disclosed an incidence of 14.3 per cent in adults.[77]

Morbidity and mortality

Of those diseases studied in the survey, amoebic dysentery occupied 14th place as a cause of illness and 13th place as a cause of death (Tables 7 and 8).

For the entire survey area a morbidity rate of 32.3 per 100,000 and a mortality rate of 0.67 per 100,000 were found (Table 15). More than half of the countries and territories of the survey reported amoebiasis. These countries comprised 31.92 per cent of the total population of the area surveyed. The highest morbidity rate per 100,000 for any area was 83.3 reported for Africa. The lowest rate (8.49) was from South Central and Southeast Asia. In the Caribbean, Central and South America the rate was 58.7. Rates of 29.8 and 18.4 were reported from Southwest Asia and Oceania, respectively. The highest mortality rate per 100,000 (3.38) was for the Caribbean, Central and South America. Elsewhere the disease was characterized by relatively low rates, 0.39 in Africa, 0.041 in Southwest Asia, 0.095 in South Central and Southeast Asia and 0.67 in Oceania.

Great variation in rates for morbidity and mortality was recorded among countries of the five major areas of the survey. The highest rates in each area are presented below, those for morbidity followed by those for mortality in each case:

Caribbean, Central and South America: Colombia (508.27 and 4.62), Nicaragua (457.93 and 2.25), Venezuela (271.07 and 3.34), Dominican Republic (76.76 and 0.89) and Mexico (55.38 and 16.98).

Africa: Former French Equatorial Africa (332.61 and 1.52), former French West Africa (317.6 and 1.3), Morocco (228.84 with no deaths reported), former Belgian Congo (208.29 and 0.2), Ruanda-Urundi (179.93 and 1.3) and Nigeria (82.64 and 0.48).

Southwest Asia: Iraq (190.84 and 0.11), Iran (48.66 and 0.03) and Afghanistan (0.72 and 0.04).

South Central and Southeast Asia: Ceylon (77.98 and 0.74), Laos (2,022.14 and 5.79), Cambodia (105.59 with no deaths reported), Vietnam (38.86 and 0.02) and the Philippines (19.49 and 1.54).

Oceania: Gilbert and Ellice Islands (251.22 and 9.76), U. S. Trust Territory (215.49 with no deaths reported), New Hebrides (150 with no deaths reported) and New Guinea (18.92 and 1.83).

Public health importance

On the basis of morbidity rates the data showed amoebiasis to be of moderate importance in certain localities. In general, however, the present data support the widely-held consensus that the great majority of cyst-carriers are clinically asymptomatic. Their numbers are high but the number of clinical cases is limited.

It would seem safe to say only that amoebic disease is not shown by the available data to be more than a problem of relatively moderate importance. Exceptions to this generalization are in evidence, such as the Durban area in South Africa.

KWASHIORKOR

Distribution

The distribution of this deficiency disease, as it has been understood, is summarized in a map (Plate III). The entity has been recognized only recently and the use of the term "kwashiorkor" to indicate this polydeficiency disease is not universal in the literature. Although this condition can doubtless be found anywhere in the underdeveloped tropical world, 99 per cent of the cases identified in reports in 1957 were from Africa, and the remaining 1 per cent from the Caribbean, Central and South America (Figure 1-b). Inadequate knowledge of distribution is related also to the fact that the disease is often reported in a group with other nutritional deficiencies without etiological specification.

Table 10 shows that the disease was reported from only four of the countries of the Caribbean, Central and South America: Panama, El Salvador, Haiti and Antigua. However, descriptions of the syndrome under various names have been made in Mexico (1908), Cuba (1929), Costa Rica (1938), Guatemala (1938), Honduras (1939), Venezuela (1939), and after 1940 in Chile, Colombia, Uruguay, Brazil, Jamaica and Curaçao. In Africa, kwashiorkor was reported from 9 of the 58 countries and territories. The syndrome has been recognized in many other countries. No reports of kwashiorkor were made from Southwest Asia. In South Central and Southeast Asia, 2 of the 24 countries reported the disease. It has been described from others. In Oceania, 3 countries out of the total of 23 reported the disease. The syndrome has been described without name in Fiji, which did not report the disease.

Incidence and prevalence

Studies have been performed in only a few scattered regions within the areas included in the survey.

Nearly all children in rural and poor areas of Central America suffer growth retardation and other evidences of protein malnutrition and many develop kwashiorkor.[291] In Guatemala (1938), a survey disclosed the fact that no children under 6 months of age presented symptoms and that the heaviest incidence, 50 per cent, occurred in the age group 1-2 years.[292] In Costa Rica, a study in 1946 found 22 per cent positive in the group 1-2 years, 26.6 per cent positive in the group 3-4 years, 25.8 per cent positive in the group 5-8 years and 12.2 per cent positive in the group 9-12 years. Of all the subjects positive for kwashiorkor 62 per cent were under 4 years and 38 per cent were over 4 years. In a similar study in Central America (Guatemala, Honduras, Nicaragua, Costa Rica and Panama) in 1949, the proportion of cases under 4 years was 58 per cent and over 4 years 42 per cent.[292]

In Brazil, the incidence of kwashiorkor has been reported by several authors; all are in agreement that the highest incidence occurred in the age group 12-23 months (50 to 57 per cent of cases).[293]

In Curaçao, 39 per cent of cases were in the age group 6-11 months and 61 per cent in the group 12-23 months. No cases were recorded in the group 24-60 months.[293] A survey in Haiti uncovered an incidence of 7 per cent.[294]

In Africa, it is estimated that the true number of cases of kwashiorkor is considerably greater than those reported. The disease has been reported from the Cape Verde Islands.[295] No cases were found among 1,586 infants and children in three localities in Northern Rhodesia.[28] In Brazzaville, Republic of Congo, the syndrome is considered rare. Incidence varies according to region in the former Belgian Congo, being high in the southern savannahs and eastern mountains but low in the central forests.[296] In Uganda, a high incidence of kwashiorkor was found in children under 5 years of age.[28] It occurs frequently in the Lagos region of Nigeria.[297] A survey in Nigeria showed that the incidence of protein malnutrition in children up to 9 years of age was 2.2 per cent in millet-eating areas and 5.3 per cent in yam-eating areas.[298]

A study of infants and preschool children in Ethiopia found evidence of protein malnutrition and preclinical kwashiorkor.[299]

In South Central and Southeast Asia, 1 per cent of 4,536 children examined in the Indian states of Madras, Mysore, Kerala and Andhra Pradesh were found to have kwashiorkor.[300] The disease is probably responsible for 16 per cent of children's admissions in hospitals. At any given time it is estimated that the number of frank cases of kwashiorkor must exceed 120,000.[301] In Poona, India, 100 cases of kwashiorkor were found in 1,460 admissions to a pediatric unit in 1955 (6.84 per cent). The disease was reported from Rajasthan.[302]

Examination of 3,145 children, aged 1 to 4 years, in Malaya produced evidence of kwashiorkor in only 189, or 6 per cent. Of these, 123 were from Perak, the only district where the disease seems to be common.[303]

In Oceania, a survey of a mountainous area in New Guinea was done in 1959. Of 1,223 infants and children up to 10 years of age, 163 were found to be suffering from malnutrition but only 32 cases of advanced kwashiorkor were found, representing 2.62 per cent of the total number examined and 19.6 per cent of the malnutrition cases.[304]

Morbidity and mortality

Advanced kwashiorkor is generally accompanied by high mortality rates. In Johannesburg and Pretoria, 30 and 40 per cent of cases, respectively, end fatally.[305] In some centers deaths occur in up to 90 per cent of cases. The introduction of skim milk into infant diets has reduced death rates dramatically. In Durban, a recent report states that only 2.8 per cent of kwashiorkor cases die, excluding those which die within 24 hours of entering a hospital.[305]

According to the data available, kwashiorkor occupied 25th place as a cause of illness and 20th place as a cause of death on the list of diseases considered in the survey (Tables 7 and 8).

In 1957, only cases were reported from the Caribbean, Central and South America, although cases and deaths were recorded from Africa. Thus the over-all rates for morbidity and mortality (Table 18) must be considered most unreliable. In the Caribbean, Central and South America, only 0.57 per cent of the population lived in areas reporting kwashiorkor. In fact, no reports were made from countries in which the disease is of frequent occurrence. In Africa, the percentage of the population in areas reporting the disease was 31.24. The data from the few countries reporting from South Central and Southeast Asia and Oceania are insufficient.

Of those countries which reported the disease, highest rates per 100,000 for morbidity and mortality, respectively, were obtained from Kenya (68.33 and 3.37), the former Belgian Congo (54.3 and 4.09), Zanzibar (23.75 and 0.67) and Uganda (16.71 and 1.57). The Leeward Islands of the Caribbean reported 60 cases per 100,000 but attributed no deaths to this disease.

Public health importance

It is clear that a grasp of the true public health importance of this condition is not to be gained from the data available. The high mortality associated with advanced cases, coupled with the irreversible effects upon the liver of surviving cases, makes kwashiorkor a most serious problem; without doubt it is one of the most malignant of all deficiency diseases. The over-all picture provided by the present data would relegate kwashiorkor to a position of low importance. However, as pointed out, reporting was entirely inadequate. Therefore, it provided no basis for a true evaluation of the public health importance of the disease. Since research on kwashiorkor has not been conducted in many countries in which the disease undoubtedly occurs, it is probable that additional information will become available and will eventually provide an adequate basis for a rational analysis of the relative importance of the disease.

Table 18. Morbidity and mortality due to nutritional diseases of high endemicity as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY: CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Kwashiorkor	Relative population[1]	0.57	31.24	—	—	—	6.10
	Morbidity (per hundred thousand)	0.044	5.80	—	—	—	1.12
	Mortality (per hundred thousand)	—	0.41	—	—	—	0.078
Other nutritional diseases	Relative population[1]	52.29	48.04	9.60	64.84	65.45	48.48
	Morbidity (per hundred thousand)	6.37	67.96	0.39	234.70	102.99	150.50
	Mortality (per hundred thousand)	0.59	1.13	0.25	3.57	3.91	2.41

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

OTHER NUTRITIONAL DISEASES

Distribution

The principal features of the distribution of certain common nutritional deficiency diseases are included in Plate III. The geographical distribution of endemic goiter is presented in Figure 9.

Only 83 of the 169 countries and territories of the survey reported malnutrition (Table 10). It is to be assumed that nutritional deficiencies must be more widely distributed than indicated by the available data.

According to the data, the countries and territories of South Central and Southeast Asia were foremost in reporting malnutrition. Here 17 of 24 countries reported the condition. Nine of 18 countries in Southwest Asia were represented in the reports, as were 20 of 46 countries in the Caribbean, Central and South America. Reports came from 26 of 58 countries in Africa and 11 of 23 in Oceania.

In 1957, there were reported 1,812,367 cases of nutritional deficiency disease (excluding kwashiorkor) in the major survey areas. The vast majority of these were recognized in South Central and Southeast Asia (90 per cent). Of the remainder, 1 per cent were in the Caribbean, Central and South America, 9 per cent were in Africa, less than half of one per cent were in Southwest Asia and in Oceania (Figure 1-c).

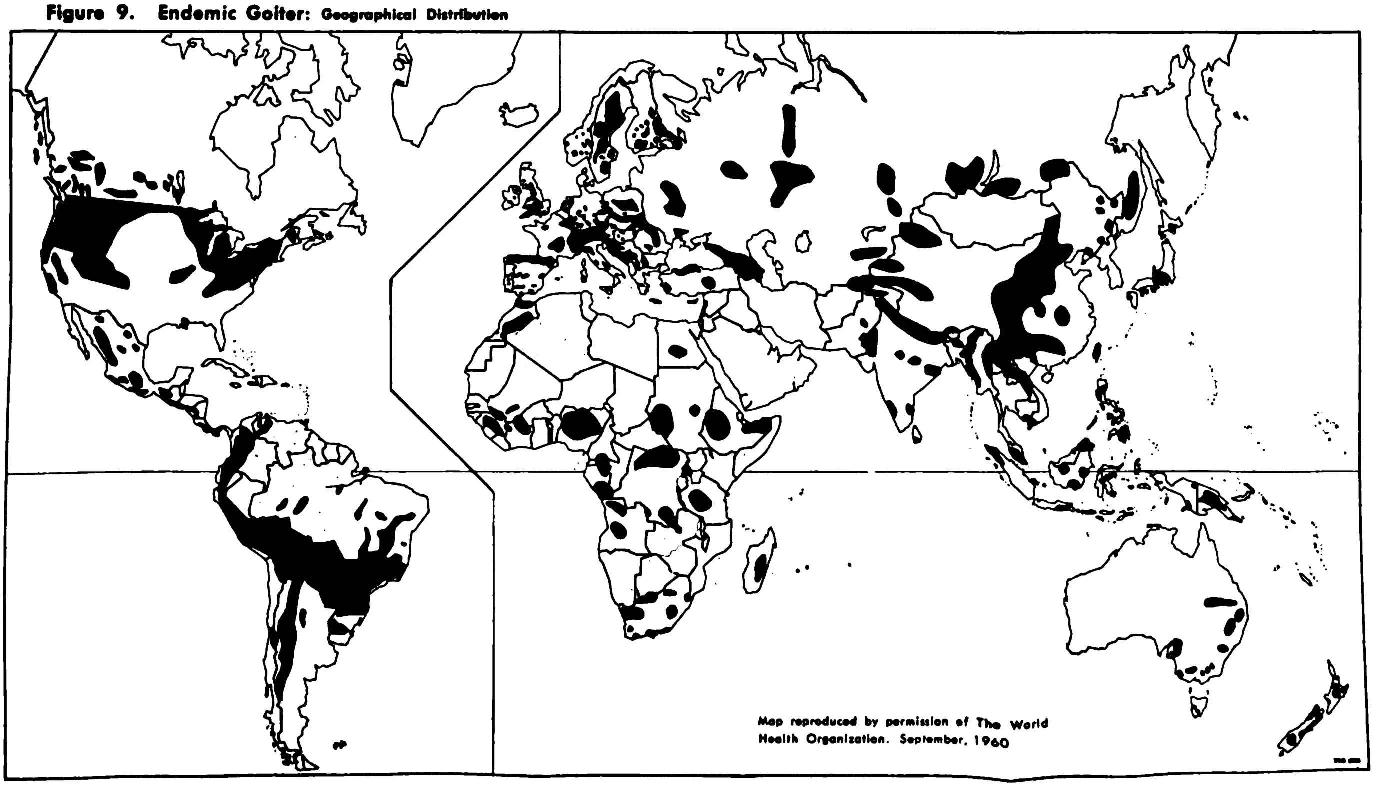
The multiplicity of nutritional diseases renders it difficult to group them in this report. When specific information on any of the different forms of malnutrition is available, it will be singled out for attention.

Caribbean, Central and South America. Information on the distribution of nutritional diseases in this region ranges from the total lack in some areas to detailed studies of a specific nutritional deficiency in others.

In the Netherlands Antilles, clinical examination of children revealed no distinct symptoms of nutritional deficiency. Somatometric examination, on the other hand, showed that, from island to island, there were differences in body weight, muscular development and tissue fat. Skeletal age lagged behind real age from 6 to 12 months. Xerosis and folliculosis of the skin were common and slight liver enlargement was frequent. Dental caries is widespread.[306]

In Puerto Rico, nutritional disorders are now rarely seen.[307] In Jamaica, among malnourished groups, the albumin fraction is low as well as the levels of beta and gamma globulin.[308] In St. Kitts-Nevis-Anguilla a study has shown that diets are deficient in protein, vitamins A and B complex, calcium and iron,[309] and in Dominica in 1955 a disturbing increase in the number of deaths from avitaminosis and other deficiency states was noticed.[310] In the Bahamas malnutrition, mostly of the

Figure 9. Endemic Goiter: Geographical Distribution



protein-deficiency type, is universal among the poorer population groups. Beriberi, anemias and scurvy are found to be common.[311] Artificial feeding is held responsible in Trinidad for malnutrition among infants.[312] In the southern part of this island, fatty liver disease is common in prematurely weaned children under six months of age.[313]

In Mexico, the diet is generally deficient in "first-class" protein as well as vitamins A and C, and riboflavin, calcium and amino acids. Pellagra is found among children.[314] A study of 98 adult inhabitants of a village in Panama revealed that total serum protein varied from 6.45 to 8.72 gm/100 ml. Electrophoretic examination indicated that all serum proteins contributed to the elevated totals, in contrast with studies in other tropical areas where elevated levels of gamma globulin have been held responsible for high total proteins.[315]

A study conducted in a mixed Mayan and Spanish population in a poor agricultural community in Guatemala revealed that the dietary intake of most children was inadequate, especially in vitamin A, riboflavin, calcium, ascorbic acid and protein of good quality. The children's diets compared poorly with the diets of their parents, although these were also inadequate.[316] In Colombia, food is often rich in carbohydrates and fats but deficient in proteins, minerals and vitamins and, among the poor, also deficient in calories. The observed deficiency disease indicated lack of proteins, iron, calcium and vitamins A and B.[317] In Peru, a study of three population groups produced evidence of considerable deficiency in thiamin, riboflavin and nicotinic acid.[318]

Information on goiter in this area is fairly complete.[319] Three of the four states affected in Mexico are located on the Pacific coast. In Guatemala, only the district of Peten is not included in the endemic goiter area. In Honduras, the two departments on the Caribbean coast are little affected as are the inland regions, but the disease is highly endemic on the Pacific coast. In El Salvador, goiter is endemic. In Nicaragua, the heaviest endemic zones are located on the Pacific coast and in the western valleys. In Costa Rica, the over-all prevalence is low except in the Pacific coast areas. Goiter is uncommon on the Atlantic coast of Panama but is frequent elsewhere in the country. In Colombia, the Andes form three mountain ranges which delimit the goiter area, the disease not having been found in the coastal regions. Venezuelan Andes are traditionally thought of as goiter regions but the Orinoco Valley is considered to be free from the disease. In Ecuador, the goiter area is located mainly in the inter-Andean valleys. In Peru, the endemic goiter area occupies all the regions of altitude over 1,500 feet and extends from the coast inland to the 600-foot level. Goiter is not thought to be widely distributed in Chile, but in a small area around the capital goiter is endemic. The disease has also been found to the north of Valparaiso and in Santiago Province, as well as in some coastal areas. The deficiency is widespread in Paraguay and is considered endemic in all the districts of Bolivia. In Argentina, two endemic goiter areas have been identified, one in the Andean valleys and another in the basin of the Prata River. In Uruguay, endemic goiter is found in a small area in the northwest. In Brazil, the deficiency is widespread but the intensity of prevalence varies according to region. Lowest rates are encountered in Pernambuco, Alagoas, southern Sergipe, a small area in Ceará and around Fortaleza. Isolated foci are found in Ceará, southwest Piauí, the coastal areas around Belem, Serra Tiracambú in Maranhão, the coastal zone of Amapá, the interior of Pará, Amazonas, Rio Branco, northwest Bahia, around Vitoria, and Santos and the coastal areas of São Paulo, as well as near Porto Alegre, Rio Grande do Sul. All the regions of Mato Grosso, Santa Catarina, Paraná, Goias, southeast Piauí, western Bahia, Minas Gerais, Rio de Janeiro, São Paulo (except the area referred to previously) and northern Rio Grande do Sul, are highly endemic zones of goiter. No goiter has been found in the Guianas.

Africa. The food availability in Tripolitania, Libya, meets average calorie and protein requirements of the Arab population only marginally and was found deficient in calcium and vitamins A and C.[320] Signs of malnutrition become evident in Libyan children[321] in the first 2 or 3 years of age, active rickets being common. Cheilosis is the most frequently observed sign of malnutrition among them. In the Sudan, scurvy, pellagra and kwashiorkor are widespread and the natural resistance to infection is low;[322] goiter is common and hepatomegaly often found. Anemia is relatively uncommon in Ethiopia but vitamin C deficiency is prevalent as well as protein malnutrition and rickets.[299] The impression is that the general nutritional status of the population is poor.[323] People are underweight, easily exhausted and ready victims of infectious diseases. Many Ethiopians live on a diet supplying about one-third less energy than needed for carrying out even light work. Endemic goiter has also been identified in several areas.[264]

In Mauritania, serious malnutrition was not found in examination of 538 children, but gingivitis was common.[324] In Gambia protein and vitamin deficiencies have been recorded but not to the extent shown elsewhere in Africa.[325]

Malnutrition is found all over the former Belgian Congo. In rural areas the intake of calcium is low by American and European standards, yet there is no indication that people suffer from lack of minerals.[7] Although the caloric need may appear to be satisfied, the nutritional quality of the diet is unsatisfactory, being deficient in protein, especially animal protein, and certain vitamins and minerals.[326] In Brazzaville, considerable hypoalbuminemia and corresponding hypergammaglobulinemia among Africans have been found.[327] In Ruanda-Urundi, signs of vitamin A deficiency are reported common and diet is notoriously low in fat.[328] A survey of 1,057 inhabitants of six villages in Uganda showed that protein supply is uncertain but that the vitamin intake is not markedly deficient. Growth rates in the country were for the most part satisfactory, though tending to slow down after the age of 12.[329] In Tanganyika, growth curves are similar to those of Europe and North America until the age of 6 months. After weaning, African children fall behind in growth, compared with the children of more developed areas.[330] The diet of the Sukuma people in Tanganyika is adequate for the most part.[331] Chronic malnutrition and hyponutrition were found among a large number of children in Matanda in Northern Rhodesia;[28] most of the children showed dry skin and an anemic condition. One of the most frequently encountered nutritional deficiencies in Basutoland is pellagra, but signs of vitamin A deficiency are also present and riboflavin deficiency is common, poor muscular development and poor cellular tissues being prevalent in the country. Among the younger people, retardation of growth and development is often noticed.[28] Endemic goiter is widespread and a serious problem in Basutoland.[332]

On Mauritius, anemia is prevalent and is considered the most important health problem of the island.[28] In the Seychelles Islands, vitamin deficiencies are prevalent;[11] however, here anemia is neither prevalent nor severe and is primarily due to hookworm disease.[131] A WHO study on St. Helena showed that the diet was low in animal protein, very low in iron and riboflavin, and inadequate in vitamin A and ascorbic acid.[28]

Southwest Asia. In Turkey, a survey of military personnel indicated that the diet contained inadequate amounts of vitamin C, vitamin A and riboflavin.[333] Nutritional deficiencies are surprisingly uncommon in Saudi Arabia.[13] Rickets, night-blindness and pellagra are reported but considered infrequent. Undernutrition is commonly seen in Syria, the main deficiency diseases being rickets, scurvy, pellagra, beriberi and anemia.[17] Rachitic manifestations are commonly seen in Yemen, where hemeralopia is not uncommon and gingivitis and stomatitis due to vitamin C deficiency are widespread.[37] The Iraqi diet is generally lacking in protein and minerals and also usually below the minimum caloric requirements.[213]

In Jordan, undernourishment and dietary deficiencies are common, anemia occurs throughout the country and seasonal deficiencies in vitamins A and C are widespread. Scurvy prevails among the poorer Bedouin population. Rickets, xerophthalmia and pellagra have been reported.[15] In Lebanon, the picture is similar, the dietary requirements in protein and minerals are not met and often caloric requirements are not satisfied.[16] Nonspecific avitaminosis, anemia, rickets, scurvy, beriberi and pellagra are commonly reported.

South Central and Southeast Asia. India is an area where famine takes a traditionally large toll. However, detailed information for India is not available and only localized reports on nutritional conditions are found in the literature. Among the rural population of Penhattur the total food supply estimated for adult male and female was considered insufficient to allow much strenuous work and several signs of malnutrition, such as conjunctival pigmentation, Bitot's spots, cheilosis, dry rough skin, palpable liver and low hemoglobin levels, are commonly found.[334] In an orange-growing center in Nagpur, 28 cases of infantile scurvy were recognized.[335] A survey carried out in Madras, Mysore, Kerala and Andhra Pradesh showed that lactation after six months is usually inadequate to supply the needs of children and marked retardation in growth is common.[300] The dietary supply of the people in these regions is inadequate; caloric, protein, mineral and vitamin requirements are not satisfied.[301]

In Pakistan, deaths due to marasmus are reported each week and a study in 1955 showed children to be often affected by xerophthalmia, pellagra, pellagroid pigmentation and oral signs of riboflavin deficiency. Scattered deaths from starvation elsewhere in the country were also reported in 1955.[73]

In Burma, Thailand and Vietnam there is evidence that beriberi is increasing among the rural populations, especially in children.[336] Keratomalacia, leading to blindness, is an important problem in these countries. Thiamin deficiency seems to be widespread in Burma[337] and Vietnam.[338] In Thailand, a survey showed that children and adolescents were generally less affected by nutritional deficiencies than adults. Signs most commonly encountered were changes in tongue, lips, skin and hair, associated with apparent dietary deficiencies in riboflavin, vitamin A and thiamin. In the Bang Chan area, the only clearly defined deficiency disease was beriberi.[122]

In Malaya, a survey showed that caloric, animal protein, vitamin A, riboflavin and thiamin intake is low in the dietary pattern.[339] A study of two groups of population, one Chinese and the other Macanese in Macao,[340] showed marked deficiencies in protein, fat and especially vitamins in both groups. Chronic malnutrition exists in the Jogjakarta area of central Java.[341] Hunger edema occurs sporadically in cities and in rural rice-maize growing areas but is endemic in cassava areas of Java. In the first instance, caloric deficiency is the proximate cause with protein deficiency as a predisposing factor; in the cassava areas extreme protein deficiency due to the cassava diet may be responsible for the endemicity.[342]

In Sarawak, iodine deficiency is encountered in certain areas in the interior.[343] Examination of soldiers in Taiwan during 1954-1955 revealed a high prevalence of ariboflavinosis and pellagroid mouth lesions. Other signs indicated vitamin A insufficiency. Overt beriberi, protein and calcium deficiency were not noted; vitamin C levels were considered barely adequate.[344] Cases of endemic goiter are found among Taiwanese, the main endemic area being Hsinchu Hsien.[46] Deficiencies in riboflavin, iron, vitamin A and niacin were found. Children especially showed evidence of hypoproteinemia and beriberi.[345] Approximately 80 per cent of troops of the Chinese Nationalist Army on Taiwan in 1954-1955 manifested signs of ariboflavinosis; half of the cases were severe. Vitamin A insufficiency was evident in 30 per cent.[344]

Oceania. In the New Hebrides malnutrition is rare.[76] In a small area in the Western Highlands of New Guinea, protein intake was found to be low.[346] In Papua, there is evidence that reduced protein intake is responsible for the fall in serum albumin among the population surveyed in 1958.[347]

Incidence and prevalence

Caribbean, Central and South America. Details of the incidence of endemic goiter were available for some countries. Most of the information on goiter is supplied in a 1959 report as follows:[319]

In Mexico in 1953, incidences of endemic goiter exceeded 30 per cent in four states, three of which (Mexico, Morelos and Tlaxcala) are located on the Pacific side. In the Department of Izabal, Guatemala, the endemic goiter incidence was around 20 per cent but in the departments fronting the Pacific Ocean rates varied from 34 to 54 per cent. A 2 per cent incidence was found in Atlantida, a Department of Honduras bordering Guatemala, but in the Pacific coast incidences as high as 20 per cent or more could be found. In El Salvador, the disease is endemic throughout the country and at La Liberdad, a town on the Pacific coast, an incidence rate of 22 per cent was found. Costa Rica had a general low incidence of goiter, but in some central and Pacific provinces the incidence rate reached 20 per cent. In coastal communities of Santiago Province, Chile, reported incidences from 11 to 20 per cent are available. In the interior of the country the incidence was higher and cretinism common. In Paraguay, examination of populations in 35 towns and villages only twice produced incidences of less than 15 per cent.

In Brazil, a great variation in incidence rates was found from region to region. In Pernambuco and Alagoas, as well as in the southern part of Sergipe, incidence rates of goiter were less than one percent. Isolated foci with incidences varying from 1 to 10 per cent were found in Ceará, Piauí, Belem, Maranhão, Amapá, Pará, Amazonas, Rio Branco, northwest Bahia, the areas along the coast in São Paulo, as well as in Santa Catarina and in the southernmost part of Rio Grande do Sul. Foci where incidence exceeds 10 per cent were found at Marajo Island, Pará, Amazonas and Rio Branco. All the area of the States of Mato Grosso, São Paulo (except the foci mentioned), Rio Grande do Sul (to the north of the area mentioned), Santa Catarina, Paraná, Goias, southeast Piauí, west Bahia, Minas Gerais and Rio de Janeiro have incidence rates well over 10 per cent.

With regard to general malnutrition, the data are not as detailed as those for goiter.

In Mexico, among ill-nourished communities, more than 5 per cent of the children show signs of malnutrition and the pre-school mortality exceeds 40 per 1,000.[314] In Guatemala, a study in a mixed Mayan and Spanish community showed that nearly all children fell below the 16th "percentile" in weight and more than one standard deviation below the mean height, though weight-height ratio was frequently normal. Measurements of skinfold thickness were abnormally low. Of 32 children examined 5 had serum protein levels below 6 gm/100 ml and about the same number had low serum cholinesterase and alkaline phosphatase; half the children had serum-vitamin A levels below 20/μgm/100 ml with low serum-carotene.[348] In Haiti, of 1,323 children examined, 37 per cent showed first degree malnutrition, 21 per cent second degree malnutrition and 3 per cent third degree malnutrition. In this regard 69 per cent presented an abnormally low arm circumference related to poor muscle tissue.[294] In Trinidad, 79 per cent of deaths from malnutrition occur in the first 7 months of age.[312]

Africa. Several studies have been carried out to evaluate the dietary value of food intake in the African population and the incidence of deficiency disease. In the majority of cases the figures are related to the over-all deficiency rate without specification of etiology.

In 1954, a nutritional survey of school children was carried out in Cyrenaica and Tripolitania. A total of 1,150 students from 30 schools was examined. The children were registered in three categories: a) Those of approximately normal height and weight for age according to local standards; b) those obviously below normal size and weight for the age group, with or without objective signs of malnutrition or deficiencies; and c) those showing serious lack of adequate nutrition or frank malnutrition. In Tripolitania, approximately 15 per cent fell in the third category but in Cyrenaica only 10 per cent fell into this category. Follicular hyperkeratosis was found in 14.4 per cent in Cyrenaica and in 17.3 per cent in Tripolitania. Angular stomatitis and/or cheilosis occurred in 10.1 per cent in Cyrenaica and in 11.4 per cent in Tripolitania.[349] Another Libyan study showed that a 1-year-old Libyan child corresponds in weight to a 6-month-old American baby and an 8-month-old Italian baby. At 18 months the Libyan child only equaled the weight of an 8-month-old American baby and a 10-month-old Italian baby. By the age of 5 years the weight curve of the Libyan child approximates that of the Italian but not that of the American child. Of 187 school children examined (6 to 17 years of age) 70.7 per cent presented good nutritional status, 28.2 per cent moderately good nutritional status and 1.1 per cent poor nutritional status. Dental caries was found in 26 per cent and malposition of two or more teeth in 12.2 per cent.[321]

A survey of 65 pupils and staff in a primary school north of Khartoum and of 744 others from six localities in Upper Nile Province, Sudan, showed an over-all incidence of goiter of 49.6 per cent, signs of pellagra in 61 per cent and hepatomegaly in 12.5 per cent.[119]

In Ethiopia, a survey showed that 65 per cent of those examined presented deficient levels of vitamin C. Growth rate is satisfactory up to 5 or 6 months but after that, and up to 6 years, compares unfavorably with that of United States children.[299] A survey carried out in 1958 on about 6,200 adults and children representative of all the major geographic and ethnic regions of Ethiopia and Eritrea showed that the over-all nutritional status was low. The average per cent "standard weight" for Ethiopians was estimated at 82. Twelve per cent of those examined fell below 70 per cent of the standard weight. There was a calculated caloric deficit of up to 400 calories per person per day. Mild rickets was present in up to 30 per cent of school children.

In Nigeria, the incidence of protein malnutrition among children up to 9 years old was 2.2 per cent in millet-eating regions and 5.3 per cent in yam-eating regions. The mean daily protein intake of these two groups was 85 gm. and 51 gm., respectively.[298] At Nsukka, Nigeria, the average birth weight is 6 lb. 4 oz., with a variation of 16 oz. for 70 per cent of those examined, this figure being below the United Kingdom standard of 7 lb. and above the Indian figure of 6 lb. 1 oz. The gain in weight is 9 lb. in the first 6 months and 3 lb. after the first 6 months, these figures in the United Kingdom being 10 lb. and 5½ lb., respectively.[350] In one Nigerian district where there was a shortage of food, only 85 per cent of the required dietary intake was met.[351]

In rural areas of the former Belgian Congo, mean dietary intakes of calcium were 11 mgm/kgm/24 hours, which is low by American and European standards.[326] In Brazzaville, in 2,375 sera examined, 7.5 gm. per cent was the mean protein level, with 45 per cent albumin and 27 per cent globulin.[327] Bitot's spots are found in 10 per 1,000 males and in about 2 per 1,000 females in Ruanda-Urundi although in some districts the incidence was higher.[328] In the environs of Fort Rosebery in Northern Rhodesia, most children suffer from anemia, the average hemoglobin concentration being 50 to 70 per cent and, in several cases, as low as 20 per cent.[28] In Mozambique, 32 per cent of persons studied in the northern districts presented hemoglobin values below 8 gm/100 ml.[131] A WHO survey carried out in Basutoland and comprising 13,140 persons found 41 per cent suffering from endemic goiter, with a range from 30 to 50 per cent according to region.[28]

In Mauritius, 1957 official statistics indicated that about 9 per cent of the population were anemic.[352] A survey in the Seychelles showed that anemia was not as prevalent as in some other African countries.[131] In one study 5,587 inhabitants living in 984 dwellings were examined. Of these, 9.1 per cent proved to be obese, 40.4 per cent were "normal," 41.8 per cent were thin and 8.7 per cent were emaciated. Signs of malnutrition were discovered in about a quarter of those examined.[353] In St. Helena, a 1958 WHO survey showed that the energy value of the diet was 80 per cent of the estimated requirement for optimal development and health at moderate activity levels.[28]

Southwest Asia. No figures were available regarding the incidence or prevalence of any of the nutritional deficiency diseases known to occur in this area.

South Central and Southeast Asia. In Penhattur, India, the total food supply is estimated at just over 1,700 and 1,500 calories per day for adult males and females, respectively. Incidence rates for signs of several deficiencies were found to be as follows: Conjunctival pigmentation, 35 per cent; Bitot's spots, 5 per cent; angular stomatitis, 14 per cent; dry and rough skin, 15 per cent; and palpable liver, 8 per cent. The mean values for hemoglobin were 11 gm. per cent for women and 12.5 gm. per cent for men. In the states of South India (Madras, Mysore, Kerala and Andhra Pradesh) with a population of approximately 94.8 million and a population density of 146 per square kilometer, over 80 per cent of the population lives in villages with agriculture as the main occupation. A survey, confined to 4,536 children under 5 years, in 10 widely separated rural and urban areas, showed 25 per cent to have had a history of diarrhea and 2 to 5 per cent to have suffered from one or more episodes of edema. At the time of examination 12 to 18 per cent of the children were suffering from diarrhea attributable to malnutrition.[301] In the state of Bihar, an examination of over 55,000 children 2 to 15 years of age indicated that the nutritional grading of 8.7 per cent of the boys and 7 per cent of the girls was considered "very poor."[354]

In Taiwan, approximately 80 per cent of military troops showed signs of ariboflavinosis. Approximately 20 per cent displayed the "oral-genital" syndrome, 30 per cent showed signs of vitamin A deficiency, and approximately 20 per cent had pellagroid oral lesions.[344] The incidence of goiter was studied in Hsinchu Hsien, Taiwan, and was found to vary from 44.9 to 58.2 per cent in 6-year-old school children.[46] In another study signs of malnutrition in school children in the 6th grade were found to include the following rates: Riboflavin deficiency, 70 per cent; low urinary thiamin, 55 per cent; iron deficiency, 13 per cent; avitaminosis A, 10 per cent; niacin deficiency, 10 per cent; and hypoproteinemia, 3.2 per cent. The evidence of beriberi was lacking in these children, but an incidence of 6 per cent was found in the adult population.[345]

In Thailand, 46 per cent of the school children and 47 per cent of the families sampled were free of signs of malnutrition. The remainder, representing somewhat more than half of the persons examined, presented from one to seven signs of nutritional deficiency each. The larger percentage of people with two or more signs were in the older age groups.[122]

Oceania. In Guam, there is no over-all insufficiency of food but the intake of some minerals and vitamins tended to be low. The average protein intake is relatively high when compared with diets elsewhere in the Pacific.[355] In a study by Oomen and Malcolm in Papua[356] undernutrition and malnutrition were present in the eight regions visited, though to a different degree and in a different pattern. Among the types of malignant malnutrition, marasmus seemed more common in the sago areas and kwashiorkor in the sweet potato areas. Xerophthalmia was observed infrequently. In certain groups of Highlands children, cretinism was by no means rare. The diet in American Samoa is adequate for the most part, although a limited percentage of children suffer from evident malnutrition.[357] In the Trust Territory of the Pacific, medical opinion is unanimous that overt malnutrition is rare, but it is agreed that approximately 30 per cent of the children, especially those during the period 7-14 months are not in normal nutritional condition.[358]

Morbidity and mortality

According to the figures reported in 1957, nutritional deficiency diseases were responsible for 1,812,367 cases of illness and 29,028 deaths in the survey area (Tables 7 and 8). This group of diseases occupies fifth place as a cause of illness and eighth place as a cause of death among those studied in this survey.

In the survey areas 48.48 per cent of the total population lived in countries and territories where nutritional diseases were reported.

A general morbidity rate of 150.5 per 100,000 and a general mortality rate of 2.41 per 100,000 were found, thus placing nutritional deficiency diseases among the most significant problems in the survey area (Table 18).

South Central and Southeast Asia presented the highest morbidity rate per 100,000 (234.7), which is more than twice that of the next highest rate (Oceania 102.99). The lowest morbidity rate was found in Southwest Asia (0.39). Mortality rates per 100,000 were highest in Oceania (3.91) and South Central and Southeast Asia (3.57) and lowest in Southwest Asia (0.25).

Very high morbidity and mortality rates were found in several countries and territories of the survey area. Some of the most significant rates per 100,000 are presented below:

Caribbean, Central and South America: Dominica (1,791.9 and 320.95), Leeward Islands (1,093.84 and 21.54), British Guiana (832.26 and no deaths) and British Honduras (183.58 and 0.99). Puerto Rico did not report cases but had a mortality rate of 5.43.

Africa: Basutoland (1,581.6 and 11.37), former Belgian Congo (364.59 and 4.45), former French West Africa (218.46 and 1.09), Ghana (163.01 and 2.65), Kenya (95.87 and 3.07), Tanganyika (63.52 and 2.74) and Nigeria (40.82 and 2.12).

Southwest Asia: Cyprus (21.64 and 1.31). Iraq only reported deaths and had a mortality rate of 1.04.

South Central and Southeast Asia: North Borneo (4,472.32 and 2.09), Vietnam (1,835.91 and 0.51), Ceylon (475.94 and 10.99), India (279.28 and 0.46) and Philippines (277.69 and 95.54).

Oceania: U. S. Trust Territory (535.21 and no deaths), British Solomon Islands (194.74 and no deaths), New Guinea (179.63 and 7.48) and Papua (134.61 and 4.27).

Public health importance

The high incidence and prevalence rates noted in several countries, together with high rates for morbidity and mortality and wide distribution of the nutritional deficiency diseases, combine to make this group of diseases one of the most significant of the public health problems considered in this survey.

Undernourishment and malnutrition are associated for the most part with economic conditions and are usually prevalent in the underdeveloped countries with a low per capita income. Concomitant with these conditions is the frequent occurrence of communicable diseases and parasitic infections which are mutually interacting with low nutritional levels. Under these conditions, it is difficult, if not impossible, to define precisely the relative role of these entities in the generally low health status of the population. Consequently, the impact of inadequate food intake and malnutrition *per se* is difficult of analysis. However, it is generally conceded that nutritional diseases tend to recede or to disappear with a rise in the economic level of the population.

Chapter 4

Diseases of Relatively Low But Potentially Great Endemicity

CHOLERA

Distribution

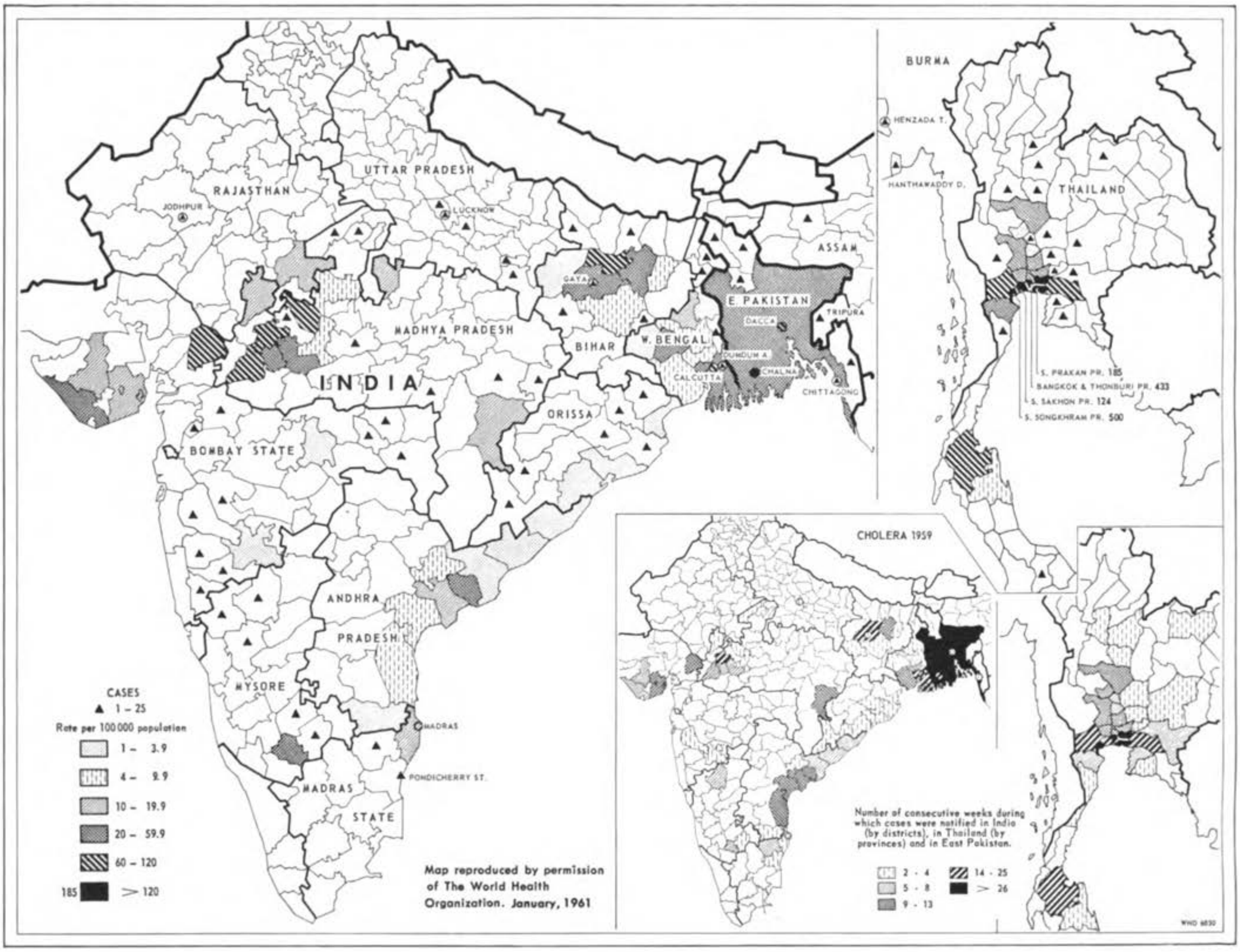
The best summary of the present situation with regard to the distribution of cholera is contained in the Report of the SEATO Conference on Cholera (1961). The following excerpts are taken from this report, which is reproduced in its entirety in Appendix 19.

> "This century has seen a great reduction in the geographic distribution of cholera in the world in comparison with that of the preceding one. No invasion of the Americas has occurred since 1900, and during the past 30 years, and even since World War II, cholera has receded from the Pacific. The only notable spread of cholera in recent years to a non-contiguous area was a short-lived invasion of Egypt in 1947.
>
> "The first decade of the second half-century began with a minimal recognized distribution of cholera; both West Pakistan and Thailand which had outbreaks in late 1940's were free from 1950 to 1958. However, in the past three years, 1958 to 1960, cholera has shown a capacity for expansion. In 1960 outbreaks were recorded in many parts of India, East Pakistan, Burma, Nepal, West Pakistan and Afghanistan. Classic clinical cholera apparently disappeared from Thailand in 1959 during the second year of an epidemic first noted in May, 1958.
>
> "The generally accepted concept of the epidemiology of cholera is that East Pakistan and a contiguous area of India constitute the permanent endemic focus where the infection is always found and from which it tends to spread more or less widely each year as circumstance permits. Health authorities of Thailand were alerted to the increased threat of invasion by cholera early in 1958 by reports of increased activity of the disease in Calcutta.
>
> "The story of the recent epidemic in Thailand is a fascinating one when superimposed on a history of practically constant endemicity from 1916 to 1949 (with marked epidemic waves 1919 to 1920, 1925 to 1929, 1935 to 1937, and 1943 to 1947) followed by a total absence of observed cases from 1950 to May, 1958. This outbreak was characterized by great rapidity of spread to some 38 provinces of the country in a few weeks and a rapid decline following the onset of the heavy monsoons, but with a considerable recrudescence in 1959. . .
>
> "West Pakistan is not part of the endemic cholera focus. It suffered a serious outbreak during the troubled period from 1947 to 1949, but was then free until November, 1958 when the disease was observed in a few towns not far from the Indian frontier. After a quiet period in 1959 the disease reestablished itself in West Pakistan in May, 1960, apparently imported from the port of Bombay. The spread of the infection has been attributed to both water and food, and the epidemic was still continuing in certain areas in November 1960.
>
> "Unfortunately, details of the outbreaks of cholera reported in 1960 are not available from Afghanistan, Nepal, and Burma. . . .
>
> . . . .
>
> "The data on reported cases of cholera in East Pakistan for the past decade, averaging almost 18,000 annually, establish beyond doubt the wisdom of locating the SEATO Cholera Research Laboratory in this area."

Several other reports from Africa, Southwest Asia, and South Central and Southeast Asia confirm the views expressed in the above quotation. Sources consulted showed cases of cholera reported only from Africa (Senegal and Tanganyika), Southwest Asia (Syria), and South Central and Southeast Asia (Burma, Cambodia, India, Indonesia, Laos, Nepal, Pakistan, Thailand and Vietnam).

Figure 10 summarizes the distribution of cholera as it was known in 1959.

Figure 10. The Cholera Situation in 1959



Incidence and prevalence

In South Central and Southeast Asia some references to incidence and prevalence were available for India, Pakistan and Indonesia.

In India the immediate area of Calcutta may be considered hyperendemic with case rates of 30-60 per 100,000 annually. The districts of Hooghly, Burdwan, Midnapur and Nadia are moderately endemic with rates of 15-30 per 100,000. The districts of Bankura, Birbhum and Murshidabad may be considered hypoendemic with rates of 10-15 per 100,000. Of doubtful endemicity, but with epidemics of cholera, are the districts of Maldah and West Dinajpur with case rates of 1-10 per 100,000. The districts of Jalpaiguri and Darjeeling are considered nonendemic with rates of 0-1 per 100,000 annually.[359]

Cholera is of considerable importance in East Pakistan. Between 1948 and 1959, the number of deaths yearly varied between 7,002 and 29,582.[360]

In Indonesia the island of Celebes seems to be the major focus of the disease. An epidemic of paracholera due to the El Tor vibrio was reported in 1957, with high pathogenicity and a case mortality of 88-90 per cent, depending on location, but with a low morbidity rate (2.2 per 10,000 at Makassar).[361] El Tor vibrio infections were also reported from Java, and the disease was said to behave like true cholera, with a high death rate.[362]

Southeast Asia experienced substantial outbreaks of cholera in the latter part of 1961.[363] Sarawak was declared infected on 27 July; there were 268 cases and 50 deaths. The disease appeared in Macao during the week ending 12 August, and 15 cases and 3 deaths were recorded. Hong Kong was declared infected on 17 August and reported 196 cases and 23 deaths. The disease appeared in Manila during the latter part of September and later spread to the central and southern Philippines. It is estimated that somewhat fewer than 5,000 cases occurred with a 15 per cent mortality. As of the middle of January 1962, the disease was probably not under complete control in the Philippines.

Morbidity and mortality

Although cholera is one of five diseases considered notifiable in all of the countries and territories of the survey area, only South Central and Southeast Asia reported the disease officially. Cholera ranked 11th as a cause of illness and 2nd as a cause of death in 1957 among the diseases studied in this survey (Tables 7 and 8).

The general morbidity and mortality rates were 44.3 per 100,000 for the entire survey area (Table 19). The equal rates were occasioned by the fact that three of the four reporting countries failed to report morbidity. While the death rate is high, it certainly escapes being 100 per cent. This rate actually conveys a false impression due to the fact that the disease was confined to only one region of the survey. If the population of that region is alone considered, the rate would be 76.5 per 100,000. Despite the fact that only 11 of the 169 countries reported cholera, more than 50 per cent of the total population of the entire survey area dwelt in the endemic zone as constituted at the time of the survey.

Cambodia, the only country reporting morbidity, had a rate of 0.13 per 100,000. The mortality rates per 100,000 in the four countries reporting were as follows: India (134.31), Pakistan (8.26), Burma (0.1) and Cambodia (0.02).

Public health importance

Although cholera seems to be confined to South Central and Southeast Asia and has shown a tendency toward decline during the present century, nevertheless, it still is one of the chief causes of illness and death among a population constituting more than half that of the areas included in the survey. This fact, rather than its geographical limitations, must be considered in assigning it a position of major importance among the diseases considered in the survey.

PLAGUE

Distribution

Plague was reported from only 24 of the 169 countries and territories of the survey area. In Oceania no reference to the existence of the disease was found in the literature. Of the countries reporting plague, nine were in South Central and Southeast Asia, eight were in Africa, five were in the Caribbean, Central and South America and two were in Southwest Asia (Table 10). The number of cases of plague reported in 1957 totaled

Table 19. Morbidity and mortality due to bacterial diseases of relatively low endemicity but potentially important, as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY					
		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Cholera	Relative population[1]	—	—	—	71.91	—	41.68
	Morbidity (per hundred thousand)	—	—	—	76.50	—	44.30
	Mortality (per hundred thousand)	—	—	—	76.50	—	44.30
Plague	Relative population[1]	39.39	20.64	—	75.45	—	53.93
	Morbidity (per hundred thousand)	0.079	0.046	—	0.058	—	0.055
	Mortality (per hundred thousand)	0.012	0.035	—	0.031	—	0.027

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

662. Of these, 23 per cent were from the Caribbean, Central and South America, 16 per cent from Africa, 61 per cent from South Central and Southeast Asia. No cases were reported from Southwest Asia or Oceania. (Figure 1-d.)

According to one report on the world-wide distribution of varieties of the plague bacillus, *Pasteurella pestis* var. *orientalis* has been identified in Arabia, Argentina, Brazil, Ceylon, Egypt, India, Malaya, Indonesia (Java and Sumatra), Malagasy, Morocco, Israel, Senegal, Taiwan and Thailand, to include only those countries which fall within the area of the survey. *P. pestis* var. *anticua* has been reported from the former Belgian Congo and Uganda and *P. pestis* var. *mediaevalis* from Iran. Mixed varieties have been recognized in Kenya, the Philippines and South Africa.

Figure 11 presents the distribution of plague in 1959.

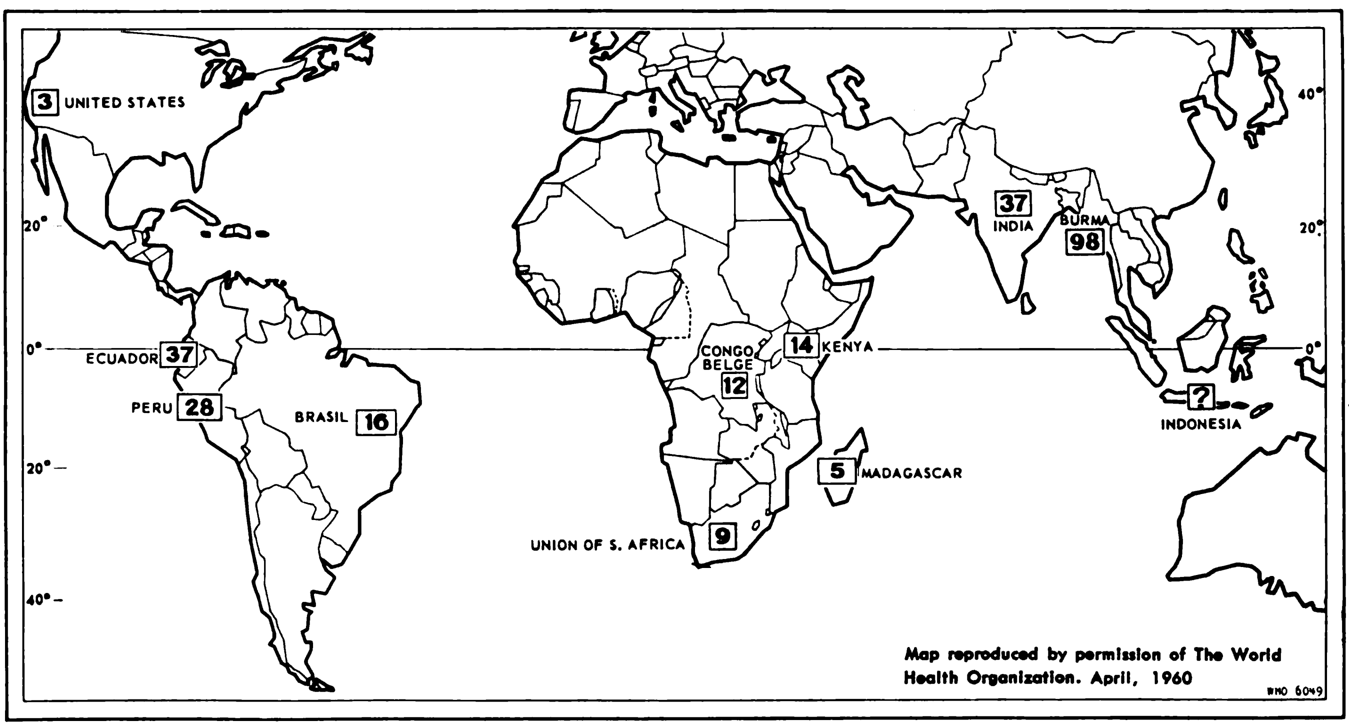
Incidence and prevalence

Reference is made below to some very general statements with regard to prevalence in the survey area.

In the Caribbean, Central and South America during the period from 1953 to 1957 only five countries reported cases of plague, namely, Bolivia, Brazil, Ecuador, Peru and Venezuela.[21] The endemic area of plague in Bolivia occupies a narrow strip in the south central region extending from the frontier with Argentina to Santa Cruz in a zone intermediate between the mountainous region in the west and the plains in the east and southwest. In the last twelve years, 15 outbreaks of human plague have been recorded in 40 localities in the departments of Chuquisaca, Tarija and Santa Cruz. The number of individual cases varied from 1 to 14, but were usually less than 7. There were 179 cases in all during the period 1949-1960, with 91 deaths (50.84 per cent).[364] Twenty cases were reported in March 1961. Sylvatic plague was not considered to be of practical significance in northeast Brazil.[365] Endemic foci of plague have long existed in the Peruvian departments of Piura and Tumbes, as well as in contiguous areas across the border in Ecuador. Macchiavello[366] conducted studies on sylvatic plague in the Lancones district, department of Piura, where human plague is seasonal and occurs during the maize harvest.

In Africa an epidemic of pneumonic plague in Doany, Madagascar, in 1957 was considered most serious. The main spread of infection was in family groups, among those tending the sick and along the routes of transport of the sick or dead.[367] In the former Belgian Congo, sylvatic plague is enzootic with sporadic cases occurring in scattered villages in the forest and bush country around Lake Albert and Lake Edward. From 1952 to 1958 the average number of human cases reported per year was 28. The disease nevertheless presents

Figure 11. Reported Cases of Plague in 1959



an average high fatality rate of 60 per cent.[7] Human plague in southern Africa is thought to result usually from transient murine foci derived from permanent sylvatic foci, *Mastomys* being the strongest link between the cycles.[368]

In Southwest Asia, Saudi Arabia is known to have epidemics of plague about every twenty years. The last such epidemic occurred in 1923-1924 and killed 10-20 per cent of the population.[13] In Iraq a minor outbreak of plague was reported in 1945 but no reports of the disease have since been made.[213] In November 1958 an outbreak of bubonic plague occurred in Iran in the region of Miandoab south of Lake Rezaïeh.[369] In Syria the disease is reported infrequently and may be considered uncommon.[17] In Jordan, although *Xenopsylla cheopis* and potential rodent reservoir hosts are abundant, the disease has not appeared for many years.[15] *Xenopsylla cheopis* is also prevalent in Turkey but the last plague outbreak occurred in 1947 and involved only 18 cases.[38] In Lebanon no cases of plague have been reported since shortly after World War II but the possibility of an outbreak still exists.[16] Bahrain has had serious outbreaks in the past and a potential danger exists, mostly at Manama and Muharraq.[14]

In South Central and Southeast Asia the disease has been endemic in Thailand since it appeared there in 1904.[370] On Taiwan proper the last case of plague was reported in 1947. On Quemoy, the last deaths from the disease were recorded in 1951.[46] Vietnam maintains old foci of plague and as of 1956 still reported cases and deaths from the disease but the incidence seems to be low.[371] In Assam, India, a small outbreak of bubonic plague occurred in Gauhari in 1956; there had been no previous record of plague in Assam. Of the four cases diagnosed, two died.[372] In the province of Uttar Pradesh, India, plague has been known to persist for over fifty years. The spread of infection in rural areas is due to field rodents, among which epizootic outbreaks flare up, spreading from burrow to burrow and infecting village rats in passing. The persistence of rural plague is associated with the relatively high resistance to the disease of the most abundant field species, the Indian gerbil, *Tatera indica*.[373] A similar focus exists in Central Java.[374] Regardless of the potential menace of plague in India, there has been a marked reduction in the disease in recent years. The annual death rate from plague in the different states has varied from year to year and reached its peak in 1947 when the rate per 100,000 was 18.61. By 1957, the rate had been reduced to 0.0044.[375]

Burma, Cambodia, India and Indonesia all consistently reported cases and deaths due to plague but no incidence or prevalence figures were available.

Morbidity and mortality

Plague can be considered to be steadily declining and has ceased to constitute a major health problem in the survey areas. The potential danger of spread still exists because of permanent endemic foci of human plague and the presence in many areas of sylvatic plague.

As a cause of illness and death, plague ranks as 33rd and 26th, respectively, among the diseases studied in this survey (Tables 7 and 8).

The total morbidity rate gathered from reported cases in 1957 was 0.055 per 100,000 and the total mortality rate was 0.027 per 100,000 (Table 19). The Caribbean, Central and South America showed the highest morbidity rate (0.079) and Africa the highest mortality rate (0.035). Only 13 of the 169 countries and territories surveyed reported plague in 1957, yet the disease is considered notifiable in all of the countries in the survey area. Although morbidity rates are low, 53.93 per cent of the population of the survey area lived in countries which reported the disease in 1957.

High morbidity or mortality rates were not registered for the few countries reporting the disease. The rates per 100,000, respectively, were as follows:

Caribbean, Central and South America: Ecuador (1.95 and 0.57), Peru (0.37 and no deaths) and Brazil (0.06 and no deaths).

Africa: Malagasy (1.13 and 0.95), former Belgian Congo (0.26 and 0.22), Uganda (0.09 and no deaths), Kenya (0.08 and 0.02) and Tanganyika (0.06 and 0.01).

South Central and Southeast Asia: Burma (1.13 and 0.21) and Vietnam (0.01 and 0.004). India, Cambodia and Indonesia reported only deaths with the following mortality rates: 0.04, 0.02 and 0.01, respectively.

Southwest Asia and Oceania: The disease was not reported from these two areas in 1957.

Public health importance

It is evident from the information gathered that plague is no longer a public health problem of major importance. Morbidity and mortality rates reveal the disease to be only a minor health hazard. However, it is still reported in a rather large number of tropical countries. In view of the continuing existence of endemic foci in certain countries, the disease constitutes a constant threat requiring close surveillance until the foci can be eliminated.[376]

RELAPSING FEVERS

Distribution, incidence and prevalence

The presence of relapsing fever (Plate IV) was acknowledged in all the regions of the survey area with the exception of Oceania; 49 of the 169 countries and territories in the survey area reported the disease. The reports covered 28 of 58 countries in Africa, 7 of 18 in Southwest Asia, 5 of 24 in South Central and Southeast Asia and 9 of 46 in the Caribbean, Central and South America (Table 10).

The vast majority of the 7,661 cases of relapsing fever for which official accounts were available in 1957 occurred in Africa (96 per cent). Of the remainder, 3 per cent were in the Caribbean, Central and South America, 1 per cent in Southwest Asia and less than half of 1 per cent in South Central and Southeast Asia. None was in Oceania. (Figure 1-e.)

In the former Belgian Congo the reported cases are mostly of the tick-borne type although the louse-borne type is present.[7] In Ethiopia there is a vast focus of relapsing fever of the louse-borne type. The number of cases mentioned by Sparrow (see Appendix 19) between 1950 and 1960 varied annually from 2,227 in 1956 to 7,499 in 1953. This focus seems to extend to the highlands of east and central Africa.[377] In Eritrea an epidemic of relapsing fever occurred in 1958, starting in Asmara in January and lasting the entire year, with a total of 707 cases diagnosed microscopically.[378]

Both forms are known to be widespread in Jordan.[15] Tick-borne relapsing fever is sporadic in Israel and almost always contracted by individuals entering caves infested with *Ornithodorus*. Small outbreaks have been reported among children on picnics and excursions.[144] Relapsing fever is considered uncommon in Syria where it is reported infrequently.[17] The highlands of Yemen serve as foci of relapsing fever, Taiz and nearby localities being considered important centers. In the highlands the disease is mainly louse-borne but in the lowlands the tick-borne type predominates.[37] Although the disease has not been reported from Saudi Arabia, it may be present but undiagnosed.[13] In Iraq relapsing fever has shown a decrease in incidence; there is no information regarding the type predominating.[213] In Aden relapsing fever is seldom reported.[14]

Louse-borne relapsing fever is endemic in West Pakistan.[73] Relapsing fever was formerly reported from Taiwan but in the past ten years no case has been notified.[46] The louse-borne type was the predominant one.

Morbidity and mortality

Based on the information data for 1957 (Tables 7 and 8) it was found that relapsing fever of all forms was responsible for 7,661 cases and 66 deaths in the

Table 20. Morbidity and mortality due to spirochaetal diseases of relatively low endemicity but potentially important, as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY: CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Relapsing fever (all forms)	Relative population[1]	29.19	54.76	43.90	0.055	—	18.12
	Morbidity (per hundred thousand)	0.12	3.20	0.11	0.00072	—	0.64
	Mortality (per hundred thousand)	0.0037	0.025	—	—	—	0.0055
Leptospirosis	Relative population[1]	20.60	10.94	2.39	2.39	4.69	6.93
	Morbidity (per hundred thousand)	0.0079	0.15	0.42	0.0072	0.72	0.039
	Mortality (per hundred thousand)	0.0052	0.032	0.025	0.002	0.11	0.009

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

survey area, placing it 28th among causes of illness and 29th among causes of death of the diseases considered in the survey.

Table 20 summarizes the information obtained with regard to morbidity and mortality. Relapsing fever showed a total morbidity of 0.64 per 100,000 and a total mortality of 0.0055 per 100,000 in the survey area. The total population of countries reporting relapsing fever was 218,234,000, or 18.1 per cent of the total survey area.

Africa, with 54.8 per cent of its population living in countries in which the disease was reported, seems to be the principal region where the infection prevails. The morbidity rate for this region was 3.2 per 100,000 and the mortality rate 0.025 per 100,000, both the highest rates found in the entire survey area. Otherwise, mortality was only reported in the Caribbean, Central and South America, with a rate of 0.0037 per 100,000 and a morbidity rate of 0.12 per 100,000, the second highest in the area. Apart from Oceania, where the disease was not reported, the lowest morbidity rate was found in South Central and Southeast Asia (0.00072 per 100,000).

As of August 1961, Ethiopia continued to be a highly endemic area for louse-borne relapsing fever. Tick-borne relapsing fever was reported during the first seven months of 1961 in Angola, the number of cases exceeding those for the same period of 1960. Unspecified disease was recorded from Gabon, Morocco, Nigeria and Sudan. In Southwest Asia, the tick-borne type was still being recognized frequently in Israel and Jordan.[379]

Morbidity and mortality rates were generally low in the countries reporting relapsing fevers. The highest rates per 100,000 for each region were as follows:

Caribbean, Central and South America: Colombia (1.11 and no deaths), Venezuela (1.08 and no deaths) and Mexico (reported only deaths, with a rate of 0.02).

Africa: Tanganyika (19.49 and 0.31), Ruanda-Urundi (18 and 0.19), Ethiopia (16.18 and 0.04), Mozambique (5.8 and 0.13) and former Belgian Congo (4.3 and 0.04).

Southwest Asia: Jordan (4.08 and no deaths) and Israel (1.46 and no deaths).

South Central and Southeast Asia: Malaya (10.64 and 0.16) and Ceylon (3.99 and 0.28). India and Pakistan reported only deaths, with rates of 0.13 and 1.12, respectively.

Public health importance

The relapsing fevers seem to have attracted very little interest on the part of researchers. Practically no information was obtained regarding incidence and prevalence, suggesting that the disease has not been viewed as an important public health problem. To a certain extent this is confirmed by the morbidity and mortality reports. However, the potentiality of epidemics arising from permanent foci of endemicity needs to be kept in mind.

LEPTOSPIROSIS

Distribution, incidence and prevalence

Only 37 of the total number of countries and territories under survey provided data regarding the presence of leptospirosis (Table 10). The largest number of countries reporting the disease was found in Africa (14 of 58). In South Central and Southeast Asia the disease was reported by 7 of the 24 countries.

The disease is present in the five areas of the survey but detailed information regarding distribution is lacking, except for the Caribbean, Central and South America. In 1957, of 478 cases of leptospirosis reported, 3 per cent were from the Caribbean, Central and South America, 74 per cent from Africa, 7 per cent from Southwest Asia, 11 per cent from South Central and Southeast Asia and 5 per cent from Oceania (Figure 1-c). The known features of the world distribution of leptospirosis are summarized in Plate V.

A detailed study of the distribution of serotypes of leptospiral species in the Caribbean, Central and South America indicates that *L. icterohemorrhagiae* has been reported from Mexico, Cuba, Puerto Rico, Argentina, Brazil, Uruguay, Surinam, Ecuador, Peru and Chile. It has been recovered principally from the rat. Other leptospires which have been identified at one time or another with human infections include *L. canicola*, principally a dog parasite, recorded from Argentina, Brazil and Peru; *L. pomona*, found primarily in cattle and swine, recorded from Argentina; *L. grippotyphosa*, *L. ballum*, *L. borincana*, *L. djatzi* and *L. alexi*, all from Puerto Rico; *L. kremastos* from Jamaica and *L. bataviae* recorded from Peru.[380]

With regard to other regions, partial information was available from certain countries. In the former Belgian Congo, infection with *L. icterohemorrhagiae* numbered 254 cases, with 75 deaths, in 1957; the great majority (198) of the total reported and all the deaths were from Kivu Province.[7] Leptospirosis, although not reported, is known to be endemic in Turkish Thrace; the Mediterranean area and European Turkey have been reported to have widespread occurrences of the disease caused by *L. icterohemorrhagiae*. *L. bovis palaestinensis* has been reported from the area between Gelibolu and Izmir and at Ankara, according to a 1950 report, although it may exist in other areas of Turkey.[38] The prevalence of the disease in Taiwan is not known and cases reported in the past ten years have not been confirmed by laboratory techniques. Sodoku is considered uncommon in Taiwan, although rat bites are relatively frequent in the island.[46] On Rarotonga, in the Cook Islands, rats are plentiful but no cases of leptospirosis or jaundice have been admitted to the hospital in recent years.[77]

In the former French community of nations,[381] leptospirosis exists in Morocco in the cities of Casablanca, Rabat, Meknès and Fèz, from which 132 serodiagnoses were conducted in the Pasteur Institute in Paris between 1945 and 1959 with 51 positives. Human infection was noted with *Leptospira icterohemorrhagiae*, which was the type most commonly observed; *L. canicola* exists also as a human infection and *L. grippotyphosa* was serologically identified from Rabat. Few human cases have been diagnosed in Tunisia but *L. icterohemorrhagiae* has been identified. In the former French West Africa, human cases have been recognized in a few instances, the serologically positives being due to *L. icterohemorrhagiae* and *L. canicola*. In the former French Equatorial Africa, the disease has been diagnosed to a limited extent with identification of serotypes *L. bataviae*, *L. grippotyphosa* and *L. australis*. In the Malagasy Republic, several studies have been conducted on infection in lower animals. Serodiagnosis was made in one human case which was apparently due to *L. australis*. Infection is not uncommon in domestic animals.

In former Indochina, extensive serological surveys have been carried out. Epidemics of leptospirosis in military personnel in 1950 and 1952 permitted isolation and identification of serotypes. Human infection has occurred with *L. icterohemorrhagiae*, *L. canicola*, *L. grippotyphosa*, *L. australis* and *L. bataviae;* the latter two are present frequently in man and domestic animals.

In New Caledonia in 1957, three of five patients gave positive reactions to agglutination tests with *L. icterohemorrhagiae*. In 1952, of 35 human sera from Tahiti, 7 were positive for *L. icterohemorrhagiae* and 4 doubtful.

In French Antilles, human cases have been diagnosed in Guadeloupe and Martinique, although some of the diagnoses were clinical and not confirmed serologically. In French Guiana up to 1954 serodiagnosis was positive in nine human cases with *L. icterohemorrhagiae*.

In Egypt (UAR) serum samples from 368 individuals occupationally associated with bovines were examined by an agglutination-lysis test; samples were also tested from 558 buffaloes and 388 cattle. Antibodies against serotypes were detected in 38 samples. Three individuals showed antibodies against *Leptospira autumnalis*, *L. grippotyphosa* and *L. malaya*, respectively. Among 27 buffaloes, reactors were found against *L. autumnalis*, *L. bataviae*, *L. canicola*, *L. icterohemorrhagiae* A and *L. icterohemorrhagiae* AB. Eight cows had antibodies against *L. bataviae*, *L. canicola*, *L. icterohemorrhagiae* A, *L. icterohemorrhagiae* AB or *L. malaya*. Apparently leptospirosis has a low incidence in Egypt (UAR).[382]

In a survey of 327 sera from healthy natives in the territory of Papua and New Guinea, 188, or 57.5 per cent, were found to contain antibodies of one or more serotypes at titers varying from 1/100 to 1/1,000. Of the positive sera, 58, or 30.9 per cent, contained, exclusively, antibodies of the *L. hebdomadis* serogroup.[383]

Morbidity and mortality

Leptospirosis occupies 34th place as a cause of illness and 27th place as a cause of death of the diseases considered in the survey (Tables 7 and 8).

In 1957 rates per 100,000 for morbidity and mortality were very low for this disease, being 0.039 and 0.009, respectively, in the total survey area (Table 20). Oceania had the highest morbidity rate (0.72) of any area surveyed. The lowest rate was found in South Central and Southeast Asia (0.0072). These areas also presented the highest and lowest mortality rates recorded for this disease (0.11 and 0.002, respectively).

In the Caribbean, Central and South America four countries reported the disease but only two of them reported deaths. In Venezuela the morbidity rate was 0.07 and in Jamaica it was 0.06, neither of these countries reporting deaths. In Mexico and Barbados, reported mortality rates were 0.01 and 3.51, respectively.

In Africa only four countries reported leptospirosis, of which only the former Belgian Congo reported deaths. Morbidity rates were 4.53 in Sierra Leone, 2.5 in the Seychelles, 1.87 in the former Belgian Congo (which had a mortality rate of 0.55) and 0.02 in Algeria.

In Southwest Asia only Israel reported the disease with morbidity and mortality rates of 1.77 and 0.1, respectively.

In South Central and Southeast Asia, three countries reported leptospirosis. Singapore presented a morbidity rate of 1.23 and a mortality rate of 0.07. In Malaya these rates were 0.49 and 0.21, respectively. In Ceylon, where no deaths were recorded as due to this disease, the morbidity rate was 0.01.

In Oceania the disease is known in the islands of Wallis and Futuna, but lack of data does not permit the establishment of morbidity and mortality rates. Elsewhere, Tonga had morbidity and mortality rates of 26.32 and 3.51, respectively. On Guam morbidity was measured at 2.7 although no deaths were reported. In French Polynesia morbidity was 2.67 and no deaths were recorded.

Public health importance

On the basis of the extremely low figures for morbidity and mortality, it will be seen that leptospirosis occupies a minor position as a public health hazard in the areas of the survey. However, it should be kept in mind that many cases undoubtedly lack diagnosis.

TYPHUS FEVER (ALL FORMS)

Distribution, incidence and prevalence

Plates VI and VII present the distribution of all forms of typhus fever in the areas included in the survey.

The information obtained for this survey is summarized in Table 10 and shows that typhus fevers were reported from 81 of the 169 countries and territories of the survey area. Reports emanated from 19 of 46 countries in the Caribbean, Central and South America, 34 of 58 countries in Africa, 10 of 18 countries in Southwest Asia, 17 of 24 countries in South Central and Southeast Asia and 1 of 23 countries in Oceania.

In 1957, of 15,384 officially reported cases of typhus fevers, 12 per cent were from the Caribbean, Central and South America, 70 per cent from Africa, 1 per cent from Southwest Asia and 16 per cent from South Central and Southeast Asia (Figure 1-f).

Typhus of the Brill type has been only recently described from South America.[384] In Peru, low titer complement fixation results on 7,000 persons provided evidence of past typhus infection in 94 per cent of the rural population above 40 years of age.[385] However, the latest available information with regard to the incidence and prevalence of the various forms of typhus would seem to indicate that in the Caribbean, Central and South America, the most important endemic foci are still in Colombia, Ecuador and Mexico.[379] In Puerto Rico, the number of reported cases of murine typhus in 1944 was 189, and in 1945, 199. In 1954 and in successive years no cases of murine typhus have been recognized in San Juan, and in 1958, 1959 and 1960 none was reported in Puerto Rico as a whole. The disappearance of this disease in the island would seem to be associated with a concomitant but unexplained reduction in numbers of the rat flea, *Xenopsylla cheopis*.[386]

With regard to the African region, murine and epidemic typhus are found in the Nile Valley. *R. prowazeki* antigen gave positive results in complement fixation tests in up to 19.3 per cent of sera examined in Egypt and Sudan. It is thought that the endemicity of louse-born typhus in Egypt is due to recrudescences of the Brill-Zinsser type.[387]

Murine typhus is enzootic in rats in Tunis.[388] It is suspected that Kivu Province (Republic of the Congo) and Ruanda-Urundi are sites of endemic louse-born typhus. Murine typhus is endemic in the former country and the majority of cases are reported from Kivu but the agent has also been found in Coquilhatville, Leopoldville, Matadi, Elisabethville and Costermansville, as well as from the Congo basin below Stanleyville and in the Kasai, Katanga, Lake Kivu and Ituri River regions.[7]

Two outbreaks of typhus occur annually in Ethiopia, one in June and the other in December and January. Reiss-Gutfreund[389] claimed to have demonstrated that *R. prowazeki* may be harbored by domestic animals and visualized that two cycles of infection may occur in certain tropical countries, *i.e.,* domestic animal-tick-domestic animal and man-louse-man. It was stated that the cycles may be linked through the accidental infection of man by ticks.

In southwest Asia, flea-born typhus has been reported from Muscat and Oman.[14] Louse-borne typhus occurs in the upper highlands of the Aden Protectorate and murine typhus is probably also endemic in this country. The vectors of flea- and tick-borne typhus are widespread in Saudi Arabia but the disease has not been reported; sporadic cases of louse-borne typhus are seen. In Yemen, louse-borne typhus causes epidemics from time to time; the major focus of infection is situated in the highlands. However, flea-borne typhus appears to be more important in Yemen than louse-borne typhus.[14] Sporadic epidemics of louse-borne typhus occur in Jordan, but murine typhus is rare.[15] Tick-borne typhus is rarely encountered in Iraq and murine typhus occurs only sporadically.[213] In Lebanon, flea-borne typhus has been reported and murine and louse-borne typhus also occur.[16] Louse-borne typhus occurs only rarely in Syria and only sporadic cases of flea-borne typhus are found.[17] In Turkey, both louse-borne and murine typhus are reported only occasionally and are considered unimportant in the country. In the spring of 1954 an estimated 10 to 20 cases per month of louse-borne typhus occurred in Turkey.[38]

In South Central and Southeast Asia, scrub typhus has been reported along the Pakistan-Burma frontier and in other parts of East Pakistan. Scattered cases of louse-borne typhus were reported throughout West Pakistan in 1948. Murine typhus has not been reported.[73] Scrub typhus continues to be recognized in the Federation of Malaya.[379]

In Taiwan, epidemic typhus has not been recorded for ten years. The louse *Pediculus humanus* exists on the island and the immunity of the population is low. Endemic typhus occurs in Taiwan but only sporadically. Scrub typhus is transmitted in Taiwan by *Trombicula akamushi*, the rodent *Microtus montebelli* being the most important reservoir host. An epidemic of this disease occurred in the Pescadores Islands in 1954.[46]

Morbidity and mortality

Tables 7 and 8 indicate that the various forms of typhus fever were 22nd as a cause of illness and 16th as a cause of death in 1957 among the diseases studied for this survey.

In 1957 typhus fevers were responsible for a total morbidity rate in the survey area of 1.27 per 100,000 and a total mortality rate of 0.2 per 100,000 (Table 21). The highest morbidity rate was from Africa (4.7), while the highest mortality rate was reported from the Caribbean, Central and South America (0.45). The lowest rates for morbidity and mortality were recorded from Southwest Asia (0.34 and 0.0062, respectively).

Typhus fevers are legally notifiable in all of the countries included in the survey. However, of the total population of the survey area, only 69.51 per cent lived in countries reporting these fevers.

Morbidity rates do not represent the true lethality of the disease since deaths were attributed to typhus in only nine countries.

In the Caribbean, Central and South America the highest rates per 100,000 for morbidity and mortality due to typhus fevers were found in Ecuador (5.06 and 0.31), Colombia (4.35 and 4.32), Bolivia (2.02 with no deaths recorded), Mexico (1.77 and 0.73), Chile (1.76 with no deaths recorded) and Peru (1.29 with no deaths recorded).

In Africa the countries with the highest morbidity and mortality rates were Ethiopia (46.68 and 0.09), Libya (13.5 and 0.09), the former Belgian Congo (2.68 and 0.07), Ruanda-Urundi (2.23 and 0.02) and Egypt (1.95 and 0.11).

In Southwest Asia the following countries had the highest rates: Israel (9.23 and no deaths recorded), Trucial Oman (6.25 and no deaths recorded), Iraq (0.66 and 0.03) and Afghanistan (0.24 and 0.02).

In South Central and Southeast Asia the following rates were recorded: Malaya (10.64 and 0.16) and Ceylon (3.99 and 0.28). India and Pakistan reported only deaths, the respective rates being 0.13 and 1.12.

Public health importance

Although typhus was reported from almost half of the countries and territories of the survey, the recorded morbidity and mortality rates were generally low with some notable exceptions. In certain areas, such as Ethiopia, Libya and Malaya, typhus constitutes a problem of first-hand importance, but in the totality of the areas surveyed it can only be considered of minimum concern.

Table 21. Morbidity and mortality due to rickettsial diseases of relatively low endemicity but potentially important, as reported in 169 countries and territories in 1957

		GEOGRAPHIC AREAS OF THE SURVEY					
DISEASES		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Typhus	Relative population[1]	51.79	67.35	83.60	73.80	—	69.51
	Morbidity (per hundred thousand)	0.93	4.70	0.34	0.36	—	1.27
	Mortality (per hundred thousand)	0.45	0.027	0.0062	0.22	—	0.20

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

DENGUE

Distribution, incidence and prevalence

According to reports, dengue presented a rather limited distribution. Only 34 of the 169 countries and territories of the survey acknowledged its presence, including 8 of 46 in the Caribbean, Central and South America, 12 of 58 in Africa, only 3 of 18 in Southwest Asia, 8 of 24 in South Central and Southeast Asia and 3 of 23 in Oceania.

In 1957, official reports indicated a total of only 801 cases of dengue in the entire survey area. Such a low number is extremely unlikely and suggests a serious degree of under-reporting with respect to this infection. Only 1 per cent of this number (8 cases) were from the Caribbean, Central and South America. Most of the reported cases occurred in Africa (87 per cent). None were from Southwest Asia. Of the rest, 7 per cent were from South Central and Southeast Asia and 5 per cent from Oceania. (Figure 1-a.)

The disease is either endemic or occurs sporadically, but occasionally epidemic outbreaks of importance have been recorded, such as the epidemic in Panama in 1941-1942,[390] and the outbreak in Yemen in 1954 in which almost 98 per cent of the population of Hodeidah were involved.[37]

Eradication of the chief vector *Aëdes aegypti* has certainly contributed to the disappearance of the disease in certain countries, as is the case in the Canal Zone[390] and other areas in Central and South America. In Panama City hemagglutinin-inhibiting antibodies were found in 27 per cent of 213 sera examined. In persons less than 20 years of age, of 15 positive sera, 8 had dengue-2 antibody but none had dengue-1 antibody.[390]

In the former Belgian Congo, dengue is considered endemic. Between 1952 and 1957, an average of 244 cases was reported annually in the Congolese and 118 among the European population.[7]

Dengue is considered endemic in Qatar[14] and Iraq.[213] It has been reported to occur in Saudi Arabia in the Red Sea and Persian Gulf areas and in Trucial Oman and Muscat.[14]

It is thought to be endemic in Pakistan.[73] In India, it is understood that dengue type 4 virus has been isolated from cases of hemorrhagic fever. In the Philippines in 1954, an unusual clinical syndrome, not immediately associated with dengue, made its appearance and at that time was termed hemorrhagic fever. Subsequently, a similar outbreak occurred in Manila in 1956, when some 750 cases were observed in hospitalized children. A similar condition was recognized in Bangkok, Thailand, in 1954 and in 1958 about 3,000 cases were hospitalized with some 250 deaths. Cases were also recognized in 1959, 1960 and 1961. Dengue types 3 and 4 have been described from cases in the Philippines; similar types of dengue virus were isolated in Bangkok in addition to Chikungunya virus and types designated as TH-Sman and TH-36. TH-Sman is closely related to dengue type 1 and TH-36 to dengue type 2; they may represent new strains of dengue virus.[391] An outbreak of hemorrhagic fever occurred in Singapore in 1960 and dengue types 1 and 2 have been tentatively identified from patients.[392] It thus becomes apparent that dengue is probably more widespread and of more frequent occurrence in Southeast Asia than previous reports would indicate. In one case, however, the opposite seems to be true. The last reported epidemic on Taiwan occurred in 1943. No cases have been recorded since 1948 and the disease is not now considered endemic on the island.[46]

In the Society Islands (French Polynesia), the disease has not been recorded since 1944 when an epidemic occurred. It is thought that all susceptibles became immune at this time.[393] In Fiji, from 1953 to 1957, the number of cases reported annually varied between 12 and 72.[49]

Morbidity and mortality

Because laboratory diagnosis is often lacking in underdeveloped areas, and because of clinical similarities with other conditions, dengue undoubtedly goes frequently undiagnosed. The figures for morbidity which are available must be accepted as representing extremely minimal values. The literature records no deaths connected with dengue.

Total morbidity in the survey area in 1957 was 0.067 per 100,000. The highest morbidity rate was reported from Oceania (1.05). Southwest Asia did not report the disease at all. Only 11.17 per cent of the total population of the survey area were represented by the countries reporting the disease (Table 22).

A total of 801 cases of dengue was reported in 1957, placing the disease 32nd on the list of causes of illness considered in the survey. This figure exceeds only those reported for plague, leptospirosis, yellow fever and rabies.

Of the areas surveyed, the highest morbidity rates per 100,000 for dengue were reported from the following regions:

Caribbean, Central and South America: Mexico (0.003) and the Canal Zone (18.87). The latter represents the highest rate found for any country.

Africa: Ghana (7.87), the former Belgian Congo (2.08) and Kenya (0.16).

South Central and Southeast Asia: North Borneo (1.83), Singapore (1.57) and Ceylon (0.31).

Oceania: The morbidity rate in Fiji was 10.8, the second highest found.

Public health importance

In 1957, dengue was of minor public health importance in the survey area. However, it must be kept in mind that the disease is difficult of diagnosis in the absence of laboratory facilities and is therefore under reported. The explosive epidemic character of the disease renders it of great potential significance.

SMALLPOX

Distribution

The distribution of smallpox in the survey area in 1960 is presented in Figure 12. From the literature consulted for this survey it was found (Table 10) that smallpox is reportable in 87 of the 169 countries and territories of the survey area. In 1957, there were 93,363 reported cases of smallpox. Of these, 7 per cent were from the Caribbean, Central and South America, 38 per cent were from Africa, 4 per cent were from Southwest Asia and 51 per cent were from South Central and Southeast Asia. None was from Oceania. (Figure 1-e.)

In most countries smallpox is a mild disease, seldom endemic throughout the entire territory but localized in regions, either of difficult access or of low socio-economic status. Endemic foci still exist in Africa, Southwest Asia and South Central and Southeast Asia.

Incidence and prevalence

A few references to the incidence and prevalence of smallpox were found for three of the survey regions, Africa, Southwest Asia and South Central and Southeast Asia. No data were located for the Caribbean, Central and South America or for Oceania, where the disease seems to make its appearance only in a sporadic fashion.

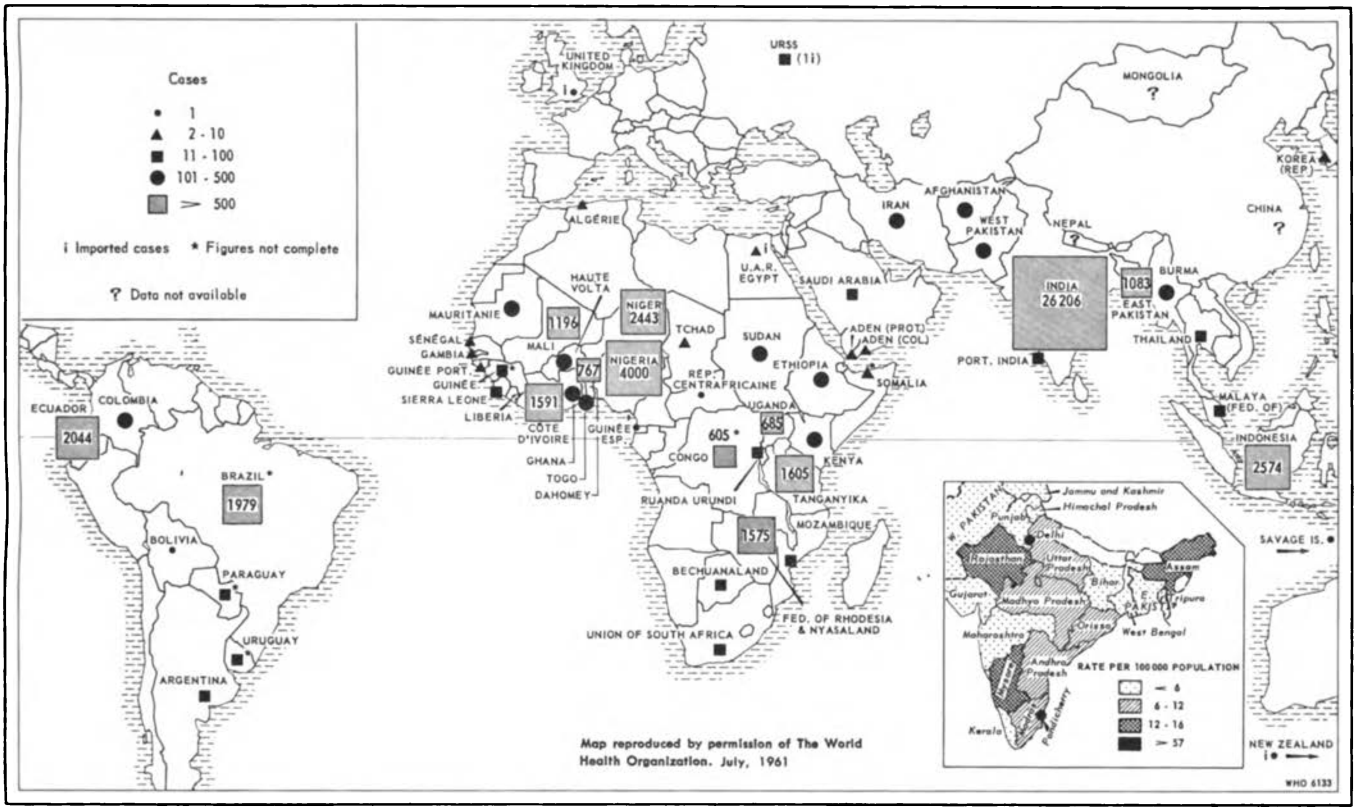
In Nigeria, after years of progressive decline in

Table 22. Morbidity and mortality due to viral diseases of relatively low endemicity but potentially important, as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY: CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Dengue	Relative population[1]	16.51	39.66	—	13.39	9.77	11.17
	Morbidity (per hundred thousand)	0.0058	0.30	—	0.072	1.05	0.067
	Mortality (per hundred thousand)	—	—	—	—	—	—
Smallpox	Relative population[1]	55.02	82.43	91.88	91.99	—	84.21
	Morbidity (per hundred thousand)	3.26	15.20	4.40	6.90	—	7.80
	Mortality (per hundred thousand)	0.21	1.20	0.36	6.40	—	3.99
Yellow fever	Relative population[1]	50.84	13.99	—	—	—	10.73
	Morbidity (per hundred thousand)	0.036	0.00086	—	—	—	0.0058
	Mortality (per hundred thousand)	0.016	0.00043	—	—	—	0.0028

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

Figure 12. Smallpox, 1960



incidence, a moderate recrudescence occurred in 1955 in the Eastern Region, with scattered outbreaks affecting mainly the Provinces of Onitsha and Owerri.[68] Systematic vaccination has resulted in decreased incidence in the former Belgian Congo, where the predominant clinical type of the disease has been *Variola minor*, only about 14 per cent of the cases being of the *Variola major* type occurring almost exclusively among the Congolese population. The highest incidence of *V. major* has been reported from Kasai Province.[7] *V. minor* is widespread in Kenya but the infection is mild with a low death rate.[111] In Uganda, a relatively few cases are reported each year and the infection is considered of low virulence.[394]

Almost every country of Southwest Asia reported the disease and Iraq, Iran and Saudi Arabia recorded it each year during the five-year period. All endemic areas are subject to occasional epidemic outbreaks and an increase in incidence has been noted in recent years.[395] Until the summer of 1957 smallpox had only been reported sporadically in Yemen but at that time a mild epidemic spread throughout the country. This followed similar epidemics in Syria and Libya.[37] In Jordan, approximately the same situation prevails, most cases being imported from neighboring countries.[15] In Trucial Oman, smallpox appears in recurrent epidemics only.[14] In the Aden Protectorate, smallpox epidemics occur in localized foci.[14] Smallpox is considered endemic in Iraq,[213] Kuwait,[14] Turkey[38] and Saudi Arabia.[13] In Iraq, Baghdad is a heavily affected area and epidemics flare periodically. This situation is also common in Turkey. In Saudi Arabia, the disease is considered one of the most important medical problems. A large percentage of the population is pock-marked and epidemics occur every five to seven years with high virulence and thousands of deaths usually from the hemorrhagic form.[13]

Smallpox continues to be an important problem in Pakistan where it is endemic throughout the year. The regions most affected are Hazara, Peshawar, Bannu and Kohat (where an outbreak in 1951 assumed an epidemic nature).[73] During the latter part of 1961, smallpox appeared in Karachi; according to press reports 500 deaths had resulted by the end of the year. The disease was carried to England by air travelers from Pakistan. In Thailand, of 381 persons examined, less than 3 per cent showed smallpox scars.[122] The last cases and deaths in Taiwan were reported in 1954.[46]

Since 1957, progress has been made in many countries in the tropics in the control of smallpox, although as in the case of Pakistan just cited the disease always constitutes a potential menace. In the Caribbean, Central and South America, a reduction in cases and deaths was witnessed between 1957 and 1960. The only country in which morbidity was higher in 1960 than in 1957 was Ecuador. Improvement was noted in most countries in Africa, the main exceptions being Niger, Nyasaland and Tanganyika in which the number of cases in 1960 exceeded the number reported for 1957. Fewer cases and deaths were recorded in Southwest Asia. The situation in South Central and Southeast Asia was not as encouraging during certain years after 1957. In India, the smallpox cases in 1958 were double those in 1957 and the deaths were tripled. However, there was a considerable reduction in morbidity and mortality in 1959 and 1960. Nevertheless, there appeared to be some recrudescence in the first seven months of 1961. Smallpox cases in Pakistan in 1958 were almost twice those in 1957, but substantial reductions in cases and deaths were noted in 1959 and 1960. Thailand experienced an unusual number of cases and deaths in 1959, while Indonesia in 1960 reported more cases than for the previous five years and more deaths than in any year since 1956.[379]

Morbidity and mortality

Except during epidemic outbreaks smallpox is usually present in a mild form. During some epidemics the morbidity and mortality rates can be very high. Although mass vaccination campaigns have been carried out in many areas, smallpox in 1957 ranked 19th as a cause of illness and 6th as a cause of death among the group of diseases studied in this survey (Tables 7 and 8).

The total morbidity rate per 100,000 in 1957 was 7.8 and the total mortality rate per 100,000 was 3.99 (Table 22). Africa with a morbidity rate of 15.2 led all other areas. South Central and Southeast Asia had the highest mortality rate (6.4). The Caribbean, Central and South America showed the lowest rates of morbidity and mortality in the survey area (3.26 and 0.21, respectively). Oceania did not report cases or deaths from smallpox in 1957.

Elevated morbidity and mortality rates were found in several countries surveyed as follows:

Caribbean, Central and South America: Bolivia (40.02 and no deaths), Ecuador (23.34 and 3.6), Colombia (16.22 and 1.71) and Paraguay (3.12 and 0.03).

Africa: Sierra Leone (228.58 and 10.75), former French West Africa (76.28 and 5.58), Nigeria (30.1 and 4.17), Kenya (17.72 and 0.03), former Belgian Congo (14.38 and 0.44), and Rhodesia and Nyasaland (10.91 and 0.78).

Southwest Asia: Iraq (29.43 and 3.4), Lebanon (7.08 and no deaths), Iran (5.32 and 0.22) and Afghanistan (1.74 and 0.008).

South Central and Southeast Asia: Burma (13.93 and 2.96) and Indonesia (1.78 and 0.37). India and Pakistan reported only deaths, the mortality rates being 6.44 and 21.67, respectively.

Public health importance

Mass vaccination of populations throughout the survey areas has reduced the public health importance of smallpox but the disease is still endemic in many countries and still represents one of the major causes of death of the diseases studied in this survey. These factors together with the tendency for recurrent epidemic outbreaks influence its public health significance. However, at present the disease is mainly centered in certain areas where it still remains an important public health problem.

YELLOW FEVER

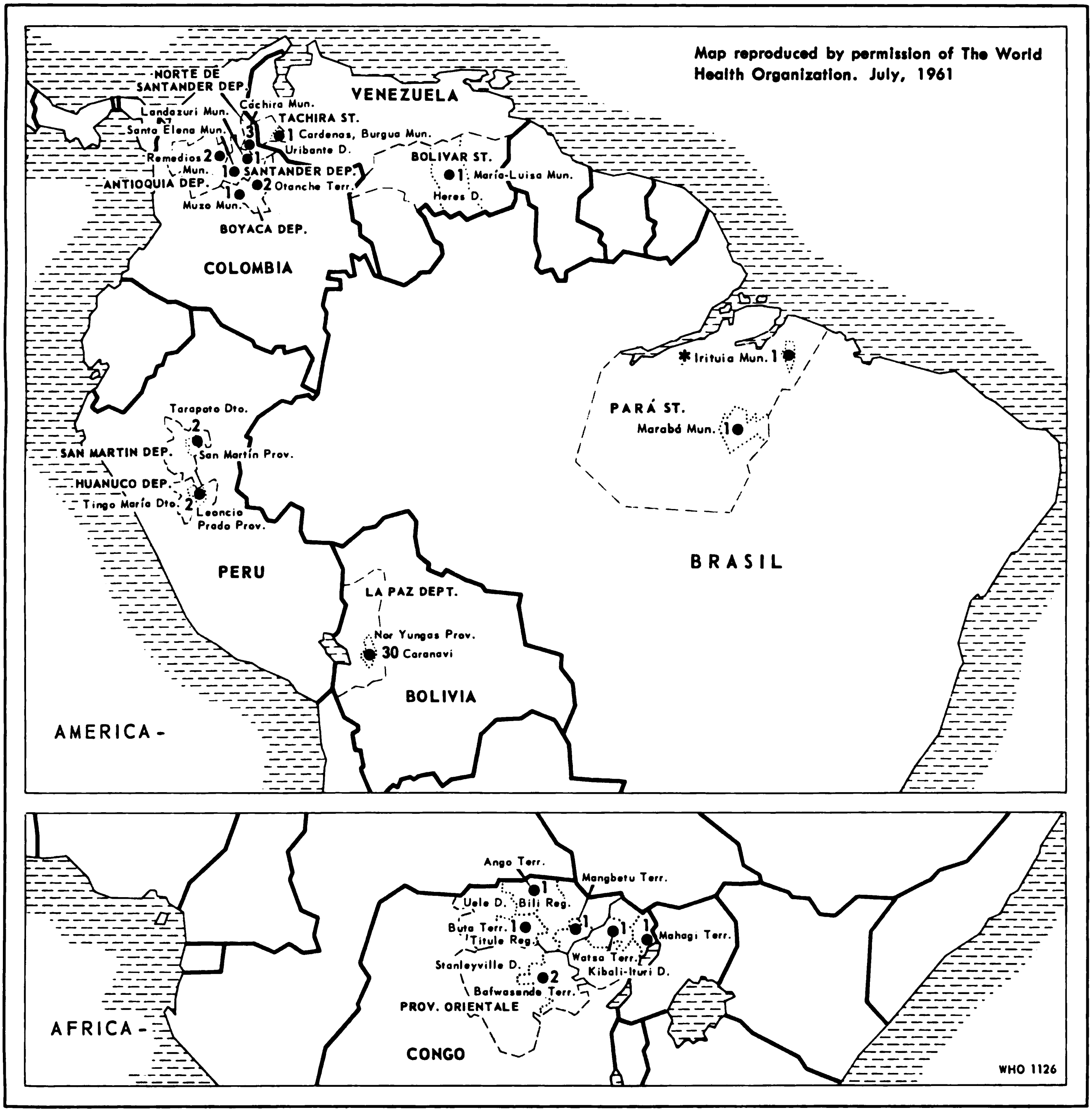
Distribution

The distribution and prevalence of yellow fever showed definite signs of decrease in the survey areas (Figure 13). In 1957, its distribution was greatest in the Caribbean, Central and South America where 11 of the 46 countries reported the disease, and in Africa where 9 of the 58 countries reported it. The disease was not reported from Oceania, but one country in Southwest Asia and one in South Central and Southeast Asia reported its presence.

Sixty-eight of the 70 cases of yellow fever reported in 1957 were from the Caribbean, Central and South America, and 2 were from Africa. Such figures are evidently inadequate and illustrate a major need in improved reporting in Africa (Figure 1-f).

The success achieved in eradication of urban yellow fever in the Caribbean, Central and South America represents one of the principal triumphs of preventive medicine. On the other hand, sylvatic yellow fever is not amenable to control by known methods and today offers a threat in many localities to urban areas. Clinical yellow fever appeared in Panama in 1948 and in the period from 1949 to 1954 there was a succession of yellow fever fatalities in both humans and monkeys in central and western Panama, Costa Rica, Nicaragua and Honduras. The last human fatality was reported in Honduras in September 1954, and it was anticipated that the epidemic had run its course. However, in January 1956, the disease reappeared in howling monkeys (*Alouatta*) in two areas on the north coast of Honduras

Figure 13. Cases of Yellow Fever Notified in 1960



* The case at Irituia, Brazil, was in a monkey.

and extended into the lower Montagua River valley in Guatemala. Later the disease extended through the Peten region of the latter country as far as the northern and western borders and undoubtedly entered Mexico.[396] Yellow fever has more recently occurred in monkeys and man in Trinidad. In Argentina, sylvatic yellow fever transmitted by *Haemagogus* mosquitoes is believed to occasionally infect man.[397] The disease is known to exist in monkeys in Venezuela[398] and in the Amazon Valley of Brazil where it occasionally attacks forest workers.[399] In Colombia, repeated large-scale mass vaccination programs in San Vicente have failed to prevent the appearance of sporadic cases.[400]

In Africa, no clinical yellow fever was diagnosed in Gambia in 1955; the last known epidemic occurred here in 1934-1935.[325] São Tomé and Principe Islands were also free of infection.[401] However, in Nigeria cases were reported from Maiduguri although no overt epidemic occurred.[68] Efforts to isolate the virus in the former Belgian Congo were unsuccessful until the last quarter of 1958 when a strain was recovered in Eastern Province.[402] The disease was known to occur sporadically throughout the Congo, where it is enzootic in forest monkeys. In 1958, there was a report of the first epidemic in 20 years, with 60 cases and 23 deaths.[7] The southern limit of the endemic zone in Africa is recognized by WHO as 10° south latitude but including all of Angola and Tanganyika.[403]

In Southwest Asia, cases were reported only from Iraq.[213]

Incidence and prevalence

Protection tests were performed with 576 sera from individuals of various races in Surinam. Positive results were obtained in 40.1 per cent of 374 bush Negroes, 27 per cent of 81 Indians and 31.4 per cent of 121 Creoles. Females consistently showed lower rates than males.[404]

A survey involving sera from 509 individuals in Ethiopia and Eritrea disclosed positive mouse-protection tests in seven sera from inhabitants of Assab, Eritrea. Yellow fever was not endemic in the seven provinces surveyed in Ethiopia.[405]

In the Americas, the yellow fever situation had not changed much between 1957 and 1960. Actually, the number of cases of jungle yellow fever had been somewhat reduced, although the distribution pattern had changed to a slight extent. In 1959, Trinidad reported cases; the last previous reports from this island were in 1954. In Africa, Ghana reported two cases and deaths in 1959 with none in 1957. Uganda, which reported two cases and one death in 1957, recorded none since that time. The former Belgian Congo continued to be an endemic center with more cases and deaths reported for 1958, 1959 and 1960 than were recorded in 1957.[379]

Ethiopia recently reported an epidemic with more than 3,000 deaths up to June 1961. A survey conducted by WHO in 1953 and 1954 in the Kaffa Province had shown yellow fever antibody to be absent. A severe epidemic occurred in this location in 1959 but the number of cases and deaths is not known. A second epidemic made its appearance in the Blue Nile and Upper Nile Provinces in August 1959; this outbreak extended into Sudan and apparently ended following the rainy season in October 1960. A third major outbreak was recognized in February 1961 in the northern part of the Province of Gamu-Goffa in southwestern Ethiopia bordering on Kenya. There is suggestive evidence that this epidemic actually was characterized by two successive waves beginning sometime in 1959. The number of deaths may have reached 8,000 estimated to comprise 6 to 10 per cent of the population of the area. Despite the onset of the dry season, information would indicate that the epidemic has continued to advance up the Omo Valley.[363]

Morbidity and mortality

The death rate during epidemics of yellow fever is generally high, often reaching 50 per cent or more. In endemic areas 7 to 10 per cent of cases die of yellow fever. In 1957, the disease was reported only from the Caribbean, Central and South America and Africa. It is a notifiable disease in all the countries and territories of the survey area.

Reported morbidity and mortality rates are extremely low. When applied to the entire survey area, the total morbidity rate was 0.0058 per 100,000 and the total mortality rate 0.0028 per 100,000 (Table 22). However, only 10.73 per cent of the population of the entire survey area inhabited countries which reported the disease. In the Caribbean, Central and South America, eight countries reported yellow fever. In Africa, the disease was reported only from Nigeria where two cases and one death occurred.

Morbidity and mortality rates per 100,000, respectively, in Central and South America were as follows: Panama (2.15 and 0.5), Bolivia (0.6 and no deaths), Brazil (0.02 and no deaths) and Colombia (only deaths were reported, 0.17).

Public health importance

Under localized epidemic situations yellow fever is still a serious hazard principally because of the very high case fatality rate. Nevertheless, low general morbidity and mortality rates in the survey area do not indicate that this disease should today be accorded a leading position among the diseases of highest significance. However, the continued presence of the chief urban vector, *Aëdes aegypti*, in many localities under threat of invasion by human cases of sylvatic yellow fever indicates that the disease must still be regarded as of primary significance in these localities.

LEISHMANIASIS

Distribution

A summary of the distribution of the several forms of leishmaniasis is presented in Plate VIII.

According to reports leishmaniasis was present in all the areas of the survey in 1957 with the exception of Oceania. In Table 10, it will be seen that 6 of the 46 countries in the Caribbean, Central and South America recorded this disease, 10 of 58 countries in Africa, 8 of 18 countries in Southwest Asia and 7 of the 24 countries in South Central and Southeast Asia.

In 1957, there were reported 11,473 cases of leishmaniasis, the great majority of which (72 per cent) were from Africa. Of the remainder, 1 per cent were from the Caribbean, Central and South America, less than half of one per cent were from Southwest Asia and 27 per cent were from South Central and Southeast Asia (Figure 1-b).

All three forms of leishmaniasis occur in Central and South America. Kala-azar has been reported from Mexico, El Salvador, Guatemala, Venezuela, Colombia, Bolivia, Paraguay, Argentina and Brazil; it probably occurs in Panama, Ecuador, Peru and Surinam. Recognized cases are not numerous except in northeast Brazil. Of a total of 2,175 reported cases summarized by Deane,[406] 2,145 were in Brazil. The main endemic focus in this country is in the State of Ceará. The cutaneous and muco-cutaneous forms are also widely prevalent in the above-mentioned areas.

Both the systemic and cutaneous forms of leishmaniasis are found in North, West, East and Central Africa. Kala-azar is endemic in Morocco, Spanish Morocco, Algeria, Tunisia, Libya, Egypt, Sudan, Ethiopia, Eritrea, Somalia, Kenya, Uganda, many of the republics formerly constituting French Equatorial and French West Africa, Gambia, Nigeria and Mozambique.[407] Severe epidemics of kala-azar have occurred in Sudan and Kenya during the past twenty years. The main endemic area in the Sudan lies in the eastern portion of the country and embraces the southern tip of Kassala Province, eastern portions of Blue Nile and Upper Nile Provinces and southeastern Equatoria Province.[408] From the main endemic focus in the Sudan, the disease radiates westward. Heisch[409] described an epidemic of 3,000 cases in Kenya, where the main foci are in three areas, viz., Saricho on the Uaso Nyiro River in the Northern Province, Ngomeni between Kitui and the Tana River, and the Machakos District. The disease is probably more widely distributed than reports indicate. It has now become endemic in the south and the foothills of the Highlands.[410]

In tropical Asia, a considerable recession has been witnessed in the occurrence of kala-azar and cutaneous leishmaniasis in countries in which malaria eradication programs have been extensively carried out.

The cutaneous and systemic forms are present in the highlands of Yemen.[37] San'a and Taiz are suspected foci of kala-azar, and Tihama is a suspected focus of cutaneous leishmaniasis.[14] The visceral form of the disease seems to be present in the Eastern Province of Saudi Arabia.[132] It may be present throughout the peninsula.[14] Cutaneous leishmaniasis is endemic in Jordan. Infantile kala-azar has occurred in Jerusalem and Zerka but is reported to be rare.[15] In Iraq, kala-azar affects infants primarily; it is most frequent in the region around Baghdad.[132] The cutaneous form is rare in Israel where *Phlebotomus* flies are reported to have been virtually exterminated. However, a small focus is known in the Acre region.[132] Cutaneous leishmaniasis is prevalent in Iraq, occurring principally in the southern and central regions.[213] In Iran, the Caspian shore, the central plateau, the Northeastern District, the south and southwest regions and Azerbaijan are foci of visceral leishmaniasis.[132] This form exists in localized foci in Turkey, predominating in the western and northern coastal areas.[132] In Syria, an endemic focus of the cutaneous form has been reported from the area of Aleppo.[17] Foci of cutaneous leishmaniasis are present in Lebanon; in the Al Biqa valley both forms are endemic. Kala-azar is uncommon in Lebanon.[16]

In South Central and Southeast Asia, kala-azar is endemic in India and East Pakistan where in the past extensive epidemics have occurred. Apparently the disease is absent for the most part from Burma, Vietnam, Laos, Thailand, Malaya and Indonesia. In India, the main endemic areas have been West Bengal, Assam, Bihar, Orissa and the eastern part of Uttar Pradesh. Epidemics have not been reported in recent years, and it is probable that the incidence and prevalence have been materially reduced through the application of residual insecticides in the malaria eradication campaign. The cutaneous form of leishmaniasis prevails in the old North West Frontier Province; it also occurs in Baluchistan (West Pakistan) and extends into the Punjab.[73]

Incidence and prevalence

In Central and South America, clinical leishmaniasis assumes various forms. Pessôa[411] has recently classified these types together with the variety of the etiological

type of leishmaniasis constituted as much of a problem in that country as in some parts of South America.

Balzer *et al.*[415] reported a peculiar form of leishmaniasis in a young male Ethiopian from an area 400 km. north of Addis Ababa. There were extensive lesions of the feet, arms and face which simulated those described in the post-kala-azar cutaneous form.

Jelliffe[416] diagnosed 9 cases of oriental sore at Kano, Northern Nigeria, in 1954 and summarized cases previously reported by others. Lefrou[417] compiled 138 cases for former French Sudan which were confirmed at Bamako.

Heisch[409] described an epidemic of kala-azar in the Kitui District of east central Kenya, which apparently began in 1946. By the end of May 1954 a total of 2,725 cases had been recorded. The outbreak was most severe at Tseikuru, where there were 1,100 victims, or 19 per cent of a population of 5,800. The age incidence in years was: 0-3, 5.4 per cent; 4-9, 29.5 per cent; 9-18, 28 per cent; and 18 and over, 36.3 per cent. Seventy per cent of the patients were males.

Vermeil[418] summarized 164 cases of kala-azar in Tunisia from 1912 to 1956. Rageau[419] reported the occurrence of 326 cases of cutaneous leishmaniasis in the Northern Cameroons between 1936 and 1946.

Berberian[420] reported 3 cases of infantile kala-azar in the North Syrian village of Kessab near the Turkish border in 1946.

Pringle[421] indicated that during 1954-55 kala-azar appeared sporadically over some 15,000 km.^{2} of the alluvial plain of central Iraq. He diagnosed 18 proved cases in Baghdad. Other cases occurred at Mosul in Northern Iraq and at Hillah, south of Baghdad.

Taj-Eldin and Al Hassani[422] reported that 130 cases of kala-azar were admitted to the Children's Welfare Hospital in Baghdad between 1954 and 1960. One hundred of the patients were analyzed in detail. The children were aged 6 months to 8 years, more than half being under 3 years old. A total of 14 patients died. The authors concluded that endemic kala-azar in Iraq resembles the Mediterranean type.

Oriental sore has been extremely prevalent in Iraq, although the employment of residual insecticides has no doubt reduced the incidence in recent years. Pringle[423] surveyed school children in Baghdad City and other areas in Iraq and found that the incidence of fresh lesions or scars was 4.1 per cent in 1,914 in Shatt Al-Arab and Hammar Lake Region, 30.6 per cent in 4,908 individuals in Euphrates-Alluvial Plain, 27.1 per cent of 1,857 persons in Tigris-Alluvial Plain, 30.3 per cent of 1,385 individuals in Dyala-Alluvial Plain, 41.1 per cent of 1,728 persons in Steppe-Desert, 26.2 per cent of 305 examined in Zagros-Submontane and 10 per cent of 285 persons in Zagros-Montane.

Until the employment of residual insecticides for malaria control, oriental sore was widespread throughout Iran. Cases of kala-azar also occur sporadically and a summary of these cases has been reported by Eghbal *et al.*[424]

Morbidity and mortality

Of the diseases included in the survey leishmaniasis was found to be 26th as a cause of illness and 15th as a cause of death (Tables 7 and 8).

Table 23 indicates that 40.09 per cent of the population of the total survey area inhabited countries which

Table 23. Morbidity and mortality due to parasitic diseases of relatively low endemicity but potentially important, as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY: CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Leishmaniasis	Relative population[1]	17.02	20.29	6.66	57.70	—	40.09
	Morbidity (per hundred thousand)	0.055	3.59	0.0087	0.44	—	0.95
	Mortality (per hundred thousand	—	0.11	—	0.44	—	0.27

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

reported the disease in 1957. The disease was not reported from Oceania. Deaths were reported only in Africa and South Central and Southeast Asia. The total morbidity rate per 100,000 for the survey area was 0.95; the total mortality rate per 100,000 was 0.27. Africa presented the highest morbidity rate of any area (3.59). The highest mortality rate (0.44) was recorded from South Central and Southeast Asia. The rates for the latter region, however, must be viewed with reserve; only three countries reported the disease and of these, India, with the largest population, did not report cases. No deaths were reported due to leishmaniasis in the Caribbean, Central and South America. The morbidity rate per 100,000 was 94.34 for the Canal Zone, 2.71 for Panama and 0.09 for Mexico.

Of the 13 countries reporting leishmaniasis in Africa, the highest morbidity and mortality rates per 100,000, respectively, were found in Sudan (72.72 and 2.36), Kenya (10.32 and 0.24) and former French West Africa (1.11 with no deaths recorded).

In Southwest Asia, only Cyprus reported leishmaniasis with a morbidity rate of 0.02; no deaths were reported.

Three countries of South Central and Southeast Asia reported leishmaniasis. In Singapore, a morbidity rate of 0.14 was recorded. The morbidity rate in Ceylon was 0.02. These two countries reported no deaths. India reported only deaths from this disease, the mortality rate being 0.78.

Public health importance

When the number of recorded cases and deaths are diluted in the total population of the survey area, leishmaniasis becomes a disease of low importance. Its patchy distribution within countries and its sporadic occurrence contribute to this impression. Indeed, it is recorded that the disease has shown a marked epidemiological retrenchment in recent years in many areas of the survey. However, it is still an important problem, especially in countries such as Sudan and Kenya and in certain parts of Central and South America.

Chapter 5

Diseases of Relatively Low Endemicity But High Mortality or Serious Complications

RABIES

Distribution

No reference was found regarding the occurrence of human rabies in Oceania. All other areas acknowledged the presence of this disease. Table 10 indicates that rabies was reported from 12 of the 46 countries of the Caribbean, Central and South America, 31 of the 58 countries of Africa, 6 of the 18 countries of Southwest Asia and 11 of the 24 countries of South Central and Southeast Asia. Where the disease is endemic, only occasional human cases occur. Rabies is usually reported as a zoonosis, not a human disease. Since the distribution of the human infection parallels that of the animal disease, details should be sought in Part II of this report.

In 1957, there were reported 783 deaths from rabies. The distribution of these, shown in Figure 1-d, is as follows: 18 per cent from the Caribbean, Central and South America, 17 per cent from Africa, 6 per cent from Southwest Asia and 59 per cent from South Central and Southeast Asia.

Incidence and prevalence

Reports are usually limited to mention of the number of cases diagnosed or of persons bitten by animals suspected of being rabid. Uruguay is said to be free of the disease.[425] The number of persons bitten by rabid dogs in Guatemala and subsequently dying of rabies varied from 5 to 10 annually between 1948 and 1955. In 1956, 1,555 persons were bitten by 1,183 rabid dogs.[426] In Peru in 1957, 1,289 persons were reported to have been bitten.[427]

In the former Belgian Congo, an average of 48 cases and 26 deaths from rabies were reported between 1952 and 1957.[7] There were 184 cases reported from Southern Rhodesia in 1954 and 100 cases in 1955. In 1955, Uganda reported 37 human cases, Northern Rhodesia had 128 cases and South Africa had 68 cases.[428] The number of persons applying for Pasteur treatment in Tunisia has climbed steadily in recent years. In the eight-year period, 1952-1959, a total of 25,062 persons received this treatment, an average of 3,133 each year.[429] The disease is said to have disappeared in Tangier.[430]

In Israel, only 23 cases of rabies were reported in the period between 1948 and 1957. During this period the Pasteur treatment was administered to 17,000 persons.[431]

The disease has been known in humans for centuries in India; more than 150,000 persons are treated annually following bites by suspected animals.[432] Rabies was brought to Taiwan in 1948. By 1956 a total of 709 cases had been reported. More than half the cases occurred in males and 40 per cent in children. However, mass inoculation and registration of dogs resulted in control with no cases reported in 1959.[46]

Morbidity and mortality

The case death rate is extremely high in untreated rabies. All reports of human cases were limited to the number of deaths.

As a cause of death, rabies occupied 22nd place among the diseases considered in the survey in 1957 (Table 8).

The total mortality rate per 100,000 for the survey area in 1957 was 0.065 (Table 24). Rates were quite similar in all areas which reported the disease, being 0.076 in the Caribbean, Central and South America, 0.056 in Africa, 0.06 in Southwest Asia and 0.066 in South Central and Southeast Asia.

Mortality rates were generally low. Among the highest rates per 100,000 recorded from the Caribbean, Central and South America were the following: Colombia (0.31), Ecuador (0.28), Venezuela (0.23), Mexico (0.15) and Brazil (0.03).

Table 24. Morbidity and mortality due to viral diseases of low endemicity but high mortality, as reported in 169 countries and territories in 1957

DISEASES		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Rabies	Relative population[1]	66.16	69.64	43.13	7.53	—	31.11
	Morbidity (per hundred thousand)	—	—	—	—	—	—
	Mortality (per hundred thousand)	0.076	0.056	0.060	0.066	—	0.065

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

In Africa, the highest rates were recorded from the former Belgian Congo (0.24), Sudan (0.13), former French West Africa (0.07) and Egypt (0.06).

In Southwest Asia, Turkey presented a rate of 0.14 and Iraq had a rate of 0.14.

In South Central and Southeast Asia, the Philippines had a mortality rate of 0.83, Ceylon 2.2, Burma 0.27 and Taiwan 0.22.

Public health importance

Based upon reported deaths from rabies, the available data support the position that rabies is not a problem of primary importance in the areas of the survey. The nuisance value of rabies may be determined in connection with the number of Pasteur treatments given annually, a figure which becomes very high in some countries.

HYDATID DISEASE

Distribution

Hydatid disease is discussed in Part II of this report. To avoid undue repetition, this section will deal with human aspects only.

Only 21 of the 169 countries and territories of the survey area reported human hydatidosis (Table 10). Only 1 country of the 46 in the Caribbean, Central and South America acknowledged its presence. Reports were forthcoming from 9 of 58 countries in Africa, 4 of 18 countries in Southwest Asia, 5 of 24 countries in South Central and Southeast Asia and 2 of 23 countries in Oceania.

There were 14,770 cases of hydatid disease mentioned in official reports in 1957. Of these, 2 per cent were in Africa, 1 per cent were in Southwest Asia and the remaining 97 per cent were in South Central and Southeast Asia. The absence of figures for the Americas would appear to be particularly unfortunate. (Figure 1-b.)

Incidence and prevalence

The incidence of human hydatid disease is unknown for most of the countries of the survey.

In Uruguay, a high incidence of clinical cases is seen, one author reporting a case rate of 17.5 per 100,000.[433] The disease is slightly more restricted in Argentina. Sixty per cent of 9,000 cases from 1935 to 1957 occurred in the Province of Buenos Aires, where the case incidence was as high as 24.6 per 100,000. Elsewhere in the country a rate of 3.1 was reported. In Brazil, a belt of high incidence of human hydatidosis has been recorded from the state of Rio Grande do Sul, where 1,103 cases were reported in 1952. The areas of high incidence in Chile are situated in the central provinces; the number of cases decreases northwards and southwards. In 1953 and 1954, 1,093 cases were reported, 74 per cent of them from the central provinces. The annual case incidence in the country has been estimated at 8.76 per 100,000. Incidence of hydatidosis is unknown in Peru, although the disease in animals is far from uncommon. Elsewhere in this area the incidence of hydatidosis in humans appears to be very low or still unrecognized. Limited surveys have been done in Mexico, [434] Guatemala [435] and Venezuela.[436]

One author gives the following figures for human cases of hydatid disease: Chile, from 1945 to 1957 (with the exception of 1955), had 4,528 cases; Argentina, from 1935 to 1957, 9,441 cases; Uruguay, from 1935 to 1945, 3,860 cases; and Brazil, from 1935 to 1945 (from the state of Rio Grande do Sul alone), 500 cases.[437]

In Africa no recent records are available on the incidence of hydatidosis in man. It is possible that some territories where *Echinococcus granulosus* is now imperfectly recognized will prove to be centers of extremely high human incidence. Human cases have been reported from Kenya.[438]

In Southwest Asia hydatid cysts are reported to occur in 0.3 per cent of human autopsies performed in Turkey. In Lebanon the disease is thought to be more common than in Syria.[439] Between 1925 and 1950 only 385 cases were hospitalized for hydatid infections in the Levant; this number, of course, representing only a fraction of the true number of infections in humans.[440] There were 268 cases of human hydatidosis in Israel between 1951 and 1954, of which 80 per cent were not autochthonous cases.[441] The disease is reputed to have a relatively high prevalence, particularly in the rural population on Cyprus.[12]

As regards South Central and Southeast Asia it is thought that the parasite may be more common in India than present published work would indicate.[442]

Morbidity and mortality

On the basis of the number of countries from which cases were reported in 1957, approximately 37.84 per cent of the population of the survey area is estimated to have inhabited regions in which the disease is reported to be prevalent. No cases were reported officially from Oceania. Although the disease is an important one in some countries in the Caribbean, Central and South America, only one country was represented in official reports.

Hydatidosis was 24th among causes of illness and 32nd among causes of death of the diseases considered in the survey (Tables 7 and 8).

The total morbidity rate for the entire survey area was 1.23 per 100,000 and the total mortality rate was 0.0022 per 100,000 (Table 25). The highest morbidity rate was recorded in South Central and Southeast Asia (2.06); this area also had the highest mortality rate (0.013).

Table 25. Morbidity and mortality due to parasitic diseases of low endemicity but high mortality or serious complications, as reported in 169 countries and territories in 1957

DISEASES		GEOGRAPHIC AREAS OF THE SURVEY: CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Hydatid disease	Relative population[1]	—	13.12	1.48	60.76	—	37.84
	Morbidity (per hundred thousand)	—	0.14	0.091	2.06	—	1.23
	Mortality (per hundred thousand)	—	0.0056	0.0050	0.013	—	0.0022
Onchocerciasis	Relative population[1]	16.49	40.03	—	—	—	10.31
	Morbidity (per hundred thousand)	1.41	2.10	—	—	—	0.63
	Mortality (per hundred thousand)	—	0.0035	—	—	—	0.00066
Trypanosomiasis	Relative population[1]	67.34	52.86	—	—	—	21.78
	Morbidity (per hundred thousand)	0.56	4.48	—	—	—	0.95
	Mortality (per hundred thousand)	0.047	0.42	—	—	—	0.088

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

The highest rates per 100,000 for morbidity and mortality, respectively, where obtained from the following countries:

Africa: Kenya (0.74 and 0.1), Sudan (0.66 and 0.04) and Ghana (0.41 and 0.06).

Southwest Asia: Cyprus (13.43 and 0.75) and Aden Colony (0.15 with no deaths recorded).

South Central and Southeast Asia: India (3.65 and 0.002), Macao (0.53 and no deaths recorded) and Vietnam (0.15 with no deaths recorded). Ceylon, with only deaths from this disease reported, had a mortality rate of 0.01.

Public health importance

The epidemiological data on human hydatidosis are not adequate for an accurate estimate of its public health importance. The disease must be ranked relatively low with regard to its over-all significance in tropical public health but it is of considerable concern in certain countries.

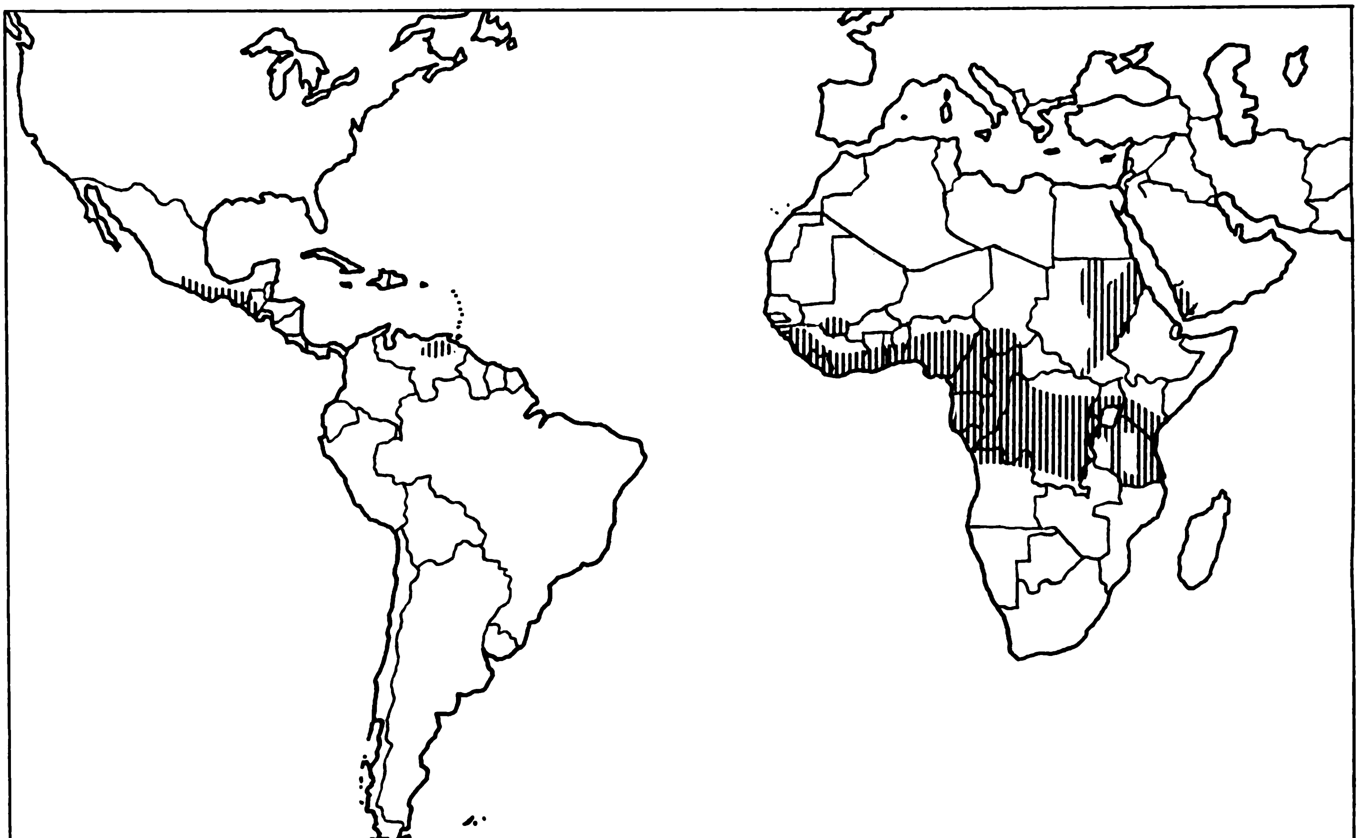
ONCHOCERCIASIS

Distribution (Figure 14)

Onchocerciasis is endemic in the Americas in Mexico, Guatemala and Venezuela, although there is a possibility that the disease exists in contiguous regions. In Mexico the states of Oaxaca and Chiapas are involved. The disease occurs in Guatemala in the departments of Santa Rosa, Escuintla, Suchitepéquez, Chimaltenango, Sololá and Huehuetenango. In Venezuela, it is present in the states of Anzoátegui, Carabobo, Cojedes, Guárico, Miranda, Monagas and Sucre.

In Africa, onchocerciasis has been reported from the Bahr el Ghazal and Northern Provinces of the Sudan, as well as along the eastern border, the southwestern part of Ethiopia, and in portions of Kenya, Uganda, Tanganyika, Nyasaland, Angola, the former Belgian Congo, Ruanda-Urundi, former French Equatorial Africa

Figure 14. Distribution of Onchocerciasis Blinding Filariasis, River Blindness



Source: Adapted from Atlas of Distribution of Diseases, Plate 4—American Geographical Society, 1952.
Map reproduced by permission of the Industrial College of the Armed Forces, Washington, D. C. November, 1959

(Gabon, Cameroun, Middle Congo, Ubangi-Shari), Spanish Guinea, Fernando Po, former British Cameroons, Nigeria, Ghana, Liberia, Sierra Leone and former French West Africa (Guinea, Sudan, Upper Volta, Togo and Dahomey).

Onchocerciasis has recently been reported from Yemen.

Of the 7,567 cases of this disease which were reported in 1957, 36 per cent were reported from the Caribbean, Central and South America and 64 per cent from Africa (Figure 1-d).

Incidence and prevalence

In Mexico there has been some subsidence of the disease due to treatment campaigns and larviciding activity during recent years. Some ten years ago, an examination of 43,858 individuals in the state of Oaxaca revealed infection in 15.5 per cent. The amount of ophthalmic disease has also been reduced since that time.

In Guatemala, Zone 1 is contained in the departments of Chimaltenango, Sololá, Suchitepéquez and Escuintla, with 41,085 inhabitants, of which 24.4 per cent or 10,024 are infected. The infected area comprises 900 km.^{2} in the departments of Escuintla and Santa Rosa (Zone 2), where 13.22 per cent of 16,824 inhabitants are infected, or 2,224 individuals. In Huehuetenango (Zone 3), the disease is contiguous to the endemic zones in Mexico. The municipalities of Cuilco and San Pedro Necta are involved. The area is about 170 km.^{2} and has a population of 3,400, of whom 935, or 28 per cent, are infected. The total endemic areas comprise some 1,800 km.^{2} with a population of 61,241, of which 13,183, or 21.52 per cent, are infected.[443]

During 1960, 38,253 individuals in seven states in Venezuela were examined in an effort to delimit the endemic zones. Of these, onchocerciasis was diagnosed in 2,228 individuals. Monagas State proved to be the most heavily infected, since 1,338 infected persons were found in 15,635 examined.[444]

In the former Belgian Congo, 45,035 persons were examined in Orientale Province and the incidence of onchocerciasis was found to be 17.3 per cent, the diagnosis being made on the presence of onchocercomata in 77 per cent and on the presence of dermal microfilariae (without onchocercomata) in the remaining 23 per cent. This figure for incidence is considerably lower than those of earlier surveys, mostly in Kasai and Orientale Provinces, which indicated that as many as 80 to 85 per cent of persons in some areas were infected. At Maniema in Kivu Province, a recent survey of 185 persons indicated clinical signs of the disease in 125. Cases of ocular disease and blindness were reported.[445] Incidence is high in the northwest part of Uganda; in the West Nile District, the entire population is reputed to be infected with *Onchocerca volvulus.* In four villages in the Nyara valley of this district, 56 per cent of 728 inhabitants were positive.[446] A survey of 2,423 male plantation laborers in Liberia disclosed skin nodules in 19.4 per cent, with almost all of the nodules being situated in the pelvic region.[447]

In an examination of 4,000 persons in Fernando Po, 100 cases of onchocerciasis were found to have nodules; eye involvement was noted in only 3 cases.[448]

There is a small endemic area of onchocerciasis at the northeastern tip of Angola and a much larger area in the Cabinda District extending southward to 12° 36′ S. latitude, the most southerly point of the disease in Africa.[449] An examination of 1,000 individuals in the first mentioned area revealed 574, or 57.4 per cent, with microfilariae in the skin. Sixty-one, or 6.1 per cent, had external or palpable nodules. In the age group over 50, 56, or 37.6 per cent, of 149 persons had visual disturbances.[450] In investigations in the vicinity of Catabola and Camacupa, 1,047 individuals were studied; 43 per cent were clinically suspected of having the disease and 32 per cent showed microfilariae of *O. volvulus.* Nodules were detected in only 3 per cent of the cases and cases of amaurosis did not surpass 6 per cent.[451]

In the former French Equatorial Africa, 23 per cent of the population of the Boko District of Middle Congo were infected and 7 per cent had eye lesions. The disease is present in Gabon and is the most important cause of blindness in the Rafai District of Ubangi-Shari.[448] In the Mayo Kebbi area, of 16,116 persons examined, 1,819, or 11.28 per cent, had ocular lesions.[452] Of 21,901 individuals in the Middle Shari region of Chad, 102 were blind.[448]

In former French West Africa, 3,357,900 persons have been examined and 114,702 cases of onchocerciasis identified.[448] Percentage of cases in various areas was as follows: Upper Volta 4.7, Dahomey 4.6, Guinea 3.4 and Sudan 2.8. Infection rates in Senegal and the Ivory Coast were very slight, and it was not thought that the disease was present in Niger.

Vellieux *et al.*[453] diagnosed onchocerciasis in 14,333, or 38.3 per cent, of 37,382 individuals in Upper Volta. Microfilariae were noted in the anterior chamber of the eye in 11 per cent of the cases; 17.5 per cent presented lesions of the fundus and 25.2 per cent lesions of the anterior segment.

Onchocerciasis is hyperendemic along the Red Volta and Sissili Rivers in the Northern Territories of the former Gold Coast and in other areas is heavily endemic. In Togo endemicity is not so pronounced.[454] It was estimated that there are 10,000 persons blind from the disease in the Northern Territories out of a total population of 1,250,000.[455]

In 1956, Budden[456] estimated that the population exposed to onchocerciasis in Northern Nigeria was 16,836,000 and that more than 339,000 individuals were infected. Infection rates per 1,000 varied from 665 to 98. A total of 19,400 were said to suffer from blindness, the onchocercal blindness rate per 1,000 varying in different localities from 57 to 0.2. Surveys of persons under 20 years of age in the Abuja Emirate of Northern Nigeria by means of a single skin-snip revealed onchocerca infection in 47.97 per cent of 3,265 individuals. The infection rate in males was 55.7 per cent and that in females 35.02 per cent.[457]

In Ethiopia, cases of blindness due to onchocerciasis have been detected at Bonga, Boghinda and Menchira.[448]

Fawdry[458] studied 50 cases from Yemen; only 5 had subcutaneous nodules but 3 of 10 showed microfilariae.

Morbidity and mortality

Onchocerciasis cases were reported only from two of the five major areas of the survey. The significance of total morbidity and mortality rates for the entire survey area is thus much reduced. In 1957 the morbidity rate was 0.63 per 100,000, the corresponding mortality rate being 0.00066 per 100,000 (Table 25). In the Caribbean, Central and South America, with only Mexico reporting the disease, the morbidity rate for the area was 1.41 with no deaths recorded. In Africa the morbidity rate was 2.1 and the mortality rate was 0.0035.

In Mexico onchocerciasis attained a morbidity rate of 8.58. The highest morbidity rates in Africa were in the Republic of Cameroon (43.1), Uganda (13.72), former French West Africa (11.4), Angola (9.54) and Ghana (2.48). Highest mortality rates were in Ghana (0.1), Uganda (0.02) and former French West Africa (0.006).

Public health importance

The significance of this disease can be considered only on a regional basis. In Guatemala, southern Mexico and Venezuela it is of considerable importance. Indeed, infection is so intense in certain foci that onchocerciasis overshadows many other public health problems.

In Africa, although the disease is a minor one when compared with others on the survey list, it is of great concern in certain countries, such as Cameroon, Ghana and former French West Africa.

CHAGAS' DISEASE

Distribution

Chagas' disease, or American trypanosomiasis, has been described only from the Caribbean, Central and South America. Human cases have not been reported from the Caribbean Islands, although triatomid vectors occur in some. The disease is probably present in all countries of Central and South America, although it has not been recognized in Surinam and British Guiana. The distribution of Chagas' disease is presented in Plate IX.

The disease was reported from 9 of the 46 countries of the above-mentioned region. Within the various countries, the known distribution is limited to certain localized regions.

Incidence and prevalence

It is difficult to judge the true prevalence of the disease in man, since many cases undoubtedly go undiagnosed. Serological surveys have generally revealed positive reactors to a much greater extent than might be anticipated from the reported clinical cases.

Only 8 human cases had been reported in Mexico up to 1951.[459] In Guatemala, as of 1959, 168 positive cases of Chagas' disease and 77 cases of infection with *Trypanosoma rangeli* had been recognized. Of 6,126 serologic examinations (Machado-Guerreiro test), 859 were positive.[460] As of the same date, 25 human cases had been diagnosed in Costa Rica.[461]

Dias[462] in 1952 reported that nearly 140 cases of Chagas' disease had been recognized in Guatemala, El Salvador, Nicaragua, Costa Rica and Panama. The same author in the same year stated that 38 cases had been recorded in Colombia and 6 in French Guiana.[463]

Peñalver *et al.*[464] stated that 31 cases of Chagas' disease had been diagnosed in El Salvador up to 1956, of which 23 were due to *Trypanosoma cruzi*, 4 to *T. rangeli* and 4 to mixed infections. Nine chronic cases showed cardiac dysfunction.

Pifano[465] reported that in the 23 years up to 1960 he had diagnosed on parasitological grounds 1,876 cases of Chagas' disease in Venezuela, representing 180 acute and 1,696 chronic cases. To determine the incidence of cardiac complications, 500 persons were examined in the State of Miranda; of these 158 were positive serologically and 110 were positive on xenodiagnosis. A total of 100 showed electrocardiographic changes while in 10 cases the readings were doubtful. In the State of Carabobo, of 500 persons examined, 300, or 60 per cent, were serologically positive for Chagas' disease. A total of 157 of the 500 had evidence of cardiac involvement.[444]

In Ecuador, the number of cases of Chagas' disease recorded between 1927 and 1955 was 305, of which 298 were found in Guayas Province, 3 in Manabi Province, 2 in Los Rios Province and 2 in El Oro Province. In 1954, a serologic survey in several provinces found 58 positives in 671 individuals, or 8.64 per cent.[466]

Chagas' disease is widely disseminated in Peru, having been found in the Departments of Tacna, Moquegua, Arequipa, Madre de Dios, Amazonas and San Martin. Up to 1957, 204 cases had been diagnosed, of which 202 were recognized between 1951 and 1958.[467]

In Bolivia, 342 human cases of Chagas' disease have been diagnosed; of 174 proved acute cases, 5 deaths have been recorded.[468]

In surveys carried out in Chile from the Province of Atacama to O'Higgins in areas found to be infested with triatomid vectors between 1944 and 1948, 12 per cent of 14,756 persons were found infected by the xenodiagnostic method. Of 10,862 individuals tested by the Machado-Guerreiro complement fixation technique, 14 per cent were positive.[469]

In Argentina, Dias[470] stated that over 5,000 cases of Chagas' disease had been reported up to 1955. In 1958, Alzugaray *et al.*[471] calculated that of 3.5 million people at risk in the endemic zones, there were 700,000 cases of the disease.

Fifty-nine cases of Chagas' disease have been recognized in Paraguay but the true extent of the disease cannot be established until widespread epidemiologic surveys can be undertaken.[472]

In Uruguay, 518 cases of Chagas' disease had been diagnosed up to 1959. The mortality in 467 acute cases was 1 per cent; 5 of 11 cases with cardiac involvement succumbed.[473]

Chagas' disease is widely distributed in Brazil with the exception of the Amazon Basin. Intensive studies, both clinical and epidemiological, have been carried out in that country. Research on the clinical aspects of the disease at Bambui, State of Minas Gerais, have been especially noteworthy.

Köberle[474] in 250 autopsies of subjects with Chagas' disease observed 69 with megacolon and 61 with megaoesophagus. The preponderance of the former may lead to fatal complications, such as volvulus, ileus and rupture, but as a clinical entity Köberle was of the opinion that megaoesophagus predominates.

De Lucena[475] reported 14.88 per cent positives in complement fixation tests on 3,268 individuals in the State of Pernambuco, Brazil. Marques *et al.*[476] studied 120 cases of Chagas' disease from two different endemic areas in Pernambuco and found abnormal electrocardiographic manifestations in 90, or 75 per cent.

Morbidity and mortality

Table 25 presents data concerning Chagas' disease. In the Caribbean, Central and South America, the number of countries reporting Chagas' disease includes 67.34 per cent of the area population. The morbidity rate for the area was 0.56 per 100,000 and the mortality rate 0.047 per 100,000.

The highest morbidity rates per 100,000 were recorded from Argentina (4.73), El Salvador (1.36) and Brazil (0.03). The highest mortality rates per 100,000 were recorded from Venezuela (1.09), Brazil (0.02) and Guatemala (0.15). Venezuela and Guatemala reported the disease only in terms of deaths.

Public health importance

Although restricted in distribution, Chagas' disease affects large proportions of the population in certain endemic foci in Central and South America. However, the extent of the available data does not permit an epidemiological evaluation of the public health importance of the disease. Indeed, the collection of pertinent data in this regard constitutes one of the most pressing of research problems on this disease.

AFRICAN TRYPANOSOMIASIS

Distribution

This disease is confined to the African continent, where it was reported by 30 of the 58 countries and territories. Details of distribution are summarized in Plate IX. Of the population of Africa in 1957, 52.86 per cent inhabited areas reporting the disease.

The endemic areas of African sleeping sickness extend from approximately 15° north latitude to 20° south latitude. The northern border of the area approximates the southern border of the Sahara, and the southern extent reaches Ngamiland. The disease occurs throughout the area from the Atlantic on the west to the Indian Ocean on the east.

Of the two forms of human trypanosomiasis, the Gambian form, transmitted by riverine tsetses, is endemic along the west coast from Senegal on the north to Angola on the south. It extends eastward as far as Kenya and Tanganyika. Within this range it has an uneven pattern of distribution in Senegal, Gambia, Portuguese Guinea, Guinea, Sierra Leone, Liberia, Mali, Republic of Upper Volta, Ivory Coast, Ghana, Togo, Dahomey, Nigeria, Cameroon, Spanish Guinea, Fernando Po, Niger, Chad, Central African Republic, Gabon, Congo Republic (Brazzaville), Republic of the Congo (Leopoldville), Ruanda-Urundi, Sudan, Kenya, Tanganyika, Uganda and Angola.

Rhodesian sleeping sickness, transmitted by the "savannah woodland" tsetses is found in Mozambique, Northern Rhodesia, Southern Rhodesia, Nyasaland, Ruanda-Urundi, Tanganyika, Uganda and Bechuanaland.

Incidence and prevalence

In 1960, Demarchi and Louis[477] reported on the occurrence of sleeping sickness in a number of countries in Africa in 1958. The following data concern Gambian sleeping sickness.

In the Ivory Coast, there were 7,075 patients under observation in a population of 3,058,000. During 1958, 1,354 new cases were diagnosed, of which 547 were in the first stage and 807 in the second stage of the disease. The main foci were in the region of Abengourou and along the frontier of Ghana. Other areas of less importance were the subdivisions of Doúekoué, Sassandra and Abidjan.

A total of 781 cases was under control in Dahomey among a population of 610,000. The main area of infection was in the Natitingou region.

In Gambia, 473 new cases were diagnosed in 1958 in a population of 290,000.

Principal areas in Ghana were in the north and around Ashanti; 1,085 cases were under observation.

In Upper Volta, 11,914 cases were under observation among a population of 3,400,000; 639 new cases were discovered in 1958. Heavy endemic areas were at Kalsi south of Ouagadougou and Boursoma northeast of Ouagadougou. The situation in the area in the vicinity of Dina, which had in 1954 an index of new cases of 12 per cent, was considerably improved with an index of only 0.4 per cent.

Sleeping sickness had practically disappeared from Niger in 1958. Among a population of 950,000 only eight cases were under control and only one new case was diagnosed.

The sleeping sickness area in Northern Nigeria is extensive, involving some 990,000 km.^{2} with a population of about 9 million. In 1958, 4,862 new cases were discovered in the Provinces of Beñoue, Kano, Zaria and Niger. In 1960, 1,628,511 persons were examined and 3,789 cases of sleeping sickness notified from all sources. Nearly 20 per cent of these were relapses.[478]

In 1958, 26 new cases of Gambian sleeping sickness were diagnosed in Sierra Leone.

The disease is still of considerable importance in the Republic of Mali where in 1958, 3,805 patients were under control and 1,168 new cases were diagnosed. The main areas of endemicity included Sikasso, Bougouni, Bamako, Dioila, Koulikoro and Segou.

Most of the sleeping sickness in Togo is in the extreme north where it is only lightly endemic. In 1957, the index of cases was only 0.045.

The disease is endemic in the north of Angola with 851,220 inhabitants in the affected zone. Here, in 1958, 1,274 patients were under surveillance and 93 new cases were discovered.

In Cameroon, sleeping sickness is sporadic and mainly confined to the middle region of the Adamaoua Plateau. Other foci are along the Logone and Chari Rivers and the lower Logone-Birni. A total of 359 new cases were recognized in 1957.

The number of patients under surveillance in the Central African Republic in 1958 was 942, with 78 new cases being discovered. The main endemic areas are Nola, Carnot, Damara and M'Baiki.

In the Congo Republic, 2,857 cases of sleeping sickness were under observation in 1958 while 149 new cases were noted. Cases were mainly sporadic but certain foci exist in the Niari Bouenza and around the Mossaka lakes.

In Sudan, the main foci of sleeping sickness are found in Equatoria Province on the frontier with the Republic of the Congo and the Central African Republic. In 1958, 167 new cases were diagnosed.

In Chad, the main endemic areas of Gambian sleeping sickness are Chari-Baguirmi, Mayo-Kebbi, Logone and Moyen-Chari. These regions have a population of 1,400,000 among which 2,349 cases were under surveillance in 1958; 384 new cases were recognized in that year.

Gambian sleeping sickness exists in all provinces of the Republic of the Congo; the disease is most prevalent in the provinces of Leopoldville, Kasai and Equator. Examination of 6,254,454 in 1958 produced evidence of 5,321 old infections and 1,218 new cases. This represented an incidence of 0.085 per cent of old infections and 0.019 per cent of recent infections.[479]

The main centers of Gambian sleeping sickness in Kenya are in the province of Nyanza in the districts of South and Central Nyanza. At the beginning of 1957, the four foci were the Kuja River system in South Nyanza, the central reaches of the Nyando River and its tributaries between Kibigori and Koru, the Samia area bordering the northeastern corner of Lake Victoria and the stretch of Lake Victoria shore from Kadimu Bay to the Uyoma Peninsula.[480]

The small focus of Gambian sleeping sickness in Tanganyika near Lake Tanganyika just south of the border with Ruanda-Urundi seems to have been controlled through the application of insecticides.[477] Only five new cases were found in 1958.

In Uganda, the Gambian form of the disease is localized in the Northern Province, where 232 new cases were discovered in 1958. The most active focus appears to be in the Lango District.

Rhodesian sleeping sickness is the form found in the Mozambique. Demarchi and Louis[477] have summarized the prevalence of this form of the disease in certain countries for the year 1958. One of the endemic zones is in the basin of the Zambezi River situated west of the 34th meridian east between Southern Rhodesia and Nyasaland; the other area is in the north between Lake Nyassa and the Indian Ocean and is limited on the south by the valley of the Lurio. The population of the endemic zones is 950,000. In 1958, 167 new cases were diagnosed and 769 patients were under surveillance.

In the Federation of Rhodesia and Nyasaland, 72 new cases were discovered in 1958, of which 68 were in the endemic areas of Munbwa and Mankoya in Northern Rhodesia, 3 in Southern Rhodesia on the Zambezi River near the confluence with the Luangwa and 1 case in Nyasaland, the origin of which could not be determined.

The endemic areas of Rhodesian sleeping sickness in Tanganyika are around Muyama Ushingu in the Kasulu District of Lake Province, where 121 new cases were found in 1958 among a population of 27,000, and in scattered foci in the Northern, Eastern and Southern Provinces. In 1959, two small outbreaks in the Galapo area near Babati in the Northern Province and in the Tunduru District of the Southern Province were quickly suppressed. The total number of cases recorded in 1959 was 836, the highest since 1955.[481]

In Uganda, *Trypanosoma rhodesiense* infection is found mainly in the Eastern Province in the districts of Busuga and Bukedi, where 155 new cases were observed in 1958. In that year, 492 cases were under observation.

Morbidity and mortality

The morbidity and mortality rates per 100,000 of sleeping sickness in Africa were 4.48 and 0.42, respectively (Table 25). With the exception of Gambia and Portuguese Guinea, rates could not be considered high. The highest morbidity and mortality rates per 100,000 were in the following countries: Gambia (154.04 and 0.21), Portuguese Guinea (123.69 and 2.71), British East Africa (13.32 and 0.99), Cameroon (11.53 and 5.41), former Belgian Congo (11.51 and 4.58), Nigeria (11.15 and 0.02), former French West Africa (6.2 and 0.05) and Tanganyika (4.67 and 0.39).

Public health importance

Human trypanosomiasis has shown signs of receding in front of the organized forces of preventive medicine and insect control. However, localized foci of high endemicity remain in many areas, providing opportunity for new outbreaks. In fact, the International Scientific Committee for Trypanosomiasis Research (a subsidiary organization of the Commission for Technical Co-operation in Africa South of the Sahara-Scientific Council for Africa South of the Sahara) has recommended that "the remarkable success so far achieved in the campaign against human trypanosomiasis should not give rise to any relaxation of effort on the part of Governments; in particular, careful and frequent surveillance of all endemic areas should be continued."

Chapter 6

New Diseases, the Present Knowledge of Which Is Limited

ARTHROPOD-BORNE VIRUS DISEASES

Distribution

References to yellow fever and classical dengue have been made above. The lesser-known arthropod-borne viroses are considered here.

It is perhaps premature to attempt an assessment of any validity of the number of cases of arthropod-borne viroses, in view of the rapidity with which new clinical and etiological entities have been discovered in recent years. In 1957 the number of these infections was 25,970, of which 24 per cent were in the Caribbean, Central and South America, 47 per cent in Africa, 6 per cent in Southwest Asia, 19 per cent in South Central and Southeast Asia and 4 per cent in Oceania (Figure 1-a).

These diseases are apparently widely distributed in many of the regions in the survey. In recent years the Virus Research Centre Laboratories of the Rockefeller Foundation have contributed materially to knowledge of these diseases. The development of improved techniques for the isolation and identification of the viral agents has been in part responsible for this advance; perhaps even more credit should be accorded the perseverance of the field workers whose mission is to search out the agents of these diseases in their natural habitats.

A review of the distribution of the numerous virus agents of disease in the areas of the survey has recently been made.[482] Agents identified clinically with fever, malaise, headache and pains of general and localized distribution have been found in Brazil (Mayaro, Oriboca, Caraparu, Apeu, Murutucu, Marituba, Itaqui, Guaroa, Guama, Catu and Oropouche viruses), Trinidad (Mayaro and Oropouche), Colombia (Mayaro and Guaroa) and Bolivia (Uruma). In Africa such agents have been found in South Africa (Wesselsbron, Bunyamwera and Germiston), Nigeria (Zika and Ilesha), Uganda (Zika and Chikungunya),[483] East Africa (Bunyamwera and Bwamba) and Central and West Africa (Bwamba). Sicilian phlebotomus virus has been recovered in Egypt.

Agents identified with fever, malaise, headache, joint pains and rash have been found in East Africa and South Africa (Chikungunya virus) and Uganda (o'nyong-nyong virus).

Agents identified with fever, headache, general and localized pains, rash and lymphadenopathy include, besides classical dengue types 1 and 2, which are dealt with in a previous section, West Nile virus, which has been found in Africa, Southwest Asia and South Asia.

Agents associated with fever, headache, general and localized pains, prostration and hemorrhagic signs have been recovered in Thailand (BAH 306, TH 35, and dengue type 3), Philippines (dengue types 3 and 4), India (Kyasanur forest disease) and Argentina (Argentinian hemorrhagic fever).

Many of the arthropod-borne viruses provoke acute febrile illnesses involving specific organ systems. The reported occurrence of various types of equine encephalomyelitis in the Caribbean, Central and South American region is given in Table 40 in Part II. In addition to these viruses, St. Louis encephalitis has been reported from Trinidad, Brazil, Colombia, Venezuela and several of the Caribbean islands. Ilheus virus is known to occur in Trinidad, Brazil, Colombia, Venezuela and in Central America. It is probably more widespread than reports indicate.

Japanese B encephalitis virus is recorded from South Central and Southeast Asia (Taiwan, Thailand, Malaya, Burma, India and the Philippines) as well as Oceania (Guam and New Guinea). The disease occurs in the Ryukyu Islands.[182] Murray Valley encephalitis has been reported from New Guinea.

Agents associated with hepatitis, nephritis or toxemia include yellow fever (mentioned previously) and Rift Valley fever, which occurs in Africa.

Quaranfil virus, isolated from ticks in the Nile Delta of Egypt, has not been associated with human disease.

Certain viruses have been characterized in the absence of demonstrated disease in man. These include Spondweni and Middleburg viruses from South Africa and Sindbis virus from Africa and India.

Incidence and prevalence

The multiplicity of viral agents which may be responsible for a given clinical entity has partly been responsible for the paucity of data with regard to prevalence and incidence of these diseases.

In the Caribbean, Central and South America the prevalence rates of acute infectious encephalitis, without mention of etiology, for the four-year period 1953-1956, have been reported.[21] These rates per 100,000 for 1956 were as follows: Argentina 0.9, Brazil 1.1, Chile 0.8, Colombia 0.9, Costa Rica 1.2, El Salvador 1.5, Guatemala 0.5, Panama 0.1, Paraguay 1.3, Peru 0.5, Venezuela 1.4, British Guiana 0.4, Canal Zone 2.7 and United States Virgin Islands 4.2.

Early in 1961 a large-scale epidemic involving some 11,000 cases occurred in Belem, Brazil. Oropouche virus was isolated from the blood of 15 patients. The clinical course of the disease was characterized by fever, headache, backache, muscular aches and articular pain. Also noted at times were photophobia, dizziness, delirium, chills and nausea. Leukopenia was observed in nearly all cases. Duration of illness rarely exceeded one week and no deaths were known to have occurred. The only other recorded isolation of Oropouche virus from humans was made in Trinidad, and there has been some doubt that this virus was capable of producing disease in man.[484]

During the latter part of 1961 an outbreak of Venezuelan equine encephalomyelitis occurred in the human population in the Almirante area of Panama. The exact number of cases is not known. One estimate indicated 800, but this may have been on the generous side.[485]

In 1958 a new clinical syndrome designated as epidemic hemorrhagic fever appeared in the northwestern part of the province of Buenos Aires, Argentina.[486] A total of 73 cases was recorded with a case fatality rate of 23.28 per cent. The etiological agent, known as Junin virus, insofar as is known at present, is not related to any of the antigenic groups that have been characterized.[487] The virus has been isolated from certain field rodents.

In 1959 an epidemic of o'nyong-nyong fever had its inception in northwestern Uganda and spread south and east into Kenya as far as Lake Victoria. It is estimated that the disease attacked 750,000 persons. Symptoms included fever, headache, rash, and severe joint and back pain. The virus is harbored by *Anopheles gambiae* and *A. funestus* and probably transmitted by both species but certainly by the latter.[488]

In Taiwan, Japanese B encephalitis has been studied.[46] Neutralizing antibodies to the virus were found in 97 per cent of adults and 80 per cent of children aged 13-14, but only in 5-20 per cent of children under 6 years of age. A survey in the Pescadores Islands (Penghu) uncovered a rate of 73 per cent in adults, but none of the 7-year-old children surveyed showed antibodies. With regard to clinical disease, the reported incidence per 100,000 in Taiwan from 1955 to 1959 was 6 and in the Pescadores Islands 27.[489]

Table 26. Morbidity and mortality due to new diseases of limited present knowledge, as reported in 169 countries and territories in 1957

		GEOGRAPHIC AREAS OF THE SURVEY					
		CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
DISEASES	NUMBER OF COUNTRIES AND TERRITORIES	46	58	18	24	23	169
	Population (in thousands)	190,609	231,672	80,517	698,100	3,603	1,204,501
Arthropod-borne virus diseases	Relative population[1]	44.68	42.02	11.33	12.37	57.39	23.25
	Morbidity (per hundred thousand)	3.21	5.27	0.21	0.71	27.67	2.16
	Mortality (per hundred thousand)	0.51	0.19	0.032	0.11	0.97	0.19

[1] Given as a percentage ratio of population of countries and territories reporting data to total population of area.

Outbreaks of Japanese B encephalitis occur yearly in the Ryukyu Islands. Between 1945 and 1958 the number of cases varied from a high of 217 in 1953 to a low of 29 in 1946. The number of deaths ranged from 66 in 1947 to 6 in 1952.[182]

Morbidity and mortality

According to official reports, 23.25 per cent of the population of the survey area lives in countries which recognize these diseases. Reports are generally of cases of encephalitis or hepatitis, without etiological reference. On the basis of the data available, a total morbidity rate for the survey area of 2.16 per 100,000 and a total mortality rate of 0.19 per 100,000 was recorded (Table 26). It seems clear that these rates are much lower than those which would result from improvements in diagnosis and reporting.

Curiously little reference has been found to these diseases in Oceania, where the highest rates for morbidity and mortality were recorded (27.67 and 0.97 per 100,000, respectively). The lowest rates were from Southwest Asia (0.21 and 0.032, respectively).

Public health importance

The paucity of data do not yet permit a clear evaluation of the public health importance of these viroses. They seem to represent a hazard in many localities, such as forest areas of India and Brazil. Moreover, there is a disturbing tendency of these conditions to appear suddenly in epidemic proportions in certain regions. Although the available data do not support the establishment of priorities, the evidence strongly suggests that research on the arthropod-borne virus diseases should receive additional attention in the areas of the survey.

Chapter 7

Control of Disease In The Survey Areas

In addition to the compilation of data on the distribution, incidence, prevalence and public health importance of those diseases of greatest concern in the tropics, one of the tasks assigned to the Academy-Research Council was to arrive at some evaluation of the status of control of these diseases. This can be done with a reasonable degree of accuracy with due consideration for the control methods which are available at this time. Complete control, even with the most effective measures, is seldom achieved in tropical countries; there are many reasons for failure to curb disease and some of them will be mentioned here.

Many of the communicable diseases have been dealt with effectively in the countries with higher economic levels, although it must be said that such control has been achieved gradually and has not as a rule been the result of well-organized, short-term, vigorously pursued campaigns. Rather it has taken place over a period of time and has coincided usually with improved sanitation, higher educational levels, increased personal income and improved living conditions. One might cite as an opposing example the dramatic results achieved in the eradication of malaria from the southern United States, an objective which was reached within a short span of years. But the fact remains that malaria in this area had been on the decline long before the eradication program was inaugurated. The campaign did of course accelerate the process of elimination.

Many, if not most, of the countries within the present sphere of interest have unfortunately not progressed economically with the same acceleration as have the countries of Western Europe and North America. The control of the communicable diseases has therefore naturally lagged in many of them. This situation constitutes no reflection on the capability of health personnel in these countries since for the most part they are well trained and thoroughly devoted individuals. However, the resources available to them are not sufficient to meet the needs or to satisfy the demands made upon them. Nevertheless, great strides have been made in communicable disease control in the tropics. One must mention the elimination of urban yellow fever in the Americas and in Africa, the great decrease in African sleeping sickness, the considerable harnessing of the perennial menace of cholera, the marked decline in plague, the practical eradication of yaws in many parts of the tropics, the decreased number of cases of smallpox annually, the great achievements which bring malaria eradication closer to realization, the hope which has been brought through new chemotherapeutic agents to the sufferers from tuberculosis and leprosy, and the progress which is being made in a better understanding of the nutritional diseases and their prevention and control. All of these are phenomenal developments to which many of the countries in the survey area can well point with pride.

Factors concerned in health improvement

Elsewhere in this report has been stressed the impact of the economy of any country on health standards. With rising economic levels, there are multiple influences which come into play to raise health levels. A better economy results in a higher average personal income so that the individual is able to improve his standard of living and in so doing he is to some extent obviating the effect of influences which have an unfavorable effect on his health. The chances are that his housing situation is improved, his diet is less restricted and more balanced, he and his family are better clothed, and he lives in a better sanitary and hygienic environment, thus in the aggregate increasing his resistance and decreasing his exposure to disease. Higher economic levels also result in more funds for health services and larger expenditures for disease control.

Industrialization of a country in most instances contributes to an improvement in the economic level. It provides more jobs and these jobs usually offer a better wage than is available in strictly agricultural pursuits. On the other hand, industrialization usually brings about migration to cities; this influx is seldom orderly and results in the municipalities' incapacity to extend sanitary facilities and to encourage public and private housing to the extent that the greater demands can be met. The result in many cities is the development of slum areas with increased rates for tuberculosis and other diseases which are favored by crowding, a thing which has been observed in many urban communities in Africa.

Improved housing usually proves to be a definite health asset. A better house frequently offers improved sanitary facilities and better provisions for bathing and laundering. With proper screening, insect vectors of disease are denied entrance and exposure to such diseases is lessened. Improved housing alleviates crowding and reduces the opportunities for the transference of the contact diseases.

Ignorance is the handmaiden of disease transmission. Few studies have been carried out to evaluate the results of improved educational standards on disease control. However, it is not difficult to accept the principle that education facilitates an understanding of disease problems and promotes collaboration in disease control. This has been established many times in health educational efforts, and it must be assumed that improved general educational levels are vitally related to the purposes of health education. A better understanding on the part of the populace of disease problems eases the task of the health officer and enhances the success of any health program.

Commercial enterprise has been the means of improving health conditions in many areas in the tropics. A review of the contributions of certain American commercial firms has been presented in another section of this report. Medical care and preventive medicine activities on the part of commercial firms operating in the tropics have of course not been carried on as mere philanthropic programs since it is anticipated that certain rewards will accrue in the form of a more productive labor force. Nevertheless, such programs have been of great benefit to the employees of such firms and in many instances have had a salutary effect in serving as models for health improvement in otherwise backward areas.

Agriculture is intimately related to human health and agricultural practices have a certain role in the transmission of some diseases. An adequate agricultural output is necessary to provide a food supply for the population and the food must be of the kind and quality which will satisfy nutritional requirements and obviate nutritional deficiencies. It has already been remarked that the nutritional diseases are not only important health problems in themselves but that a deficient diet, especially one deficient in suitable protein, acts to lower the resistance of the individual and renders him or her more prone to serious attack by the infectious diseases. On the other hand, certain agricultural practices promote the breeding of disease vectors. Good agricultural housekeeping will help to obviate the influence of these agents in the community health picture. Certain agricultural improvement such as the extension of irrigation systems offer favorable breeding grounds for the molluscan intermediate hosts of the human schistosomes and frequently contribute to the spread of schistosomiasis. Thus such improvements may be at once both beneficial and detrimental.

Methods of disease control

Some of the diseases of greatest importance in the survey area are amenable to control through the application of a single measure but others must be attacked on a broad front with various devices. However, in no instance has control been an easy task and constant vigilance needs to be exercised to hold the ground which has been gained. Such have been the advances in medical science that only 4 of the 34 diseases selected as constituting the most important public health problems in the tropics are not amenable to adequate control at this time. These diseases are schistosomiasis, measles, leptospirosis and certain arthropod-borne viroses. Of these, prospects are bright for the control of measles through vaccination.

Theoretically, certain methods of communicable disease control approach total effectiveness if universally applied. However, it is seldom possible in the tropics to achieve such coverage. Even in the advanced countries, there are always factors which obviate complete success in the elimination of many infectious diseases; in the areas covered by this survey these factors are even more difficult to combat. In addition, there are many other obstacles to disease control, obstacles which are not encountered in other parts of the world. There additional deterrents include physical barriers, lack of communication and transportation, illiteracy, poverty, social taboos, dearth of medical and health personnel, inadequate medical facilities, insufficient health budgets and others.

It is proposed to outline briefly here the major methods of control of the tropical diseases considered in this report and to designate the diseases which are susceptible to control through the application of these measures. It will of course be understood that many factors contribute to disease control and that some of them act to inhibit not only one disease but many diseases. At the same time, more than one control measure may be applicable and may be utilized in checking a single disease.

It must be recognized also that some of the control measures mentioned below may not be completely effective. Great strides have been made in the chemotherapy of leprosy but drugs currently available are not 100 per cent effective. The employment of sulphonamides in the control of trachoma has represented a great step forward but more effective measures are needed. Immunization is of great value in mass disease control if practiced on an entire population or on a large percentage of a population. In many instances in the tropics it is difficult to achieve such an end. Urban yellow fever has been curbed but the potential danger exists that the jungle variety, which is exceedingly difficult of control, may be introduced into urban areas from which *Aëdes aegypti* has not been eradicated. Meningococcal meningitis has been controlled in military and certain other populations through prophylaxis with sulphonamide compounds but difficulties in achieving the same success would no doubt be encountered in rural sections of Africa. Thus, it will be understood that the diseases enumerated below are amenable to control by the methods designated but that in most tropical areas complete control or eradication is a goal which is probably not attainable in the immediate future.

Most important diseases of the tropics listed with reference to the various measures applicable to control

A. Infectious diseases controllable by sanitary and hygienic procedures
   - Bacillary dysentery
   - Amoebiasis
   - Ancylostomiasis
   - Hydatid disease (plus treatment of infected dogs)

B. Infectious diseases controllable by chemotherapy
   - Leprosy
   - Treponematoses (syphilis and yaws)
   - Trachoma
   - Pneumonia
   - Meningococcal infections

C. Infectious diseases which are amenable to control through the systematic use of vaccines
   - Typhoid and paratyphoid fevers
   - Whooping cough
   - Poliomyelitis
   - Smallpox
   - Rabies (immunization of the dog population)
   - Influenza (certain strains)
   - Tuberculosis

D. Infectious diseases for which partially effective vaccines are available for use in control
   - Mumps

E. Infectious diseases which are amenable to control through the employment of vaccines and elimination of vectors
   - Yellow fever
   - Typhus fever
   - Plague

F. Infectious diseases in the control of which vaccination and sanitary measures are applicable
   - Cholera

G. Infectious diseases amenable to control through attacks on vectors
   - Dengue
   - Leishmaniasis
   - Chagas' disease

H. Infectious diseases amenable to control through attacks on vectors plus chemotherapy
   - African sleeping sickness
   - Malaria
   - Filariasis
   - Onchocerciasis
   - Relapsing fever

I. Diseases controllable through dietary improvements and/or supplements
   - Kwashiorkor
   - Other nutritional deficiencies

J. Infectious diseases for which effective control measures are not available at this writing
   - Measles
   - Leptospirosis
   - Schistosomiasis
   - Arthropod-borne viroses (other than yellow fever)

SUMMARY AND CONCLUSIONS—PART I

An evaluation of the public health importance of the diseases selected by the Advisory Committee as being of greatest concern in the tropics has been presented in this section of the report.

This evaluation is based on available morbidity and mortality reports. Available data with regard to population, general mortality, neonatal mortality, infant mortality and natural increase are presented and discussed for the five-year period 1953-1957.

Considerable lack of reporting was encountered and it was necessary to resort to some extrapolation in order to obtain uniform coverage. Even so, the available information in some cases was not adequate to permit reasonably accurate conclusions. Thus, the conclusions presented were reached only on the basis of available data and may consequently be subject to revision if and when reporting becomes more complete. For example, data from Part I purport to show that in 1957 morbidity from tuberculosis in Africa was only moderate (the rate, based on official data, being 68.3 per 100,000) as compared with Southwest Asia during the same period (4,964 per 100,000). But surveys undertaken by the World Health Organization in many parts of Africa have indicated that the true rate may approach 1 per cent of the total population. At the opposite end of the scale, the picture of influenza in the tropics has been greatly influenced by the 1957 pandemic. If it is understood that health reports in many countries do not refer to influenza as it is familiar to virologists but rather include under this name a whole gamut of respiratory illnesses and fevers, it becomes evident that improved reporting will considerably modify the data that were available for the present report.

Considering only the countries for which complete data on population were obtainable for the five-year period, a population increase of 32,291,000 was noted between 1953 and 1957. Population increases were found in three of the five regions of the survey area (Caribbean, Central and South America, Africa and South Central and Southeast Asia), but a population decrease was recorded in Southwest Asia and Oceania, possibly because of the paucity of reporting from countries in these areas.

Data on general mortality were obtainable only from 32 per cent of the 169 countries and territories of the survey area for the period 1953-1957. The average annual mortality rate was 9.38 per 1,000. When extrapolations were made for better coverage, the rate was 8.30.

A mean annual infant mortality rate of 95.6 per 1,000 births was found for the five-year period 1953-1957, and an average annual neonatal mortality rate of 4.68 per 1,000 births was recorded.

With regard to natural increase, it was noted that the total rise in the five-year period 1953-1957 was 19.04 per cent in the areas included in the survey. However, this rise was particularly noticeable in South Central and Southeast Asia, where it was 21.17 per cent. The area showing the next greatest increase was the Caribbean, Central and South America, where the figure was only 14.91 per cent. The lowest figure, 5.64 per cent, was recorded for Africa. On the basis of available data, it would seem that natural increase in the population presents a real problem only in South Central and Southeast Asia and possibly in Southwest Asia.

Evaluation of disease notification in the survey area showed that of all the diseases considered in the survey, only 13 were legally notifiable in three-quarters of all countries surveyed, only 22 were notifiable in half or more of the countries, and only 5 (yellow fever, cholera, plague, typhus and smallpox) were notifiable in all countries surveyed.

Available data with regard to disease distribution, incidence, prevalence, morbidity and mortality rates and public health importance are presented for each disease. Data are summarized in tables and figures.

Diseases were also reviewed with respect to available methods of control. Only four (schistosomiasis, measles, leptospirosis and arthropod-borne viroses) were included in the group for which no effective control measures had been devised at the time of writing.

Two conclusions may be drawn from the data. First, there is a serious need to standardize and enlarge the reporting of data regarding health and disease in all underdeveloped countries. Second, the true picture of epidemiology and pathology of these diseases will not emerge without the results of considerably more research than is presently being performed.

The "great diseases" of the tropics, as defined by the Advisory Committee, are analyzed to establish, tentatively, their relative importance. Evaluation of certain of these diseases was of necessity limited to official data regarding morbidity and mortality.

An arbitrary system of grading the "great diseases" was established, in accordance with the following pattern.

According to morbidity

1. Diseases of outstanding morbidity, i.e., those for which rates exceeded 500 cases per 100,000.
2. Diseases of very high morbidity, i.e., those for which rates of 250 to 499.9 cases per 100,000 were reported.
3. Diseases of high morbidity, i.e., those for which rates of 100 to 249.9 cases per 100,000 were reported.
4. Diseases of moderate morbidity, i.e., those for which rates of 10 to 99.9 cases per 100,000 were reported.
5. Diseases of low morbidity, i.e., those for which rates of less than 10 cases per 100,000 were reported.

According to mortality

1. Diseases of outstanding mortality, i.e., those for which rates exceeded 50 deaths per 100,000.
2. Diseases of very high mortality, i.e., those for which rates of 1 to 49.9 deaths per 100,000 were recorded.
3. Diseases of high mortality, i.e., those for which rates of 0.05 to 0.99 deaths per 100,000 were recorded.
4. Diseases of moderate mortality, i.e., those for which rates of 0.005 to 0.049 deaths per 100,000 were recorded.
5. Diseases of low mortality, i.e., those for which rates of less than 0.005 deaths per 100,000 were recorded.

According to public health importance

1. Diseases of outstanding importance, i.e., those presenting outstanding morbidity and outstanding mortality, or very high morbidity and outstanding mortality.
2. Diseases of very high importance, i.e., those presenting outstanding morbidity and very high mortality; very high morbidity and mortality; high morbidity and outstanding mortality; very high morbidity and high mortality; or moderate morbidity and outstanding mortality.
3. Diseases of high importance, i.e., those presenting outstanding morbidity coupled with high, moderate, low or no mortality; very high morbidity and moderate mortality; high morbidity and mortality; moderate morbidity and very high or high mortality; and low morbidity and outstanding mortality.
4. Diseases of moderate importance, i.e., those presenting very high morbidity coupled with low or no mortality; high morbidity with moderate, low, or no mortality; moderate morbidity and mortality; and low morbidity with very high or high mortality.
5. Diseases of low importance, i.e., those presenting moderate morbidity with low or no mortality; or low morbidity with moderate, low, or no mortality.

Based on these gradings, the great diseases may be arranged, according to data available, in the following fashion.

Geographical distribution according to morbidity (rates per 100,000)

Caribbean, Central and South America

1. Outstanding: Influenza (1,877).
2. Very high: None
3. High: None
4. Moderate: Measles (86.89), malaria (84.1), whooping cough (80.3), bacillary dysentery (64.7), amoebic dysentery (58.7), syphilis (33.7), mumps (27), typhoid fever (23.7), ancylostomiasis (16.8), tuberculosis (16.7).
5. Low: Pneumonia (7.16), nutritional deficiencies, excluding kwashiorkor (6.37), yaws (3.53), smallpox (3.26), arthropod-borne viroses (3.21), poliomyelitis (2.26), leprosy (2.62), onchocerciasis (1.41), trachoma (1.37), paratyphoid fevers (1.06), meningococcal infections (1.03), typhus (0.93), schistosomiasis (0.78), filariasis (0.64), Chagas' disease (0.56), relapsing fevers (0.12), plague (0.079), leishmaniasis (0.055), kwashiorkor (0.044), yellow fever (0.036), leptospirosis (0.0079), dengue (0.0058), rabies (only deaths reported).
6. Neither cases nor deaths reported: Cholera, hydatid disease.

Africa

1. Outstanding: Malaria (1,236), influenza (979).
2. Very high: None
3. High: Trachoma (224), yaws (218.5), ancylostomiasis (202.15), pneumonia (148.2), syphilis (135.6), bacillary dysentery (116.7), measles (108.89).
4. Moderate: Amoebic dysentery (83.3), whooping cough (79.8), tuberculosis (68.3), nutritional deficiencies, excluding kwashiorkor (67.96), schistosomiasis (64.1), mumps (34.1), leprosy (30.1), filariasis (26.6), meningococcal infections (16.1), smallpox (15.2), typhoid fever (13.75).
5. Low: Kwashiorkor (5.8), arthropod-borne virus diseases (5.27), typhus (4.7), trypanosomiasis (4.48), leishmaniasis (3.59), poliomyelitis (3.23), relapsing fevers (3.2), onchocerciasis (2.1), paratyphoid fevers (0.41), dengue (0.3), leptospirosis (0.15), hydatid disease (0.14), plague (0.046), yellow fever (0.00086), rabies (only deaths reported).
6. Neither cases nor deaths reported: Cholera.

Southwest Asia

1. Outstanding: Tuberculosis (4,964), trachoma (606).
2. Very high: Influenza (484).
3. High: Malaria (145).
4. Moderate: Schistosomiasis (75.96), bacillary dysentery (72.3), measles (71.5), ancylostomiasis (29.9), amoebic dysentery (29.8), mumps (28.9), typhoid fever (18.75), whooping cough (12.7).
5. Low: Pneumonia (9.97), syphilis (8.53), smallpox (4.4), paratyphoid fevers (1.36), meningococcal infections (1.25), leprosy (0.81), poliomyelitis (0.79), leptospirosis (0.42), nutritional deficiencies, excluding kwashiorkor (0.39), typhus (0.34), arthropod-borne virus diseases (0.21), relapsing fevers (0.11), hydatid disease (0.091), leishmaniasis (0.0087), filariasis (0.0025), yaws (0.0012), rabies (no cases and only deaths were reported).
6. Neither cases nor deaths reported: Cholera, dengue, kwashiorkor, onchocerciasis, plague, trypanosomiasis, yellow fever.

South Central and Southeast Asia

1. Outstanding: Yaws (1,729), influenza (897).
2. Very high: Tuberculosis (280.1).
3. High: Nutritional deficiencies, excluding kwashiorkor (234.7), malaria (141).
4. Moderate: Cholera (76.5), pneumonia (45.8), bacillary dysentery (44.5), filariasis (28.8), ancylostomiasis (18.4), trachoma (10.1).
5. Low: Whooping cough (8.8), amoebic dysentery (8.49), smallpox (6.9), measles (6.58), syphilis (5.78), typhoid fever (2.6), mumps (2.12), hydatid disease (2.06), leprosy (1.81), schistosomiasis (0.71), arthropod-borne virus diseases (0.71), meningococcal infections (0.46), leishmaniasis (0.44), typhus (0.36), poliomyelitis (0.29), paratyphoid fevers (0.29), dengue (0.072), plague (0.058), leptospirosis (0.0072), relapsing fevers (0.00072), rabies (no cases and only deaths were reported).
6. Neither cases nor deaths reported: Kwashiorkor, onchocerciasis, trypanosomiasis, yellow fever.

Oceania

1. Outstanding: Influenza (2,033), measles (841.13), malaria (571).
2. Very high: Pneumonia (251.1).
3. High: Tuberculosis (243.1), yaws (201.8), bacillary dysentery (119.95), nutritional diseases, excluding kwashiorkor (102.99).
4. Moderate: Ancylostomiasis (97.4), leprosy (58.6), trachoma (36.5), filariasis (33.5), arthropod-borne virus diseases (27.67), amoebic dysentery (18.4).
5. Low: Poliomyelitis (8.79), meningococcal infections (8.38), mumps (7.69), whooping cough (6.6), syphilis (6.05), typhoid fever (5.8), dengue (1.05), paratyphoid fevers (0.86), leptospirosis (0.72).
6. Neither cases nor deaths reported: Cholera, hydatid disease, kwashiorkor, leishmaniasis, onchocerciasis, plague, rabies, relapsing fevers, schistosomiasis, smallpox, trypanosomiasis, typhus, yellow fever.

Total survey area

1. Outstanding: Yaws (1,045.1), influenza (1,043), tuberculosis (510.7).
2. Very high: Malaria (345).
3. High: Nutritional deficiencies, excluding kwashiorkor (150.5).
4. Moderate: Trachoma (89.7), bacillary dysentery (63.7), pneumonia (57.6), ancylostomiasis (54.5), measles (45.8), cholera (44.3), syphilis (35.4), whooping cough (34.3), amoebic dysentery (32.3), filariasis (21.99), schistosomiasis (21.6), mumps (14).

5. Low: Typhoid fever (9.2), smallpox (7.8), leprosy (7.49), meningococcal infections (3.63), arthropod-borne virus diseases (2.16), typhus (1.27), poliomyelitis (1.23), hydatid disease (1.23), kwashiorkor (1.12), leishmaniasis (0.95), trypanosomiasis (0.95), relapsing fevers (0.64), onchocerciasis (0.63), paratyphoid fevers (0.51), dengue (0.067), plague (0.055), leptospirosis (0.039), yellow fever (0.0058), rabies (no cases and only deaths reported).

Only four diseases (influenza, malaria, bacillary dysentery and ancylostomiasis) are found among the first ten causes of morbidity in all five major areas, indicating that epidemiological generalizations regarding the entire survey area must be projected with care. In general, however, one observation is warranted, namely, that these are largely diseases for which effective control measures are known. Thus the great prevalence of these diseases emphasizes the need for the more general application of control procedures.

Geographical distribution according to mortality (rates per 100,000)

Caribbean, Central and South America

1. Outstanding: None
2. Very high: Malaria (16.5), influenza (14.7), whooping cough (10.7), measles (7.6), typhoid fever (3.6), amoebic dysentery (3.38), bacillary dysentery (3.15), tuberculosis (1.86), pneumonia (1.31).
3. High: Nutritional deficiencies, excluding kwashiorkor (0.59), paratyphoid fevers (0.58), arthropod-borne virus diseases (0.51), typhus (0.45), poliomyelitis (0.3), smallpox (0.21), leprosy (0.16), meningococcal infections (0.16), rabies (0.076).
4. Moderate: Chagas' disease (0.047), mumps (0.033), yellow fever (0.016), plague (0.012), leptospirosis (0.0052).
5. Low: Relapsing fevers (0.0037), ancylostomiasis (0.00053), trachoma (0.00053).
6. No mortality reported: Dengue, filariasis, kwashiorkor, leishmaniasis, onchocerciasis, schistosomiasis, syphilis, yaws.

Africa

1. Outstanding: None
2. Very high: Tuberculosis (4.09), pneumonia (3.75), malaria (2.6), measles (2.21), meningococcal infections (2.03), leprosy (1.68), smallpox (1.2), nutritional deficiencies, excluding kwashiorkor (1.13).
3. High: Typhoid fever (0.59), influenza (0.56), whooping cough (0.51), trypanosomiasis (0.42), kwashiorkor (0.41), amoebic dysentery (0.39), bacillary dysentery (0.37), arthropod-borne virus diseases (0.19), poliomyelitis (0.19), yaws (0.17), ancylostomiasis (0.12), leishmaniasis (0.11), schistosomiasis (0.068), rabies (0.056).
4. Moderate: Plague (0.035), leptospirosis (0.032), typhus (0.027), relapsing fevers (0.025), paratyphoid fevers (0.016), hydatid disease (0.0056).
5. Low: Mumps (0.0048), onchocerciasis (0.0035), filariasis (0.0022), trachoma (0.0013), yellow fever (0.00043).
6. No mortality reported: Dengue, syphilis.

Southwest Asia

1. Outstanding: None
2. Very high: Pneumonia (8.04), tuberculosis (4.45), measles (1.04).
3. High: Typhoid fever (0.53), smallpox (0.36), malaria (0.28), nutritional diseases, excluding kwashiorkor (0.25), meningococcal infections (0.17), whooping cough (0.15), influenza (0.12), bacillary dysentery (0.085), rabies (0.06), poliomyelitis (0.056).
4. Moderate: Amoebic dysentery (0.041), arthropod-borne virus diseases (0.032), leptospirosis (0.025), paratyphoid fevers (0.021), leprosy (0.009), typhus (0.0062), hydatid disease (0.005).
5. Low: Ancylostomiasis (0.0037), schistosomiasis (0.0037), mumps (0.0025).
6. No mortality reported: Filariasis, leishmaniasis, relapsing fevers, syphilis, trachoma, yaws.

South Central and Southeast Asia

1. Outstanding: Tuberculosis (222.7), cholera (76.5).
2. Very high: Malaria (39.1), bacillary dysentery (26.5), pneumonia (12.3), smallpox (6.4), nutritional deficiencies, excluding kwashiorkor (3.57), influenza (1.13).
3. High: Leishmaniasis (0.44), meningococcal infections (0.44), measles (0.28), typhoid fever (0.26), typhus, (0.22), arthropod-borne virus diseases (0.11), amoebic dysentery (0.095), whooping cough (0.08), poliomyelitis (0.072), rabies (0.066), schistosomiasis (0.057).
4. Moderate: Leprosy (0.048), ancylostomiasis (0.034), plague (0.031), paratyphoid fevers (0.015), hydatid disease (0.013).

5. Low: Filariasis (0.0046), leptospirosis (0.002), mumps (0.00086).
6. No mortality reported: Dengue, relapsing fevers, syphilis, trachoma, yaws.

Oceania

1. Outstanding: None
2. Very high: Pneumonia (18.6), tuberculosis (11.7), malaria (5.66), nutritional deficiencies, excluding kwashiorkor (3.91), influenza (2.72), meningococcal infections (2.47), bacillary dysentery (2.39), whooping cough (1.19).
3. High: Arthropod-borne virus diseases (0.97), measles (0.69), amoebic dysentery (0.67), filariasis (0.44), ancylostomiasis (0.33), leprosy (0.33), poliomyelitis (0.28), typhoid fever (0.14), leptospirosis (0.11).
4. Moderate: Yaws (0.028).
5. Low: None
6. No mortality reported: Dengue, mumps, paratyphoid fevers, syphilis, trachoma.

Total survey area

1. Outstanding: Tuberculosis (130.5).
2. Very high: Cholera (44.3), malaria (25.8), bacillary dysentery (15.95), pneumonia (8.65), smallpox (3.99), influenza (3.1), nutritional deficiencies, excluding kwashiorkor (2.41), measles (1.86), whooping cough (1.85).
3. High: Typhoid fever (0.87), meningococcal infections (0.69), amoebic dysentery (0.67), leprosy (0.38), leishmaniasis (0.27), typhus (0.2), arthropod-borne virus diseases (0.19), poliomyelitis (0.13), paratyphoid fevers (0.11), trypanosomiasis (0.088), kwashiorkor (0.078), rabies (0.065).
4. Moderate: Ancylostomiasis (0.044), schistosomiasis (0.044), yaws (0.032), plague (0.027), leptospirosis (0.009), mumps (0.0068), relapsing fevers (0.0055).
5. Low: Filariasis (0.0044), yellow fever (0.0028), hydatid disease (0.0022), onchocerciasis (0.00066), trachoma (0.00033).
6. No mortality reported: Dengue, syphilis.

Of the ten main causes of mortality in the survey area, only five (tuberculosis, pneumonia, influenza, malaria and nutritional deficiencies, excluding kwashiorkor) were among the first ten agents of mortality in all survey regions. Seven of the first ten major causes of mortality (tuberculosis, bacillary dysentery, pneumonia, influenza, malaria, nutritional deficiencies, excluding kwashiorkor, and cholera) were also among the first ten major causes of morbidity. Of these, only two (malaria and cholera) belong with the so-called tropical diseases.

Considering figures for morbidity and mortality for each disease, the following figures are obtained as regards public health importance in each region and in the entire survey area (figures per 100,000, respectively):

Geographical distribution according to public health importance

Caribbean, Central and South America

1. Outstanding: None
2. Very high: Influenza (1,877 and 14.7).
3. High: Malaria (84.1 and 16.5), whooping cough (80.3 and 10.7), measles (86.89 and 7.6), typhoid fever (23.7 and 3.6), amoebic dysentery (58.7 and 3.38), bacillary dysentery (64.7 and 3.15), tuberculosis (16.7 and 1.86).
4. Moderate: Pneumonia (7.16 and 1.31), nutritional deficiencies, excluding kwashiorkor (6.37 and 0.59), paratyphoid fevers (1.06 and 0.58), arthropod-borne virus diseases (3.21 and 0.51), typhus (0.93 and 0.45), poliomyelitis (2.26 and 0.3), smallpox (3.26 and 0.21), leprosy (2.62 and 0.16), meningococcal infections (1.03 and 0.16), rabies (no cases reported and 0.076 mortality), mumps (27 and 0.033).
5. Low: Chagas' disease (0.56 and 0.047), yellow fever (0.036 and 0.016), plague (0.079 and 0.012), leptospirosis (0.0079 and 0.0052), relapsing fevers (0.12 and 0.0037), ancylostomiasis (16.8 and 0.00053), trachoma (1.37 and 0.00053), syphilis (33.7 and nil), yaws (3.53 and nil), onchocerciasis (1.41 and nil), schistosomiasis (0.78 and nil), filariasis (0.64 and nil), leishmaniasis (0.055 and nil), kwashiorkor (0.044 and nil), dengue (0.0058 and nil).

Africa

1. Outstanding: None
2. Very high: Pneumonia (148.2 and 3.75), malaria (1,236 and 2.6), measles (108.89 and 2.21).
3. High: Tuberculosis (68.3 and 4.09), meningococcal infections (16.1 and 2.03), leprosy (30.1 and 1.68), smallpox (15.2 and 1.2), nutritional deficiencies, excluding kwashiorkor (67.96 and 1.13), typhoid fever (13.75 and 0.59), influenza (979 and 0.56), whooping cough (79.8 and 0.51), amoebic dysentery (83.3 and 0.39), bacillary dysentery (116.7 and 0.37), yaws (218.5 and 0.17), ancylostomiasis (202.15 and 0.12), schistosomiasis (64.1 and 0.068).

4. Moderate: Trypanosomiasis (4.48 and 0.42), kwashiorkor (5.8 and 0.41), arthropod-borne virus diseases (5.27 and 0.19), poliomyelitis (3.23 and 0.19), leishmaniasis (3.59 and 0.11), rabies (no cases reported and 0.056 mortality), trachoma (224 and 0.0013), syphilis (135.6 and nil).
5. Low: Plague (0.046 and 0.035), leptospirosis (0.15 and 0.032), typhus (4.7 and 0.027), relapsing fevers (3.2 and 0.025), paratyphoid fevers (0.41 and 0.016), hydatid disease (0.14 and 0.0056), mumps (34.1 and 0.0048), onchocerciasis (2.1 and 0.0035), filariasis (26.6 and 0.0022), yellow fever (0.00086 and 0.00043), dengue (0.3 and nil).

Southwest Asia

1. Outstanding: None
2. Very high: Tuberculosis (4,964 and 4.45), influenza (484 and 0.12).
3. High: Measles (71.5 and 1.04), typhoid fever (18.75 and 0.53), malaria (145 and 0.28), whooping cough (12.7 and 0.15), bacillary dysentery (72.3 and 0.085), trachoma (606 and nil).
4. Moderate: Pneumonia (9.97 and 8.04), smallpox (4.4 and 0.36), nutritional deficiencies, excluding kwashiorkor (0.39 and 0.25), meningococcal infections (1.25 and 0.17), rabies (no cases reported and 0.06 mortalíty), poliomyelitis (0.79 and 0.056), amoebic dysentery (29.8 and 0.041).
5. Low: Arthropod-borne virus diseases (0.21 and 0.032), leptospirosis (0.42 and 0.025), paratyphoid fevers (1.36 and 0.021), leprosy (0.81 and 0.009), typhus (0.34 and 0.0062), hydatid disease (0.091 and 0.005), ancylostomiasis (29.9 and 0.0037), schistosomiasis (75.96 and 0.0037), mumps (28.9 and 0.0025), syphilis (8.53 and nil), relapsing fevers (0.11 and nil), leishmaniasis (0.0087 and nil), filariasis (0.0025 and nil), yaws (0.0012 and nil).

South Central and Southeast Asia

1. Outstanding: Tuberculosis (280.1 and 222.7).
2. Very high: Cholera (76.5 and 76.5), malaria (141 and 39.1), nutritional deficiencies, excluding kwashiorkor (234.7 and 3.57), influenza (897 and 1.13).
3. High: Bacillary dysentery (44.5 and 26.5), pneumonia (45.8 and 12.3), yaws (1,729 and nil).
4. Moderate: Smallpox (6.9 and 6.4), leishmaniasis (0.44 and 0.44), meningococcal infections (0.46 and 0.44), measles (6.58 and 0.28), typhoid fever (2.6 and 0.26), typhus (0.36 and 0.22), arthropod-borne virus diseases (0.71 and 0.11), amoebic dysentery (8.49 and 0.095), whooping cough (8.8 and 0.08), poliomyelitis (0.29 and 0.072), rabies (no cases reported and 0.066 mortality), schistosomiasis (0.71 and 0.057), ancylostomiasis (18.4 and 0.034).
5. Low: Leprosy (1.81 and 0.048), plague (0.058 and 0.031), paratyphoid fevers (0.29 and 0.015), hydatid disease (2.06 and 0.013), filariasis (28.8 and 0.0046), leptospirosis (0.0072 and 0.002), mumps (2.12 and 0.00086), trachoma (10.1 and nil), syphilis (5.78 and nil), dengue (0.072 and nil), relapsing fevers (0.00072 and nil).

Oceania

1. Outstanding: None
2. Very high: Pneumonia (251.1 and 18.6), tuberculosis (243.1 and 11.7), malaria (571 and 5.66), nutritional deficiencies, excluding kwashiorkor (102.99 and 3.91), influenza (2,033 and 2.72), bacillary dysentery (119.95 and 2.39).
3. High: Arthropod-borne virus diseases (27.67 and 0.97), measles (841.13 and 0.69), amoebic dysentery (18.4 and 0.67), filariasis (33.5 and 0.44), ancylostomiasis (97.4 and 0.33), leprosy (58.6 and 0.33).
4. Moderate: Meningococcal infections (8.38 and 2.47), whooping cough (6.6 and 1.19), poliomyelitis (8.79 and 0.28), typhoid fever (5.8 and 0.14), leptospirosis (0.72 and 0.11), yaws (201.8 and 0.028).
5. Low: Trachoma (36.5 and nil), mumps (7.69 and nil), syphilis 6.05 and nil), dengue (1.05 and nil), paratyphoid fevers (0.86 and nil).

Total survey area

1. Outstanding: Tuberculosis (510.7 and 130.5).
2. Very high: Malaria (345 and 25.8), influenza (1,043 and 3.1), nutritional deficiencies, excluding kwashiorkor (150.5 and 2.41).
3. High: Cholera (44.3 and 44.3), bacillary dysentery (63.7 and 15.95), pneumonia (57.6 and 8.65), measles (45.8 and 1.86), whooping cough (34.3 and 1.85), amoebic dysentery (32.3 and 0.67), yaws (1,045.1 and 0.032).
4. Moderate: Ancylostomiasis (54.5 and 0.044), schistosomiasis (21.6 and 0.044), smallpox (7.8 and 3.99), typhoid fever (9.2 and 0.87), meningococcal infections (3.63 and 0.69), leprosy

(7.49 and 0.38), leishmaniasis (0.95 and 0.27), typhus (1.27 and 0.2), arthropod-borne virus diseases (2.16 and 0.19).

5. Low: Paratyphoid fevers (0.51 and 0.11), syphillis (35.4 and nil), mumps (14 and 0.0068), poliomyelitis (1.23 and 0.13), trachoma (89.7 and 0.00033), filariasis (21.99 and 0.0044), kwashiorkor (1.12 and 0.078), plague (0.055 and 0.027), relapsing fevers (0.64 and 0.0055), leptospirosis (0.039 and 0.009), dengue (0.067 and nil), yellow fever (0.0058 and 0.0028), rabies (no cases reported and 0.065 mortality), hydatid disease (1.23 and 0.0022), onchocerciasis (0.63 and 0.00066), trypanosomiasis (0.95 and 0.088).

On the basis of these figures, the relative rank of the first ten of the diseases of public health importance in the entire area of this survey, consisting of 169 countries or national health jurisdictions in the tropics, was as follows: Tuberculosis, malaria, influenza, nutritional deficiencies (excluding kwashiorkor), cholera, bacillary dysentery, pneumonia, measles, whooping cough and amoebic dysentery.

Of the diseases listed, only four (schistosomiasis, measles, leptospirosis and certain arthropod-borne viroses) have not been demonstrated to be controllable by known measures. Of these, measles will perhaps soon be excluded.

It should be kept in mind that the present estimate of the relative rank in public health importance of the diseases listed is based on the tenuous foundation of official reports. Before more accurate and reliable conclusions can be drawn in this regard, reporting will have to be considerably improved.

It is interesting that of the first ten disease problems listed, only three (malaria, cholera and amoebic dysentery) belong with the classical so-called tropical diseases, the others constituting health hazards in non-tropical areas as well.

Of the ten disease problems of first rank in the entire survey area, four are among the first ten listed in each major area of the survey, namely, tuberculosis, influenza, malaria and pneumonia. Although cholera ranks as the fifth most important of the diseases listed in the entire survey area, it was in fact in the period represented only reported from South Central and Southeast Asia.

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Part II

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Chapter 8

Significant Diseases of Domestic Animals in Tropical and Subtropical Areas

By including data on the status of diseases of domestic animals in the tropics, it was hoped to provide a better understanding of health problems in this part of the world. These conditions are related to human health in two ways. Many of the zoonoses, or those diseases which are transmitted from lower vertebrate animals to man, are of considerable importance in the tropics, from both the economic and the public health aspects, and lower animals constitute important reservoirs of certain tropical diseases. Diseases of livestock are of concern also from the standpoint of human nutrition. In a majority of tropical countries, calorie needs are seldom satisfied, and even in the few areas in which there is sufficient caloric intake, the nutritional quality of the diet is unsatisfactory. Deficiencies of protein, especially animal protein, and of certain vitamins and minerals appear to be widespread, as was discussed in more detail previously. Table 27 presents data concerning calorie and protein content of national average food supplies in certain countries. It will be seen that protein intake per capita per day in most tropical countries is far below that in the countries listed from the temperate zone. The differences are perhaps most marked in connection with the consumption of animal protein.

These various deficiencies, above all protein deficiency, are the cause of much morbidity and mortality in tropical regions. They contribute especially to the very high rate of infant mortality between the ages of one and four and must also cause reduced activity and productivity in the adult worker.[1]

The situation in Africa is typical of many tropical areas. Even though the per capita availability of meat food animals is about the same as in the United States, meat consumption by the population is only about one-tenth the level of 225 pounds per person a year in North America. In addition to the disease problem, other factors interfere with the nutritional status of African populations by limiting the meat supply. One of these factors, of course, is the frequent tribal view that the possession of cattle is a mark of wealth and distinction. Under these conditions, cattle are not apt to be disposed of commercially. Another factor is the lack of adequate transportation between cattle producing areas and marketing centers, such as the large cities of central Africa. Frequently, cattle are driven for many hundreds of miles to reach the market and under such circumstances arrive in very poor condition. The prevalence of disease raises quarantine barriers between countries and interferes with the distribution of meat. It is believed by some authorities that the marketing of canned meat is one of the immediate practical solutions to the problem. Movement of cattle by air is thought by some to be economically feasible. At any rate the problem is one of great magnitude and is being studied by the Food and Agriculture Organization, which convened in December 1960 a meeting of 24 African nations at Fort Lamy, Republic of Chad, to consider ways and means of effecting better production and distribution of meat and meat food animals.

Domestic animals in the tropics are not only subjected for the most part to the same disease conditions existing in temperate zones but suffer from a considerable variety of diseases peculiar to the tropics. The disease hazards tend to discourage livestock production and act also as a considerable deterrent to breed improvement. Local animals usually show some immunity to the diseases of the area, but those which are imported from outside the tropics are extremely susceptible to local diseases. Although considerable improvement has been effected in recent years in upgrading veterinary services in the tropics and increasing the extent and efficiency of control procedures, animal diseases can be said without contradiction to take a much greater toll relatively in the tropics than in other parts of the world.

Sources of information

During August 1959 requests were sent to 130 countries for annual reports of veterinary services for the years 1954 to 1958, inclusive. Of these countries, 70, or 53.8 per cent, furnished some or all of the reports requested.

A review of the annual reports indicated that in many cases they did not contain all of the information needed for the purposes of the survey. Accordingly, a questionnaire, asking for specific data, was formulated in English, French, and Spanish and dispatched during February 1960 to 105 countries. The questionnaire is reproduced as Appendix 4. Follow-up letters were later forwarded to countries not responding to the original request. Thus far, replies have been received from 56, or 53.3 per cent, of the countries. A somewhat better response was had from Oceania and Africa; otherwise, the percentage of replies was fairly uniform.

Considerable aid was received from international organizations. At the request of the survey staff, the Pan American Health Organization conducted a survey of the zoonoses in the Americas, the results of which were published by Horwitz, Puffer and Chamberlayne,[2] and which are being included in this report. This organization has cooperated in other ways also and assistance has been received from the Director, Dr. Abraham Horwitz, and numerous members of his staff.

The Food and Agriculture Organization of the United Nations has aided in this part of the survey as well as that portion related to human nutritional problems. Dr. Ervin A. Eichhorn, Chief, Animal Health Branch, Animal Production and Health Division, and members of his staff have supplied valuable data and were uniformly helpful during the time spent by the director of the survey in Rome. Publications of the Animal Health Branch have been utilized to great advantage in the preparation of this report.

Dr. Nels Konnerup, Foreign Agriculture Service, United States Department of Agriculture, has given helpful advice and has supplied a considerable amount of material, which would not have otherwise come to our attention. Mr. C. L. McColloch, Chief, Livestock, Livestock Products and Poultry Branch, Office of Food and Agriculture, International Cooperation Administration, has been most helpful.

Publications of the Commission for Technical Cooperation in Africa South of the Sahara and particularly those of its Inter-African Bureau for Animal Health have been of considerable value.

Numerous other publications, as well as the current veterinary literature, have been consulted in the preparation of this part of the survey report.

Table 27. Calorie and protein content of national average food supplies in certain countries[1]

COUNTRY	PERIOD	CALORIES	TOTAL PROTEIN (GRAMS)	ANIMAL PROTEIN (GRAMS)
		PER CAPITA PER DAY		
LATIN AMERICA				
Brazil	1948	2,360	63	24
	1951-52	2,400	60	18
	1958	2,500	62	20
Chile	1948	2,370	73	23
	1951-52	2,430	74	25
	1958	2,450	78	27
Colombia	1948	2,280	56	26
	1957	2,050	48	22
Ecuador	1954-56	2,130	51	13
Mexico	1954-56	2,380	64	13
	1958	2,560	71	17
Paraguay	1958	2,570	66	27
Venezuela	1949	2,160	57	23
	1951	2,270	59	21
	1958	2,120	61	26
FAR EAST				
Ceylon	1952-53	1,990	42	6
	1958	2,010	48	12
China (Taiwan)	1948-50	1,980	43	8
	1951-53	2,140	50	12
	1958	2,330	57	15
India	1949-50	1,640	43	5
	1951-53	1,750	47	6
	1957-58	1,800	47	6
Pakistan	1949-50	2,040	49	8
	1951-53	2,010	47	8
	1957-58	2,010	49	8
Philippines	1952-53	1,960	43	10
	1957-58	1,980	36	11
NEAR EAST				
United Arab Rep:	1948/-50/	2,370	70	12
Egyptian Region	1951/-53/	2,410	70	11
	1957/58	2,640	78	13
OCEANIA				
Australia	1948/-50/	3,220	97	66
	1951/-53/	3,170	92	61
	1957/58	3,200	91	60
New Zealand	1948-50	3,360	100	67
	1951-53	3,350	103	70
	1958/59	3,430	106	72
OTHER				
United Kingdom	1948/-50/	3,130	90	45
	1951/-53/	3,100	84	44
	1958/59	3,260	85	50
Canada	1948/-50/	3,110	93	57
	1951/-53/	3,050	93	58
	1958/59	3,110	95	62
United States	1948-50	3,180	91	61
	1951-53	3,150	92	63
	1958	3,100	93	65

[1] Source: "The State of Food and Agriculture 1960"
Note: / indicates fiscal years.

Adequacy of the data

In general the reporting of the diseases of domestic animals is far less efficient than that of human diseases, which admittedly are inadequately reported. Veterinary services are seldom organized on a scale equivalent to health services and usually are not supported to the extent that sufficient disease surveillance can be maintained. In most countries of the temperate zone, the veterinary practitioner contributes to this function and reports serious outbreaks of animal disease to the proper state or federal agency. In the tropics, however, there are few practitioners of veterinary medicine and government veterinary services lack this tie with the livestock owner.

It was anticipated that the animal disease category would be treated in the same manner as the human disease part of this survey, with the coverage indicated in Section II. B. of the Plan (Appendix 1). However, it is now apparent that the data available from the annual reports received from the various countries supplemented by the information furnished by the returned questionnaires are not sufficient for the contemplated coverage. The data are not only incomplete in many instances in which information was furnished, but unfortunately there are large gaps in available reports from certain geographical areas. In many cases, the countries not represented in our material are those with the largest livestock populations in that part of the world. Under the circumstances, it has been necessary to modify the type of anticipated report and to treat with such information as is available.

It will be noted that in the questionnaire (Appendix 4) information was requested on the number of cases of the important animal diseases during the course of a calendar year. It soon became evident that this was not a practical basis on which to gather evidence concerning the occurrence and prevalence of animal diseases in the tropics. It was therefore necessary to resort to the method adopted by the Food and Agriculture Organization of the United Nations, which in its Animal Health Yearbook indicates only the relative prevalence of a disease in a given country for that year. This method lacks the advantage of specificity but in the long run probably conveys just as adequate a picture of the disease situation because of the difficulties enumerated above.

Livestock Population and Number of Veterinarians in Survey Area

Table 28 presents data on the number of horses, mules and asses, cattle, sheep, goats and swine in the survey area, together with the number of veterinarians. While the tropics are not ordinarily considered to be an area ideal for the raising of livestock, the census figures in the table compare favorably as regards numbers with some of the temperate regions, such as Europe and the United States. Here, of course, we are dealing with numbers and not necessarily with quality.

Three of the areas, the Caribbean, Central and South America, Africa, and South Central and Southeast Asia, have a greater livestock population than has the United States and one area (the first named) has a larger livestock population than Europe. Even from sheer numbers, it must be concluded that livestock constitutes a considerable asset in the tropical world, and that it manages to flourish in many areas in spite of the inroads of disease.

Table 29 and Figure 15 show the ratio of veterinarians to total livestock and to the number of cattle in various portions of the survey area. In comparison with the United States, which has one veterinarian to each 11,419 head of stock, South Central and Southeast Asia ranks the closest, with one veterinarian to every 51,256 head. This portion of the survey area has more veterinarians than any other area. The lowest ratio of veterinarians to total livestock is in Africa, with one veterinarian to 160,315 animals. It must be recognized that the number of veterinarians in a country does not necessarily mean that all such individuals are engaged in large animal practice.

Veterinary Education in the Tropics

From the viewpoint of European and North American standards, veterinarians in the tropics are too few in number, and the present supply is inadequate to fulfill the needs of the livestock industry. This is especially true when the greater prevalence of animal diseases in this part of the world is taken into consideration.

Veterinary education has lagged in many parts of the tropics. In 1960, an international conference was held in London under the auspices of the Food and Agriculture Organization to discuss problems of veterinary education. The conference viewed with concern the present world-wide shortage of veterinarians. It was emphasized that additional veterinary schools are urgently needed, especially in developing countries, in order to meet the general requirement for adequate veterinary services in relation to the world food supply and human and animal health.

Table 28. Livestock population (in thousands) and number of veterinarians in survey area[1, 2]

AREA	HORSES	MULES AND ASSES	CATTLE	SHEEP	GOATS	SWINE	TOTAL LIVESTOCK	NUMBER OF VETERINARIANS
Caribbean, Central and South America[3, 4, 5]	20,124	13,516	212,722	127,553	31,139	69,691	474,745	4,014
Africa[6]	3,000	11,400	106,800[7]	137,000	93,500	4,200	355,900	2,220[8, 9]
Southwest Asia[10]	2,297	6,242	22,010	85,124	40,988	59	156,720	1,478
South Central and Southeast Asia	3,124	2,102	269,141[7]	48,881	73,668	24,918	421,834	8,230
Oceania[11, 12]	17	0	123	4	52	857	1,053	8

[1] Sources: FAO Animal Health Yearbook (1959), FAO Production Yearbook (1959), and UN Statistical Yearbook (1958). Additional data for veterinarians from direct country reports, WHO Annual Epidemiological and Vital Statistics (1959), and "Health in the Americas and the Pan American Health Organization," Committee Report, 86th Congress, 2d Session. In most cases, data are for 1957-58.
[2] Poultry census omitted because of inadequate data.
[3] No data for Bahamas, British Guiana, British Virgin Islands, Haiti, Montserrat, St. Kitts-Nevis, and St. Lucia. Only partial data from Antigua, Argentina, Bermuda, Chile, Colombia, Costa Rica, Dominica, Ecuador, French Guiana, Grenada, Honduras, Panama, Puerto Rico, St. Vincent, and Uruguay.
[4] Some data from 1956-57 in case of the following countries: Chile, Colombia, Cuba, Ecuador, Grenada, Honduras, Trinidad and Tobago, and Venezuela.
[5] Some data from 1955-56 in case of the following: Antigua, Argentina, Chile, Honduras, St. Vincent, and Uruguay.
[6] No reports included from Guinea, Spanish territories in Africa, British Cameroons, and Togo.
[7] Includes buffaloes.
[8] No data for Guinea and Madagascar.
[9] Incomplete data for French Equatorial Africa and French West Africa.
[10] Persian Gulf Shiekdoms omitted.
[11] Complete data only for New Caledonia and Papua and New Guinea.
[12] Some data from 1955-56.

The following is the breakdown of the 61 veterinary schools in the survey area: Caribbean, Central and South America 29; Africa 4; Southwest Asia 4; South Central and Southeast Asia 24; and Oceania 0. The information is based on the report of the above-mentioned conference and data from the World Health Organization; for the Caribbean, Central and South America, information was furnished by the Pan American Health Organization.

Veterinary educational facilities are pitifully inadequate in Africa and Southwest Asia. Veterinary services in Africa have been supplied mostly by European veterinarians; with the emergence of independence of many of the countries in Africa, it seems probable that a further shortage of veterinarians will materialize in some of these areas and that the shortage will be of economic concern until nationals of these countries can be given adequate training.

In addition to the shortage of veterinary schools in some areas, it is known that some of the present schools do not have teaching standards on a level with those of other parts of the world. The above-mentioned conference was concerned also with the problem of establishing

Table 29. Ratio of veterinarians to total livestock and to number of cattle in survey area[1]

AREA	TOTAL LIVESTOCK (THOUSANDS)	TOTAL CATTLE (THOUSANDS)	NUMBER OF VETERINARIANS	RATIO OF VETERINARIANS TO TOTAL LIVESTOCK	RATIO OF VETERINARIANS TO CATTLE
Caribbean, Central and South America	474,745	212,722	4,014	1 : 118,272	1 : 52,995
Africa	355,900[2]	106,800[2]	2,220	1 : 160,315	1 : 48,108
Southwest Asia	156,720	22,010	1,478	1 : 106,035	1 : 14,892
South Central and Southeast Asia	421,834[2]	269,141[2]	8,230	1 : 51,256	1 : 32,702
DATA FOR COMPARATIVE PURPOSES					
United States	229,514	101,520	20,100	1 : 11,419	1 : 5,051

[1] Oceania omitted because of peculiar distribution of livestock population and veterinarians.
[2] Includes buffaloes.

Figure 15. Ratio of Veterinarians to Total Livestock and to Number of Cattle in Survey Areas[1]

Area	Number of Veterinarians	Ratio of Veterinarians to Total Livestock ● and Cattle ◆	Total Livestock / Total Cattle Millions
CARIBBEAN, CENTRAL AND SOUTH AMERICA	4,014	1:118,272 ● 1: 52,995 ◆	474.7 212.7
AFRICA	2,220	1:160,315 ● 1: 48,108 ◆	355.9[2] 106.8[2]
SOUTHWEST ASIA	1,478	1:106,035 ● 1: 14,892 ◆	156.7 22.0
SOUTH CENTRAL AND SOUTHEAST ASIA	8,230	1: 51,256 ● 1: 32,702 ◆	421.8[2] 269.1[2]

United States Comparative Data

UNITED STATES	**20,100**	**1:11,419 ●** **1: 5,051 ◆**	**229.5** **101.5**

[1] Oceania omitted because of peculiar distribution of livestock population and veterinarians.
[2] Includes buffaloes.

full-time faculties in such schools, in raising the teaching standards, and in extending the time required for qualifying for a degree. It was the consensus of opinion that a minimum of five years was necessary for veterinary undergraduate training. However, the extension of the course at the present time was not thought to be socially or economically possible in many countries which have need for training facilities.

Economic Loss from Diseases of Animals

On the form forwarded to national veterinary authorities in the principal livestock producing countries of the tropics, a request was included for an estimate of the annual economic losses from diseases of domestic animals. It was not anticipated that many countries would reply to this request for the reason that it is difficult to estimate losses and few studies have been conducted on the economic aspects of the problem. The subject is indeed one of considerable complexity, even though livestock has a commercial value which can be readily ascertained, in contradistinction to the human animal, whose value cannot be defined in monetary terms.

Losses from diseases of livestock can be determined with a fair degree of accuracy if precise data are available on total disease morbidity and mortality. However, such data are never complete even in countries with highly organized veterinary services and are certainly far from complete in the areas with which this survey is concerned. There are in addition many insidious losses which are difficult to evaluate in monetary terms. For instance, foot-and-mouth disease in most areas is not responsible for a high mortality and the rate is seldom more than 5.5 per cent. However, the disease causes abortion in 25 per cent of pregnant animals, a 25 per cent reduction in meat production, a similar degree of reduction in the wool crop and a 50 per cent reduction in milk yield. Nutritional deficiencies and parasitism effect a heavy drain on the animal economy, but the economic losses from such conditions are difficult to evaluate.

In spite of the inherent difficulties in arriving at estimates of the subject in question, 19 countries furnished data on the monetary value of losses due to animal diseases. The data are included in Table 30 and the amounts are given in terms of United States dollars. Included also are figures on the livestock census of the country, in order that some idea may be derived concerning the extent of monetary loss in relation to total livestock.

In addition to the above estimates, it has been calculated that the annual economic loss from diseases of cattle in Colombia amounts to $210,718,920.[3] In Argentina, a survey[4] has estimated the annual losses suffered by the livestock industry from brucellosis to be $50 million and from hydatid disease $1,416,600. Wahby[5] estimated the annual losses from animal diseases in Egypt to be $68 million.

In the summer of 1959, African horse sickness invaded the Baft region in Southern Iran.[6] Out of a population of some 200,000 horses, donkeys and mules, about one-half became ill with this disease and 10,000 died within a period of two months. The direct and indirect losses were estimated to be $10 million. This disease later spread through Southwest Asia and into India and was responsible for widespread losses. In three months in the summer of 1960, 10 per cent of the equine population of Iraq succumbed to African horse sickness, even though large-scale vaccination programs were under way. It is estimated that the total losses in the countries invaded amounted to 300,000 equines.

Reference was made previously to the insidious or hidden losses due to nutritional deficiencies and parasitism. It has been reliably estimated that subclinical parasitic infections in sheep can cause as much as a 40 per cent reduction in wool yield, especially in younger animals, which are very susceptible to parasites. In Peru, one private corporation employs a staff of veterinarians to control parasitic infections in large flocks of sheep. In the course of a few years, flock mortality has been reduced from 25 to 2.5 per cent. The average wool yield has risen from 3.5 to 6.5 pounds and the average dressed carcass weight has increased from 24 to 42 pounds. During this time, the number of sheep maintained by the corporation has risen from 160,000 to 200,000.[7]

Even in a country such as the United States with a much higher ratio of veterinarians to livestock population than any part of the tropics, losses from animal diseases are almost unbelievably large. An appraisal by the U. S. Department of Agriculture in 1954 estimated that annual losses of livestock and poultry from diseases and insect pests for the period 1942-1951 amounted to $2,420 million. The losses represented about 6 per cent of the potential agricultural production and about 15 per cent of the average annual value of farm marketings and home consumption of livestock and its products.[8]

Table 30. Estimated losses from animal diseases as supplied by the veterinary authorities of 19 countries in 1959-1960

COUNTRY	ESTIMATED LOSS (U.S. DOLLARS)[1]	LIVESTOCK POPULATION[2] (THOUSANDS)	YEAR
	CARIBBEAN, CENTRAL AND SOUTH AMERICA		
British Honduras	4,285	56	1957-1958
Chile	18,239	12,447	1957-1958
Grenada	8,750	14	1956-1957
Guatemala	1,000,000	2,907	1957-1958
Honduras	1,000,000	2,609	1955-1956
Jamaica	280,000	868	1957-1958
Mexico	280,000,000	56,763	1957-1958
	AFRICA		
Ethiopia	152,000,000	48,171	1957-1958
Swaziland	966,000	719	1957-1958
Tunisia	4,760,000	5,603	1957-1958
	SOUTHWEST ASIA		
Iraq	6,300,000[3]	17,519	1951-1952
Jordan	48,101	1,480	1957-1958
Lebanon	791,139	571	1957-1958
	SOUTH CENTRAL AND SOUTHEAST ASIA		
Cambodia	64,120	2,061	1957-1958
Ceylon	2,105,263	1,902	1960
China (Taiwan)	381,350	4,368	1957-1958
Philippines	1,000,000	14,947	1957-1958
Thailand	1,973,845[4]	15,265	1957-1958
	OCEANIA		
New Caledonia	135,074	134	1957-1958

[1] Conversion of local currencies based on factors supplied by the United Nations and the U. S. Department of State.

[2] Including only horses, mules and asses, cattle, buffaloes, sheep, goats and swine.

[3] Including value of 15,703 equines which died out of 17,065 cases of African horse sickness in 1960.

[4] Value of buffaloes, cattle and swine reported to have died of disease during the three years 1957-1959, inclusive.

Analysis of the Most Important Animal Diseases

Any evaluation of the animal diseases of the tropics must necessarily be influenced by a considerable number of factors. As with the human diseases, those of domestic animals are not universally distributed throughout the tropical world; a few may have general distribution, but even under such circumstances their relative importance in different areas may vary. It has been possible to effect control of certain diseases in some areas so that such diseases are no longer responsible for considerable losses in the livestock population.

There are numerous diseases of domestic animals in tropical areas; in fact the Animal Health Yearbook of the Food and Agriculture Organization of the United Nations contains reports on a total of 191 diseases or infections in Africa alone. It is not within the purview of the current survey to attempt an evaluation of the relative importance of such a multiplicity of conditions nor is such an evaluation essential for basic coverage of this particular section of the report. Accordingly, a selection has been made of the diseases which are regarded as of major importance in the respective geographical areas of the survey. One method of arranging such diseases is in relation to available methods of control. Dr. William A. Hagan of the Advisory Committee has kindly compiled the most important diseases of domestic animals in the tropics on such a basis. His arrangement is as follows:

Most important animal diseases of the tropics
(Arranged with reference to means of control)

1. *Infectious diseases for which practicable and effective vaccines exist. The problem is to secure their systematic and regular use.*

Anthrax	Lumpy skin disease (of cattle)
Viral encephalitis, equine	Hemorrhagic septicemia (Infection with *Pasteurella multocida* Type I Roberts)
Swine fever (hog cholera)	
Rinderpest	
Blue tongue	
Blackleg	
Sheep pox	
African horse sickness	

2. *Infectious diseases for which partially effective vaccines are available. Control possible by immunization and proper management.*

Foot-and-mouth disease	Contagious bovine pleuropneumonia

3. *Immunization procedures not practically effective. Control can be achieved by chemotherapy of the affected animals, or chemical destruction of the vectors.*

Trypanosomiases	Tick transported protozoa—East Coast fever, Piroplasmoses
Rickettsial disease—Heartwater fever	Sheep scab

4. *Control chiefly dependent upon improved stock, management, better nutrition, and better sanitation.*

Hydatid disease	Gastrointestinal helminth parasitisms
Hepatic distomatosis	Nutritional deficiencies

5. *Diseases which may be controlled only by detecting and eliminating diseased individuals.*

Tuberculosis, bovine

6. *Diseases having reservoirs in wild animals. Control depends on separating the domestic from the wild stock, eliminating the infection from the wild animal reservoir, or immunizing the domestic animals (when possible).*

Rabies—from wild quadrupeds and bats	African swine fever—from wart hogs and bush pigs

7. *Diseases of domesticated stock for which methods of control and prevention are not known.*

Sweating sickness (of cattle)

It will be noted that only one disease is listed in Category 7 for which methods of control and prevention are not known. In a memorandum accompanying his selection of important diseases, Dr. Hagan has emphasized the fact that the problem of the control of animal diseases in the tropics is not related to any lack of knowledge concerning methods of dealing with them but rests largely on the development of ways and means of applying such methods under the conditions existing in various tropical countries. Even in the economically developed countries of Western Europe and North America, losses from animal diseases are far greater than need be largely because of ignorance of control measures or negligence or failure to take advantage of them. In the tropical world, these same factors operate, sometimes to a much greater extent; in addition, the application of control measures often entails an expense which the livestock owner and the state may not be economically capable of assuming.

A selection of the most important diseases of domestic animals in the various geographical areas of the current survey was made by Dr. Hagan. Another list was drawn up after consultation with various members of the staff of the Animal Health Branch of the Food and Agriculture Organization. These lists were so similar that they have been combined with slight revisions and the final selections are given below. These are the diseases for which an evaluation will be attempted in this report.

Most important animal diseases of the tropics
(Arranged geographically)

1. *Diseases of general importance*

Gastrointestinal parasitic infections	Anthrax
Nutritional deficiencies	Sheep pox
Hepatic distomatosis	

2. *Diseases of importance in the Caribbean, Central and South America*

Foot-and-mouth disease	Hydatid disease
Rabies	Bovine tuberculosis
Equine infectious encephalomyelitis	

3. *Diseases of importance in Africa*

Trypanosomiasis	Blackleg
Tick-transmitted protozoal diseases	Lumpy skin disease
	Blue tongue
Rinderpest	Rickettsial diseases
Contagious bovine pleuropneumonia	Bovine tuberculosis
	Sheep scab (in N.W. Africa)

4. *Diseases of importance in Southwest, South Central and Southeast Asia*

African horse sickness	Swine fever (in Southeast Asia)
Rinderpest	Hemorrhagic septicemia
Foot-and-mouth disease	

It will be noted that both lists contain certain diseases which are commonly transmitted from lower animals to man. The zoonoses represented here are relatively few in number compared to the considerable number of infections which are transmissible from animal hosts to man. These infections are receiving greater attention as increasing evidence indicates the considerable role of lower animals in the field of human health.

An analysis of some zoonoses

Early in the course of the present survey, a request was made to the Director of the Pan American Health Organization for cooperation in securing data concerning the occurrence of certain zoonoses in the Americas. Not only did the Director, Dr. A. Horwitz, offer cooperation, but data were collected and presented by Horwitz, Puffer and Chamberlayne before the Advisory Committee on Tropical Medicine at its meeting on 18 April 1960. The information was published subsequently.[2] The material compiled by the above-mentioned individuals is being presented herewith. It concerns the status of four zoonoses—rabies, anthrax, brucellosis and hydatid disease. In order to present a comparable picture for other geographical regions embraced in this survey, an effort has been made to gather material concerning the occurrence of these same diseases in other areas. Unfortunately, cases of these diseases in man are not notifiable in most countries and data concerning the diseases in animals are lacking to a considerable extent. Accordingly, the information compiled for other areas suffers in the extent of coverage when compared to the report of A. Horwitz, R. R. Puffer and E. C. Chamberlayne, which follows.

Some zoonoses in the Americas. An important responsibility of the Pan American Health Organization as listed in the Pan American Sanitary Code under objectives is "The stimulation of the mutual interchange of information which may be of value in improving the public health and combating the diseases of man." Increasing emphasis is being given to the improvement of data regarding the communicable diseases for control and eradication programs. Our attention is now directed also to the provision of data regarding the zoonoses which are responsible for illness and death in both man and animals and for serious economic losses in livestock.

Many of the zoonoses, which are by definition diseases naturally transmitted between vertebrate animals and man, are known to occur in the Americas. However, the distribution of the cases of zoonoses in man and animals is only partially known. Human cases of certain of the zoonoses are notifiable according to law and regulation in some of the countries of the Americas and thus reports are received by national health services. Such reports are transmitted routinely to the Organization. Except for rabies in man and animals no attempt has been made to bring together the available data on known cases of zoonoses in man and animals. The FAO/OIE World Livestock Disease Reports[9] contain general comments regarding the incidence of zoonoses in animals.

Increasing attention is being given to zoonoses by the countries of the Americas and by PAHO/WHO; the latter has program activity in brucellosis, hydatidosis, rabies and tuberculosis. Development in this field resulted in the establishment of the Pan American Zoonoses Center in 1956 in Azul, Argentina. For additional knowledge of these problems in the Americas efforts are now being made to assemble all available data on certain of the zoonoses considered most important in the Americas. Organized reporting of morbidity from zoonoses in both man and animals is essential for the development of successful programs against these diseases. The reporting of zoonoses was recommended by the Advisory Group on Veterinary Public Health[10] convened by WHO with FAO collaboration in 1955 and the Joint WHO/FAO Expert Committee on Zoonoses.[11]

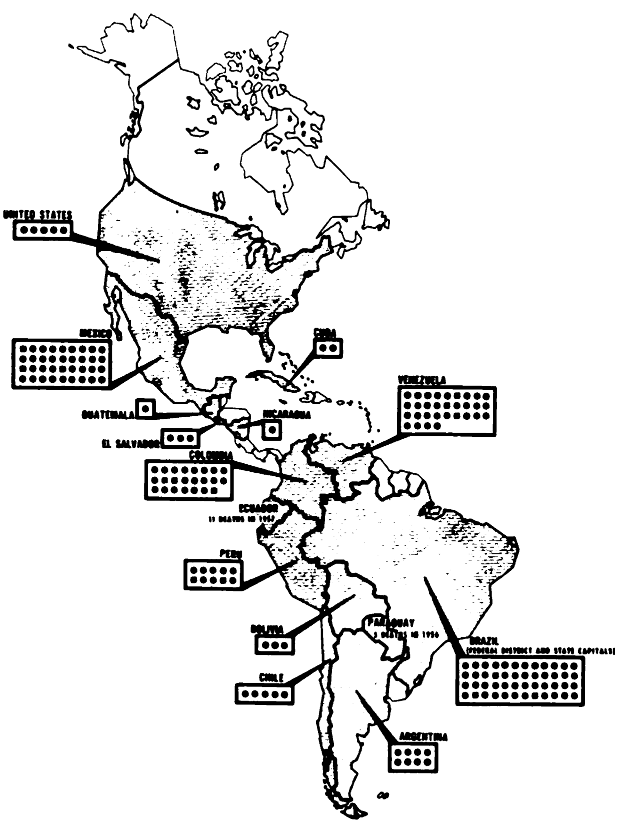
In several countries information was already available regarding the zoonoses which could be assembled by an international agency. Thus as part of our program to collect available data on communicable diseases, the numbers of known cases of zoonoses in animal populations were requested for the years 1956, 1957 and 1958. Forms for recording of the numbers of cases and remarks regarding the type of disease or type of animal were distributed through our Zone Offices to national health and agricultural services. The veterinary services of these agencies have cooperated by providing data.

This first step by the Organization for the collection and publication of the numbers of cases of zoonoses in man and animals is useful primarily in creating an awareness of the need of data to define the zoonotic problems in man and animals. The use and distribution of our material should be a stimulus for improvement in reporting and for tabulation and analysis of data in the future which in turn would be valuable for control programs.

Rabies was the only disease for which we had some, but quite incomplete, information[12] regarding cases in animals before this present collection of data. Prior to this, reports of cases of rabies in animals were received from only seven areas, while for 1958 information for 22 areas is now provided in this report. The data for these 22 areas, in which 7,724 cases of rabies in animals were diagnosed and reported, are shown on the accompanying map of the Americas (Figure 16). In six countries, namely, Argentina, Brazil, Canada, Chile, Peru and the United States, more than 100 cases were reported. However, there were in addition three others, Guatemala, Nicaragua and Venezuela, in which more than 50 cases were reported while in the remaining areas

Figure 16. Reported Cases of Rabies in Animals in the Americas, 1958

Figure 17. Reported Cases of Rabies in Man in the Americas, 1958



the numbers were less than 50. Although no information was provided for Mexico, a report[13] sent to the World Health Organization indicated that, in 1958, 747 captured animals in the Federal District were positive for rabies. Similarly 81 positive animal cases were reported by the National Institute of Hygiene[14] of Ecuador. These data show that rabies is present and is being found by examination of animals in these 22 areas. Dogs are usually the animals found to have rabies. The other animal reported most frequently is the cow. In several areas, such as Brazil, Mexico, the United States, French Guiana and Trinidad, rabies is reported to be transmitted by bats.

The distribution of reported human cases is also shown on a map (Figure 17). For 1958, 176 human cases were reported which in turn indicates 176 deaths. In five countries, 10 or more cases were reported, namely, in Brazil, Colombia, Mexico, Peru and Venezuela, and the numbers of known rabies cases and deaths in some of these were sufficiently large to indicate a serious problem. Cases of rabies are reported usually only when patients have been given medical attention and a diagnosis made with laboratory examination. In Ecuador and Paraguay, for which no reports of cases in man were received, vital statistics data revealed that 11 rabies deaths were reported in Ecuador in 1957 and 5 in Paraguay in 1956. Rabies in man and animals does not occur in Uruguay,[15] and the last case in man was reported in 1947 and in animals in 1949.

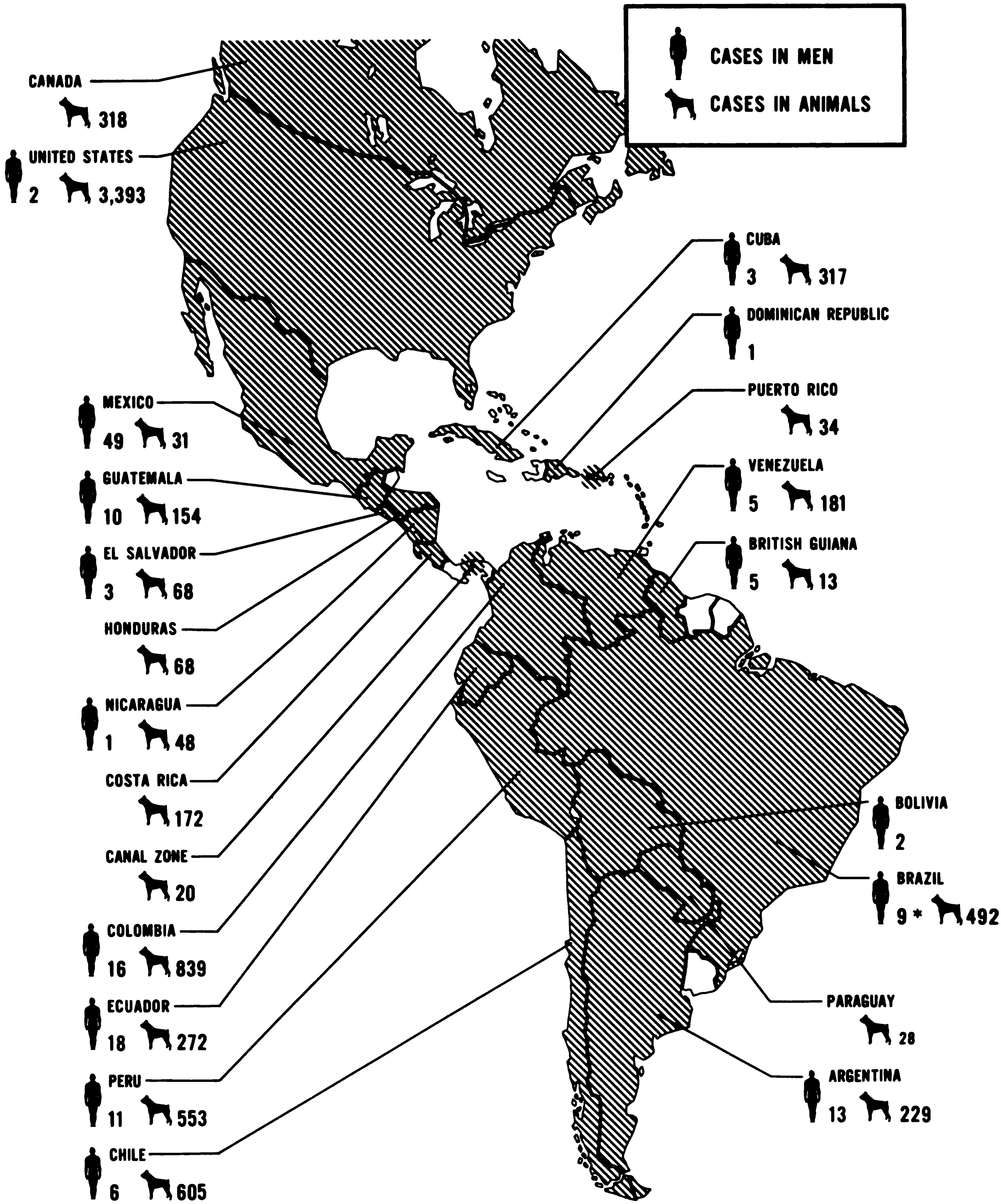
Comparison of the two maps indicates the lack of data on rabies in animals in several areas with more than 10 human cases. The seriousness of rabies justifies concentrated efforts to prevent loss of life, the needless burden of Pasteur treatments as well as economic losses in cattle. Generally when rabies occurs in an area many persons, at times hundreds, bitten by animals are submitted to the anti-rabies treatment of vaccine injections which are not without some hazard. Reporting is essential for knowledge of the problem. (More recent data (1960) on the reported cases of rabies in man and animals in the Americas are given in Figure 18.)

In addition to data on rabies in man and animals we have been able to show reported cases of anthrax, brucellosis and hydatid disease in man and animals. Even though incomplete, the data are sufficient to show the usefulness of the combination of reports of human and animal cases (Table 31).

Large numbers of cases of hydatid disease in animals were reported in Argentina and Chile. For example, in Chile in 1958 the figures were as follows:

Reported cases in animals	101,915
Reported cases in man	123
Reported deaths in man	44

Figure 18. Reported Cases of Rabies in Man and Animals in the Americas, 1960



* FEDERAL DISTRICT AND STATE CAPITALS

Table 31. Reported cases of selected zoonoses in man and animals in the Americas, 1956-1958

DISEASE AND AREA	1956 MAN	1956 ANIMALS	1957 MAN	1957 ANIMALS	1958 MAN	1958 ANIMALS
ANTHRAX						
Argentina	244	1,295	211	1,100	137	1,399
Bolivia	20	...	...	...	...	...
Brazil	5[1]	31	—[1]	152	—[1]	97
Canada	—	3	—	—	1	1
Chile	232	1,585	392	1,718	405	1,275
Colombia	38[2]	...	8[2]	...	9[2]	...
Costa Rica	8	(42)[3]	10	(28)[3]	15	(33)[3]
El Salvador	...	9	...	14	...	7
Guatemala	...	24	...	18	...	23
Haiti	45	...	76	...	...	...
Honduras	...	12	...	38	...	42
Mexico	111	...	143	...	148	...
Nicaragua	1	18	...	34	...	12
Panama	1	—	1	—	—	—
Peru	36[2]	...	35[2]	...	75[2]	...
United States	38	(247)[4]	26	(845)[4]	16	(801)[4]
Uruguay	43	...	...	...	...	...
Venezuela	58[2]	29	45[2]	290	29[2]	62
British Guiana	—	—	—	1	—	—
Puerto Rico	—	10	—	37	—	9
BRUCELLOSIS						
Argentina	3,398	1,200	2,741	293	2,747	353
Brazil	6[1]	25	1[1]	99	2[1]	18
Canada	141	...[5]	120	...[5]	113	...[5]
Chile	9	...	11	...	5	...
Colombia	11[2]	...	6[2]	...	12[2]	...
Costa Rica	9	335	6	1,042	3	599
Cuba	1	...	4	...	...	...
El Salvador	6[2]	922	11[2]	831	8[2]	645
Guatemala	...	525	...	834	...	347
Honduras	...	62	...	84	...	72
Mexico	1,218	...	921	...	1,220	...
Nicaragua	...	—	...	824	...	749
Panama	1	—	2	124	2	242
Peru	639[2]	906	880[2]	253	522[2]	345
United States	1,300	309,179	983	271,167	924	241,969
Venezuela	17[2]	...	16[2]	...	19[2]	...
Alaska	—	16	—	1	1	3
British Honduras	—	1	—	—	—	—
French Guiana	—	—	1	—	—	—
Hawaii	1	—	1	—	1	769
Jamaica	—	22	—	36	—	8
Netherlands Antilles	*	1	*	2	*	1
Puerto Rico	3	2,241	—	2,488	1	1,503
Virgin Islands (U.S.A.)	—	—	—	117	—	42
HYDATID DISEASE						
Argentina	149	323,008	126	318,063	148	447,807
Chile	122	82,709	115	111,582	123	101,915
Costa Rica	*	15	*	23	*	15
El Salvador	—[2]	—	—[2]	32	—[2]	18

[1] Federal District and State capitals except Niteroi, 1957 and 1958. [2] Reporting area. [3] Number of outbreaks (in parentheses). [4] Number of herds affected (in parentheses). [5] Estimated infection 1956, 4.2 per cent; under National Brucellosis program 6.85 per cent of herds, 0.97 per cent of cattle infected 1957-1958.

Symbols: ... Data not available. * Disease not notifiable. — No case.

Table 31. Reported cases of selected zoonoses in man and animals in the Americas, 1956-1958 (continued)

DISEASE AND AREA	1956 MAN	1956 ANIMALS	1957 MAN	1957 ANIMALS	1958 MAN	1958 ANIMALS
HYDATID DISEASE (continued)						
Guatemala	...	328	...	272	...	138
Honduras	...	—	...	64	...	62
Peru	40[2]	...	78[2]	...	59[2]	...
Uruguay	45	...	61	...	86	...
Jamaica	—	63	—	62	—	53
RABIES						
Argentina	16	1,217	13	833	8	987
Bolivia	—	...	...	...	3	...
Brazil	28[1]	150	33[1]	342	48[1]	334
Canada	—	180	—	179	—	582
Chile	4	280	2	197	5	304
Colombia	18[2]	...	33[2]	...	23[2]	...
Costa Rica	—	2	2	39	—	13
Cuba	—	...	2	...	2	...
Dominican Republic	—	3	—	2	—	4
El Salvador	4[2]	31	2	83	3[2]	48
Guatemala	2	67	4	53	1	64
Haiti	—	2	—	9	—	7
Honduras	...	48	1	46	—	44
Mexico	31	...	23	...	36	...
Nicaragua	...	51	3	52	1	57
Panama	—	—	—	2	—	2
Paraguay	...	42	1[2]	75	...	29
Peru	15[2]	213	26[2]	300	10[2]	297
United States	10[6]	5,681	5[6]	4,542	5	4,787
Venezuela	18	25	11	11	31	64
Alaska	—	15	—	4	—	11
British Guiana	*	8	*	22	*	29
French Guiana	—	—	—	—	—	25
Puerto Rico	—	23	—	23	—	17
Trinidad and Tobago	—	3	—	3	—	11
Windward Islands: Grenada	...	...	...	24	...	8

[1] Federal District and State capitals except Niteroi, 1957 and 1958. [2] Reporting area. [6] Registered deaths.

Symbols: ... Data not available. * Disease not notifiable. — No case.

Slaughterhouses were the source of the more than one hundred thousand reports of cases in animals, indicating that the reported cases may be only a part of the number that occurred. Although the number of human cases is small (123), the fact that 44 deaths were known to have occurred due to hydatidosis and to have been so certified indicates that this disease is a veterinary health problem warranting preventive measures.

Although bovine tuberculosis is a disease which could be eradicated, and eradication is a major objective in a number of countries, this disease continues to be present in all except two areas for which information was available. In 1958, 18 areas reported the finding of positive reactors.

The information in the table regarding four zoonoses in man and animals and information regarding five other zoonoses in animals will be included in the report[16] of notifiable diseases in the Americas, which will be published shortly. This report, to be published in both English and Spanish, will be distributed widely to health officials in the Americas. We trust that it will prove to be a useful reference document. Also it should serve to stimulate interest in the improvement of reporting of zoonoses for use in disease control programs.

Bat rabies. In connection with the foregoing account as it concerns rabies in Middle and South America, some cognizance should be taken of the role of the bat in the transmission of the disease.

It has long been known that bats become infected with rabies virus and exhibit symptoms either of the furious or paralytic type of the disease. Some may recover and serve as carriers of the infection. Hematophagus, frugivorous and insectivorous species have been incriminated in transmission of the disease. A considerable number of species are involved. Bats have transmitted infection to man and lower animals. The blood-sucking vampire bats have played a conspicuous role. Cattle are particularly susceptible. Vampire bat rabies in man occasionally assumes an epidemic form. In tropical America, bat rabies is distributed from the Argentine to the Rio Grande. (W.H.W.)

Some zoonoses in Africa. *Rabies.* Rabies is an important problem in many parts of Africa (Figure 19). Of 35 countries reporting to FAO in 1959, 18 listed the disease as being widespread throughout the country. Table 32 indicates data for 1958 concerning human cases and deaths as reported in a special WHO survey.[14] North of the Sahara, rabies is highly endemic in Morocco, Algeria, Tunisia and Libya. Veterinary authorities in Egypt reported only a low incidence with sporadic cases, but in 1956 more human deaths were reported from rabies than from any other African country. More human cases are recorded in Table 32 than in any other country in Africa. Sudan indicated that the disease is much reduced but still exists. Sixty-nine outbreaks were reported in dogs for 1956-57 and 17 human deaths oc-

Figure 19. Animal Rabies—Geographical Distribution in Africa South of the Sahara, 1958

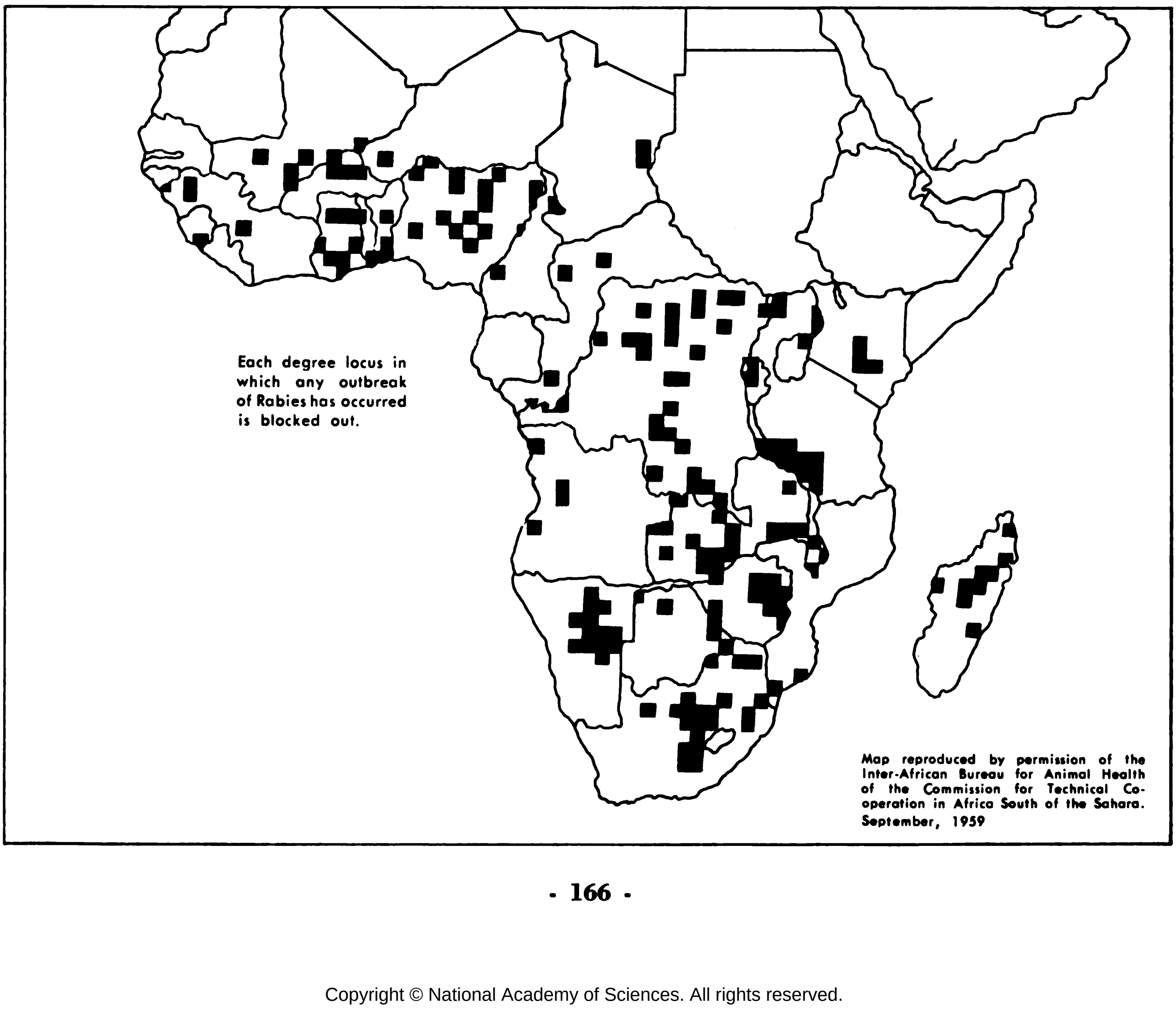


Table 32. Human rabies in Africa in 1958, based on information in world survey of rabies by World Health Organization[1]

COUNTRY OR TERRITORY	NUMBER OF HUMANS RECEIVING ANTI-RABIES TREATMENT	NUMBER OF DEATHS IN UNTREATED HUMAN CASES	NUMBER OF DEATHS IN TREATED HUMAN CASES
Algeria	1,074[2]	3	1
Belgian Congo (Katanga Province)	1,167	10	0
Belgian Congo (Leopoldville Province)	190	4	0
Chad	344	15	0
Egypt	18,510	26	4
Ethiopia	3,500	12	1
French Equatorial Africa	1,210	4	1
French West Africa	1,474	2	2
Libya	55	3	1
Madagascar	400	0	0
Morocco	2,522	16	8
Morocco (Tangiers)	162	[3]	0
Mozambique	328	3	0
Somaliland	162	1	0
Southern Rhodesia	[3]	1	0
Sudan	[3]	10	3
Tanganyika	383	2	1
Tunisia	4,000	10	2
Uganda	50[2]	0	0

[1] WHO questionnaire on rabies: Personal communication, 1959.
[2] Plus or minus.
[3] Data not available.

curred in 1956. It would appear that the disease is still important in the Sudan.

In former British Somaliland, rabies is widespread but is said not to exist in French Somaliland. The number of human cases reported from former Italian Somaliland is fairly low. Ethiopia has a considerable rabies problem.

On the west coast of Africa, the disease is indicated as constituting an important problem. In the republics of the former French West Africa, a low incidence is recorded in animals, but human cases are frequent. The problem in the area of former French Equatorial Africa is apparently of equal magnitude. The disease constitutes an important problem in the Congo and Ruanda-Urundi. It is also important in Nigeria and the Cameroon Republic. Between 1928 and 1959, there were 120 notifications of cases of human rabies in Nigeria.[17] In Eastern Nigeria, 1,434 cases and 57 deaths were reported for the period January to December 1958.[18]

In Kenya, Tanganyika and Uganda, rabies has been reduced in amount or is confined to certain regions. In Kenya, there were 7 cases and 2 deaths reported in 1957; in Tanganyika in 1959, 5 cases and 5 deaths in hospital patients; and in Uganda in 1959, there were no cases in government or mission hospitals.

In southeast Africa, the disease is widely disseminated in Nyasaland, the Rhodesias, Bechuanaland and the Malagasy Republic. In Swaziland, it is said to have a low incidence and is not recorded from Basutoland or Mauritius. Considerable progress has been made in arresting the progress of infection in the Union of South Africa.

Vaccination of dogs is employed in most countries together with a policy of destruction of infected animals.

The following data[19] are based on questionnaires received by the Inter-African Bureau for Animal Health from various countries south of the Sahara and indicate the number of cases of animal rabies in which diagnosis was confirmed by laboratory examination. The period covered is 1956 to March 1960. The data are not indicative of the total number of rabies cases but perhaps convey information of some value for comparative purposes.

Angola	57	Dahomey	31
Bechuanaland Protectorate	19	Ivory Coast	31
Belgian Congo	220	Upper Volta	47
Ruanda-Urundi	52	Niger	28
Ghana	11	Senegal	29
Portuguese Guinea	2	Soudan	23
Kenya	7	Togo	11
Uganda	15	Nigeria	28
Tanganyika	48	Nyasaland	121
Madagascar	103	South Africa	64
Mozambique	47	South West Africa	4
Chad	24	S. Rhodesia	20
Central African Republic	52	N. Rhodesia	212
Cameroun	1	Swaziland	2
		Total	1,309

Anthrax. In North Africa the incidence is low except in sheep in Morocco, in which the disease is widespread throughout the country. A total of 326 outbreaks were reported in 1959. In other animals, the disease is much reduced. In Tunisia, 1,500 cases were recorded in 1959. The occurrence of human cases in Libya would indicate that the disease is fairly well distributed in that country.

The disease is localized for the most part in West Africa and only of sporadic occurrence except in former French West Africa, in which it is of common occurrence in cattle, sheep and goats. It also is a problem in cattle in Ghana. It is reported to be troublesome in Sierra Leone. Numbers of human cases are reported each year from Angola so that the disease must be of some importance in that country.

In Central Africa, anthrax is of importance in Chad but has not been recorded from Cameroun and has been much reduced in Nigeria. It is of fairly common occurrence in cattle in the Congo and Ruanda-Urundi. As indicated in Table 33, considerable numbers of human cases have been reported from the latter territory. In Kenya and Tanganyika, anthrax is enzootic in native areas and large numbers of human cases are on record. A similar situation exists in Uganda, although to a lesser degree. Anthrax is of common occurrence in cattle in Ethiopia and cases in man are not infrequent. It is said to have a low incidence in Somalia.

Anthrax generally is not of great importance in South Africa. A low incidence is recorded from Basutoland, Bechuanaland, Swaziland, Northern Rhodesia, Southern Rhodesia, Nyasaland and Mozambique. It has been much reduced in the Union of South Africa, although human cases are not infrequent. In the Malagasy Republic, anthrax is of common occurrence in cattle but of less importance in other animals.

Brucellosis. The reporting of brucellosis in Africa both in man and domestic animals appears to be less satisfactory than in the Caribbean, Central and South America. This is probably true for the remainder of the world also. In consulting various sources, some wide discrepancies are noted concerning the occurrence of the disease. In some countries, the data with regard to domestic animal infections demonstrate little relationship to the numbers of reported human cases. This is especially noticeable in countries like Ethiopia, in which 957 human cases were recorded during the period 1954-1959 (Table 34) but in which the incidence of *Br. abortus* infection in cattle is said to be low, with no evidence for any record of the occurrence in the country of *Br. melitensis* or *Br. suis*. Discrepancies such as this illustrate some of the basic difficulties in the collection and interpretation of data of this sort.

Table 33. Human cases of anthrax in Africa, 1954-1959[1]

COUNTRY	1954	1955	1956	1957	1958	1959	TOTALS
Angola	21	35	+	21	44	71	192
Basutoland	1	—	1	—	—	+	2
Bechuanaland	—	1	—	—	1	+	2
Cape Verde Is.	34	46	...	40	75	+	195
Ethiopia	13	79	+	101	+	+	193
Ghana	19	13	6	1	5	+	44
Kenya	1,164	587	1,006	895	953	689	5,294
Libya	36	16	65	+	53	+	170
Mozambique	—	—	—	—	—	+	
Portuguese Guinea	9	2	2	6	4	+	23
Rhodesia-Nyasaland							
Southern Rhodesia	27	—	+	8	5	15	55
Ruanda-Urundi	187	229	199	120	144	+	879
Somalia (North region)	2	—	1	...	6	+	9
Sudan	53	92	82	19	25	88	359
Tanganyika	489	605	803	444	614	+	2,955
UAR—Egypt	—	1	—	—	—	+	1
Uganda	61	52	13	24	28	+	178
Union of South Africa	8	14	2	14	45	32	115
Zanzibar	—	1	—	—	—	+	1

[1] From WHO Epidemiological and Vital Statistics Report, v. 13 (11-12), 1960. In many instances data are incomplete, with reports missing for certain years.

Symbols: ... data not available; + data not yet available; — nil or magnitude negligible.

Table 34. Human cases of brucellosis in Africa, 1954-1959[1]

COUNTRY	1954	1955	1956	1957	1958	1959	TOTALS
Algeria	6	15	3	25	22	27	98
Angola	7	6	17	5	2	4	41
Basutoland	—	—	—	—	1	+	1
Bechuanaland	—	—	—	1	2	+	3
Cameroun	—	—	1	—	1	—	2
Chad	1	2	5	1	1	2	12
Congo (cap. Leopoldville)	53	50	31	19	38	5	196
Ethiopia	108	58	+	791	+	+	957
Gambia	—	1	+	—	—	+	1
Ghana	3	30	41	—	1	+	75
Kenya	101	73	164	141	178	201	858
Libya	20	5	6	8	11	90	140
Mali	5	57	25	9	1	—	97
Morocco							
Northern Zone	46	23	8	6	+	+	83
Southern Zone	11	4	+	+	+	+	15
Mozambique	1	1	3	—	—	+	5
Niger	—	—	1	1	22	3	27
Portuguese Guinea	3	—	6	—	—	—	9
Rhodesia-Nyasaland							
Southern Rhodesia	10	17	4	14	5	5	55
Ruanda-Urundi	56	102	28	12	46	17	261
Senegal	—	—	—	3	—	—	3
Somalia (North Region)	...	...	...	34	27	+	61
Sudan	47	188	87	83	47	36	488
Swaziland	—	—	—	+	1	—	1
Tanganyika	44	61	88	100	100	+	393
Tunisia	8	2	1	8	12	5	36
UAR—Egypt	79	82	81	14	17	23	296
Uganda	30	6	17	7	55	+	115
Union of South Africa	4	2	11	17	25	52	111
Upper Volta	—	2	8	7	6	+	23
Zanzibar	—	—	1	—	1	+	2

[1] From WHO Epidemiological and Vital Statistics Report, v. 13 (11-12), 1960. In many instances data are incomplete, with reports missing for certain years.

Symbols: ... data not available; + data not yet available; — nil or magnitude negligible.

Br. abortus has been recognized in nearly every country of Africa; *Br. melitensis* is apparently of recognized occurrence also; but *Br. suis* has been identified in only a few countries.

In North Africa, the disease appears to have a low incidence, although *Br. abortus* is widespread in Tunisia and Somalia. In the Sudan, the disease is a cause of considerable loss in dairy cattle, a fact in keeping with the relatively large number of human cases reported.

In West Africa, a relatively small number of human cases of brucellosis have been reported and in general the disease appears to be of low prevalence in domestic animals. However, there are exceptions. The disease is reported to be widespread in Sierra Leone and of importance in dairy cattle. It is enzootic in Liberia and Angola; a control program is being carried on in the latter country.

In Chad, *Br. abortus* is widespread in cattle and sheep, and *Br. melitensis* is of common occurrence in caprine species. *Br. abortus* is of importance in cattle in the Congo and Ruanda-Urundi and is suspected as occurring in sheep. Farther east, in Uganda, 115 human cases were reported during the period 1954-1959 (Table 34). Laboratory diagnosis has been made over past years. Incidence in cattle runs 15 to 20 per cent. In Tanganyika, brucellosis is said to have a low incidence. During 1954-1959, 858 human cases were reported from Kenya. The disease is mentioned frequently in the annual reports of the Veterinary Department. Strain 19 vaccination has been popular on European farms but the Scheme for the Accreditation of Herds has lacked general support. The disease is reported not to have been recognized in the Malagasy Republic. In Northern Rhodesia, *Br. abortus* infection in cattle is of widespread occurrence and sporadic cases of *Br. suis* in swine have been recorded. In the Mozambique a control program was initiated in 1953. Strain 19 vaccine is produced at Lourenço Marques. Up to 1958, a mobile testing unit had found approximately 7 per cent of the known cattle population infected.

In South Africa, *Br. abortus* infection is common in Southern Rhodesia where approximately 8 to 10 per cent of cattle on European farms are positive. Some progress is said to have been made in controlling the disease in Nyasaland. It has a low incidence in Basutoland but is of importance in cattle in Bechuanaland, although not recorded from sheep. The disease is enzootic throughout Swaziland. In the Union of South Africa, brucellosis is widely distributed but has been kept in check by extensive employment of vaccination.

Hydatid disease. Hydatid disease is highly endemic along the Mediterranean Coast in Morocco, Tunisia and Libya. In Tunisia, 50,000 animal cases were reported in 1959, while 15 per cent of animals slaughtered in Cyrenaica in the same year had hydatid cysts. Egypt reports that there is only a low incidence with sporadic cases. However, El Kordy (cited by Halawany[20]) examined animals in the Cairo abattoir and found infection in 31 per cent of camels, 16 per cent of buffaloes, 10 per cent of cattle and 1.5 per cent of sheep. The disease is said to be very prevalent in the camel in Ethiopia. No information is available for Somalia.

On the West Coast, the disease is thought not to be of importance. There is no record of its occurrence in Sierra Leone and Liberia. In Ghana, however, in 1956, a total of 194 human cases and 6 deaths were reported.

There is little information available concerning occurrence in Central Africa, since most of the countries do not report the disease to FAO, and there is no mention of its occurrence in annual reports from the Congo, Ruanda-Urundi, and the republics which constituted French West Africa and French Equatorial Africa. In the Sudan, infection is said to be confined to certain regions, but it would appear that the disease is of considerable importance. Eighty-two cases of hydatid disease were reported in 1958 in Eastern Nigeria.[18]

Hydatid infection is present in Tanganyika, but there are no reports from Uganda. Froyd[21] reported 25.5 per cent of hydatid cysts in 1,000 slaughtered cattle in Kenya. Wray[22] surveyed native hospitals and recorded 117 human cases between 1952 and 1955. The disease seems to have a low incidence in Northern and Southern Rhodesia, Nyasaland, Basutoland, Swaziland and the Union of South Africa. On the other hand, it is highly endemic in Bechuanaland where, in 1956, 77 per cent of all lungs of slaughtered animals were condemned for this infection.

There are no reports available for the Malagasy Republic or the Portuguese colonies of Mozambique and Angola.

The following data concerning the occurrence of hydatidosis in man are taken from health reports of the countries concerned.

Country	*Year*	*Cases*	*Deaths*
Basutoland	1957	1	
Ghana	1956	194	3
Kenya	1957	46	6
Sudan	1957	64	4
Tanganyika	1957	17	

Hydatid disease is a notifiable disease in only nine countries in Africa. Under such circumstances, information concerning the occurrence of the disease in man is extremely limited.

Some zoonoses in Southwest Asia. *Rabies.* Rabies has been reported from most countries of Southwest Asia. Cyprus is said to have been free of the disease for 45 years. There is no record of the disease in Aden Colony and Protectorate, and it has not been reported from Yemen. Table 35 presents information concerning human rabies in four countries of Southwest Asia for 1958.

Animal rabies is said to have a low incidence in Afghanistan and Iran. In Iraq, infection in dogs is widespread throughout the country and, as indicated in Table 36, 31 deaths in the human population were recorded for the period 1954-1959. The disease is also prevalent in Israel, where a total of 778 cases occurred in lower animals from 1954-1958. Infection is common in dogs and in wild fauna. Six human deaths occurred from 1954-1959. During this period, the average number of persons bitten annually by animals suspected of having rabies was 7,489.

In Jordan, 106 cases of the disease were reported in lower animals in 1956-1959; 6 deaths were reported in man for the period 1954-1959. Canine rabies is very prevalent in Lebanon; no information is available concerning the number of human cases. Infection has been reported from Saudi Arabia in dogs and goats. In 1958, an outbreak occurred in goats at Jeddah and another in foxes and dogs at Rammah.

Canine rabies is widespread in Syria, but the disease has a low incidence in other animals, including wild carnivores. Table 35 indicates that 667 individuals received treatment in 1958. Rabies is an important public health problem in Turkey. The disease is widespread in dogs and in wild fauna. Between 1954 and 1959, a total of 247 deaths occurred in the human population. A total of 25,442 persons were given treatment in 1958 (Table 35).

Anthrax. Anthrax is an important disease in Southwest Asia. Reporting of human cases is probably very scanty, but Table 36 provides some information in this regard. The countries with the largest number of reported human cases were Iraq, with 1,087 cases from 1954 to 1959, inclusive, and Turkey, with 8,214 cases and 159 deaths for the same period.

The disease is widespread in domestic animals in many of the countries of the region. In Aden, it is suspected in cattle, but the diagnosis has not been confirmed; there is no evidence of its occurrence in other animals. A low incidence is said to characterize the disease in goats and horses in Afghanistan; in sheep, the infection is confined to certain areas. The disease has been much reduced in cattle, sheep and goats in Cyprus, where it occurs occasionally in swine.

Table 35. Human rabies in Southwest Asia in 1958 based on information in world survey of rabies by World Health Organization[1]

COUNTRY OR TERRITORY	NUMBER OF HUMANS RECEIVING ANTI-RABIES TREATMENT	NUMBER OF DEATHS IN UNTREATED HUMAN CASES	NUMBER OF DEATHS IN TREATED HUMAN CASES
Iran	837	0	8
Israel	978	0	0
Syria	667	[2]	2
Turkey	25,442	3	9

[1] WHO questionnaire on rabies: Personal communication, 1959.
[2] Data not available.

Table 36. Occurrence of certain zoonoses in the human population in some countries of Southwest Asia, 1954-1959[1]

COUNTRY	BRUCELLOSIS		ANTHRAX		RABIES
	CASES	DEATHS	CASES	DEATHS	DEATHS
Bahrain			1		
Cyprus			6		
Iraq	168	2	1,087	31	31
Israel	404	2	2	1	6
Jordan			23		6
Lebanon	2		2		
Syria			23		
Turkey	245	4	8,214	159	247

[1] From WHO Epidemiological and Vital Statistics Report, v. 13 (11-12), 1960. In many instances data are incomplete, with reports missing for certain years.

Anthrax is of widespread occurrence in cattle, sheep and goats in Iran, but is of less importance in the camel, equines and swine. In 1959, 641 cases were recorded in cattle and 7,154 in sheep and goats. In Iraq, on the other hand, a low incidence is reported for cattle, goats and horses; in sheep, the disease is confined to certain areas.

The disease is not of frequent occurrence in Israel. In 1958, only two animal deaths were recorded. A total of 211,189 doses of anthrax vaccine were administered in 1958.

In Jordan, the disease is widespread in all domestic animals; a total of 1,235 cases were reported from 1956 to 1959. There is a low incidence generally in Lebanon; only sporadic cases occurred in 1959-1960. The disease is said to be epizootic in Saudi Arabia, but detailed reports are unavailable. In Syria, anthrax is widespread in all domestic animals. A total of 1,362 cases were reported in 1959. In the same year, 343,789 animals were vaccinated. The disease is also of frequent occurrence in Turkey in cattle, sheep and goats. There are no reports concerning its distribution in Yemen.

Brucellosis. Human cases are recorded only for Iraq, Israel, Lebanon and Turkey for the period 1954-1959 (Table 36).

Infection in animals varies from country to country. There are no data available for Afghanistan and Yemen. Cyprus appears to be free of infection. In Aden Colony and Protectorate, brucellosis has been suspected but its presence has not been confirmed. In Iran, infection in various domestic animals is confined to certain regions. In 1960 (less one month, 23 August to 22 September), a total of 191 herds of cattle were tested for the disease. These herds included 5,376 animals, of which 988, or 18.37 per cent, were found positive. During this time, one outbreak reported from sheep resulted in 20 deaths. The disease in Afghanistan is said to occur mainly in imported animals.

In Iraq, brucellosis in cattle is characterized by a low incidence. The occurrence of *Br. melitensis* is suspected but not confirmed. Bovine brucellosis in Israel has been largely controlled by vaccination with Strain 19, but the disease in sheep is of public health importance and probably accounts for the majority of human cases. In 1958, it appeared that the slaughter method might have to be adopted for curbing the sheep disease, which cannot be controlled by vaccination. In that year, 35,329 cattle were vaccinated with Strain 19 vaccine.

Brucella infection is reported to have a low incidence in Jordan. In Lebanon, the infection is widespread in cattle; *Br. melitensis* and *Br. suis* are of suspected occurrence but not confirmed. The disease is suspected in Saudi Arabia, but its presence is not listed as confirmed. *Br. abortus* is reported to have a low prevalence in Syria; the presence of *Br. melitensis* and *Br. suis* is suspected but not established. In Turkey, brucellosis is of importance in cattle, sheep and goats. *Br. abortus* is widespread in cattle and *Br. melitensis* occurs commonly in sheep and goats.

Br. suis has not been recorded for most parts of Southwest Asia. It is said to have a low incidence in Jordan and suspected but not confirmed in Lebanon.

Hydatid disease. Hydatid disease is enzootic in most of the countries of Southwest Asia and human infection no doubt occurs frequently. However, the disease is reportable only in Israel.

In Aden Colony and Protectorate, infection has not been recorded from domestic animals but undoubtedly occurs. One human case is on record for the years between 1954 and 1958. In Afghanistan, infection is common among cattle and sheep, although there is no information available concerning its occurrence among the human population.

Cyprus has long been recognized as a focus of heavy infection. In 1957, 100 per cent of the cattle, sheep and goats from most districts of the island were found infected on meat inspection. Swine likewise are frequently infected. Health reports list 255 cases of human hydatid disease in the five-year period 1954-1958.

Infection is widespread in all domestic animals, including the camel, in Iraq and Iran. Information is lacking concerning numbers of human cases of hydatid disease in Iran. In Iraq, Kelly and Izzi[23] reported 189 cases in Baghdad over a period of three and one-half years.

There were no reports received for the Animal Health Yearbook for 1959 of hydatid infection in domestic animals in Israel. Rakower[24] stated that there were about 100 human cases in Israel in 1959. According to this author, animal infections vary in different parts of the country. Incidence is 12 per cent in Beer-Sheva, 10 per cent in Safad, but only 0.02 per cent in Tel-Aviv. Eighty per cent of the autochthonous human cases come from four districts: Beer-Sheva, Ashkelon, Kinnereth and Safad, with a total population of 200,000. Rakower pointed out that the presumptive morbidity rate in these areas reaches 16 per 100,000, a rate which is even higher than that of Cyprus or Sardinia, which are regarded as classical endemic countries.

There is no information available concerning hydatid infection in domestic animals in Jordan and Lebanon. However, the disease is known to occur in these countries and human cases are not infrequent, although not notifiable. Schwabe and Daoud[25] reported an average of 63 surgical cases in Lebanon per year for the period 1949-1959. The case rate was 3.82 per 100,000 per annum. In Saudi Arabia, bovine infection is said to be only sporadic; human infection is relatively low. Infection has a low incidence in Syria. However, in 1959 there were 41,525 partial condemnations of carcasses on meat inspection for echinococcosis. In Yemen, hydatid disease is said to be rare because for religious reasons dogs are not kept in the home (Felsani).[26]

Turkey has long been known as an endemic area for human hydatidosis. However, the disease is not notifiable and data on human cases are not generally available. Approximately 255 cases were hospitalized in 1955. Animal infection is widespread throughout the country. Yasarol[27] found 52 per cent of 10,376 sheep infected in the abattoir at Istanbul; 4.74 per cent of 1,896 cattle were shown to have cysts. The same author reported adult *Echinococcus granulosus* in 2 of 413 dogs examined in Istanbul.

Some zoonoses in South Central and Southeast Asia and Oceania. *Rabies.* Table 37 offers data concerning human rabies in South Central and Southeast Asia for 1958. Available information concerning deaths in man from rabies is given in Table 38. Rabies is not a reportable disease in many countries of South Central and Southeast Asia; even in certain countries in which the disease is notifiable, no data are available on human cases and deaths.

Certain countries are believed to be free of the disease. The last case of animal rabies in Hong Kong occurred in 1955 after a vigorously pursued control campaign. In spite of this fact, Table 37 indicates that 1,891 persons received vaccine treatment in 1958. A similar effort in Malaya has resulted in eradication of the disease, where it is believed that the last case in animals occurred in 1958. The disease is absent from Singapore, North Borneo, Sarawak and Western New Guinea.

Information is not available concerning the occurrence of rabies in Bhutan or Brunei. The disease probably occurs in the former state but not in the latter, although the 1958 report of the Medical and Health Department indicates that stray dogs constitute a considerable problem in Brunei and Kuala Belait towns. During that year, 2,166 dogs were destroyed by the use of poison darts shot from a blowpipe.

The disease is widespread in dogs in Burma, where 164 human deaths occurred during the period 1954-1959. A similar situation exists in Cambodia. A total of 544 human deaths were recorded in Ceylon for the period 1954-1957. The disease is enzootic in dogs and occurs occasionally in cats, monkeys, cattle and goats. The Department of Health has launched an eradication campaign which is designed to effect vaccination of all dogs in the country. Opposition has been encountered to the destruction of stray dogs because of religious convictions.

Rabies is a problem in China (Taiwan), where 182 deaths in man were recorded from 1954-1959. A control program was launched in 1957 and completed two years later. Registration and mass vaccination of dogs resulted in a decline in number of cases annually from 238 in 1951 to 6 in 1958 and none in 1959.[28] On the other hand, the WHO survey indicated that 250 persons received vaccine treatment in 1958. In India, the disease is enzootic in dogs and wild carnivora. The disease is not notifiable and accurate data on the number of human cases and deaths are not available. However, indications are that approximately 3,000 persons die each year from rabies. Attempts to reduce the number of pariah dogs have met with opposition because of religious beliefs. The disease is widespread in dogs in Indonesia; it also occurs in cattle in certain areas. Rabies is not a notifiable disease in that country; however, Table

Table 37. Human rabies in South Central and Southeast Asia in 1958 based on information in world survey of rabies by World Health Organization[1]

COUNTRY OR TERRITORY	NUMBER OF HUMANS RECEIVING ANTI-RABIES TREATMENT	NUMBER OF DEATHS IN UNTREATED HUMAN CASES	NUMBER OF DEATHS IN TREATED HUMAN CASES
Burma	2,902	0	0
Cambodia	1,751	0	0
China (Taiwan)	250	5	1
Hong Kong	1,891	0	0
India—Bombay State and elsewhere	35,000	200[2]	4-5[2]
India—Kasauli	90,308	183[2]	7
India—Nilgiris	27,847	[3]	[3]
Indonesia	5,624	5	0
Laos	326	0	0
Philippines	145,439	215	2
Thailand	16,441	39	1
Vietnam—Hue	2,000	2	0
Vietnam—Saigon	6,790	8	0

[1] WHO questionnaire on rabies: Personal communication, 1959.
[2] Plus or minus.
[3] Data not available.

Table 38. Occurrence of certain zoonoses in the human population in some countries of South Central and Southeast Asia and Oceania, 1954-1959[1]

COUNTRY OR TERRITORY	BRUCELLOSIS		ANTHRAX		RABIES
	CASES	DEATHS	CASES	DEATHS	DEATHS
Burma		181		95	164
Cambodia		1	38		6
Ceylon	6		19	6	544
China (Taiwan)					182
Hong Kong	2				3
India	4,668[2]	7[2]			
Macao			13	1	6
Malaya	3	1			2
Portuguese India					7
Philippines			118	13	1,129
Sarawak			353		
Thailand				3	543
Vietnam	74		61		
Fiji	5		12	4	
French Polynesia	1				
Guam	2		4		
Ryukyu Islands			64		

[1] From WHO Epidemiological and Vital Statistics Report, v. 13 (11-12), 1960. In many instances data are incomplete, with reports missing for certain years. Table includes material from other sources also.
[2] Reported from Madras State only; period 1 November 1955 to 31 December 1956.

37 indicates that 5,624 individuals were given vaccine treatment in 1958.

In Laos, rabies is common in dogs and cats, especially among stray animals in the towns. A total of 326 persons received anti-rabies treatment in 1958. About 60 per cent of the animal brains examined at the Pasteur Institute at Phnom Penh, Cambodia, have been positive for Negri bodies. Table 37 indicates that 1,751 persons received vaccine treatment in 1958. Six deaths are recorded from Macao for the period 1954-1959, but no information is available concerning animal rabies. The disease is common in dogs and in feral animals in Nepal, but information on human cases is lacking.

Rabies is enzootic in Pakistan. In addition to dogs, infection occurs frequently in horses, mules and donkeys and has been observed in cattle, sheep and goats. It is not a reportable disease and data on human cases are lacking. A phenolized vaccine is employed for the immunization of dogs, but vaccination is not compulsory and destruction of stray dogs meets with opposition.

During the period 1954-1959, 1,129 human deaths from rabies were reported from the Philippines. A total of 57 cases of rabies in dogs were reported for 1958-1959. Mass vaccination of dogs in enzootic areas has been attempted but usually only a small percentage has been reached. The disease is a problem in Thailand, where 543 human deaths were recorded in 1954-1955. Rabies is said to be of seasonal occurrence in dogs in Vietnam. A record of human cases is not available; however, morbidity reports for 1955-1958 indicate that 4,349 persons were exposed and presumably were given the Pasteur treatment. The WHO survey indicated that 8,790 persons were treated in 1958.

Anthrax. No information is available concerning occurrence of anthrax in Bhutan, Brunei, China (Taiwan), Nepal and Portuguese India. It is said not to be present in Singapore and West New Guinea. Animal cases are rare in Hong Kong and human infections are not recorded. Cases have been reported in man in Sarawak (*vide* Table 38) and Fiji, but all reports consistently deny its presence in domesticated animals in these countries.

Anthrax is enzootic and widespread in cattle and buffalo in Ceylon, India and Laos. It also occurs in other animals in these countries. Between 1954 and 1959, 19 human cases and 6 deaths were reported from Ceylon but none from India and Laos. The disease is said to be much reduced in lower animals in Burma, but during the above-mentioned period 95 deaths were reported in man from this country. In Thailand in 1957 there were 17 outbreaks and 109 animal deaths. Three human deaths occurred in this country during the period 1954-1959. In Cambodia, the disease has a low incidence in cattle; 38 human cases were recorded for this period.

In Indonesia, anthrax is confined to certain regions as regards animal infection; there are no reports available on human cases. Thirteen human cases and one death were reported from Macao during the period 1954-1959; information is lacking on the extent of the disease in domestic animals. The disease is mainly in imported animals in Malaya and no data are at hand concerning human infections. The disease is suspected as occurring in North Borneo, but diagnosis has not been confirmed.

Anthrax is reported to have a low incidence in domestic animals in Pakistan, Vietnam and the Philippines. A total of 296 cases were reported from domestic animals in the latter country in 1958-1959. There is lack of information concerning human infections in Pakistan, but, for the period 1954-1959, 118 cases and 13 deaths are recorded from the Philippines and 61 cases from Vietnam.

The disease assumes an atypical form in Papua and New Guinea and swine only are affected. No animal infections are recorded for New Caledonia. Guam reported four human cases from 1954-1959, although there is no information concerning the disease in lower animals on that island. Sixty-four human cases are on record from the Ryukyu Islands for the same period. There is likewise a lack of reports concerning infection in domestic animals in these islands.

Brucellosis. Brucellosis is apparently widespread over these areas, but unfortunately reports of the disease in man and domestic animals are exceedingly meager. There are no data presently available concerning infection in Bhutan, Brunei, Laos, Macao, Portuguese India, Nepal and West New Guinea.

A total of 181 human deaths were reported in Burma for the period 1954-1959 (Table 38), where the disease is listed as being sporadic in cattle but not known from other animals. Cambodia reported one death in the above-mentioned period; infection in cattle is probable, but *Br. melitensis* and *Br. suis* are believed to be absent from the country. Six human cases were reported from Ceylon for the period 1954-1959; in the Animal Health Yearbook for 1959, the disease is listed as being widespread in cattle, and there is a notation that *Br. suis* has been recognized recently. A questionnaire received from the veterinary authorities of Taiwan listed 102 cases of brucellosis in cattle in 1959, but there is no record available concerning human cases. Hong Kong reported two human cases in the period 1954-1959; the disease in cattle is confined to certain regions, but *Br. suis* infection in swine is of common occurrence.

In India, *Br. abortus* infection in cattle is widespread throughout the country; *Br. melitensis* is suspected as occurring in goats, but *Br. suis* has not been recognized. Available health reports for the country as a whole make no reference to the disease in man, but it is probably of frequent occurrence. For instance, in Madras State for the period 1 November 1955 to 31 December 1956, 4,668 human cases and 7 deaths were reported. There is no record at our disposal concerning human cases in Indonesia. *Br. abortus* in cattle is confined to certain regions; *Br. melitensis* is suspected, but diagnosis has not been confirmed; *Br. suis* has a low incidence. The 1956 annual report of the Veterinary Institute at Bogor stated that 9,991 sera, mostly from cattle, were tested, of which 1,441, or 14.4 per cent, were positive.

Malaya reported three human cases and one death from 1954-1959. *Br. abortus* has a low incidence in cattle and *Br. suis* has a limited distribution in swine. The annual veterinary report for 1955-1956 states that the disease occurred in cattle at the Central Animal Husbandry Station in the past, but is now kept under control by regular calf vaccination with Strain 19. The disease is said to be absent from North Borneo. The incidence of *Br. abortus* in cattle in Pakistan is said to be low and the occurrence of other forms has not been confirmed. Bellizia[29] stated that brucellosis is of recognized importance in cattle, including buffaloes, and is probably important in sheep and goats in Pakistan. *Brucella abortus* is most common on organized farms, while among indigenous cattle a variant organism with characteristics of both *Br. abortus* and *Br. melitensis* is found.

In the Philippines, *Br. abortus* and *Br. suis* are found mainly in imported animals. The occurrence of *Br. melitensis* has not been confirmed. A total of 75 cases of cattle brucellosis were reported for 1958-1959 on a questionnaire supplied by veterinary authorities. *Br. abortus* is not reported from Sarawak, although there is a low incidence of *Br. suis*. Cattle brucellosis occurs in Singapore but has a low prevalence rate. The veterinary report from Thailand for 1955-1957 stated that brucellosis was introduced in swine imported from the United States, although the organism was identified as *Br. abortus* and not *Br. suis*. Of 4,347 serum samples examined from indigenous pigs, 0.52 per cent were positive and an additional 1.5 per cent suspicious. *Br. abortus* stained antigen was produced in an amount of 12,400 doses.

Vietnam reported 74 human cases of brucellosis between 1954 and 1959. There are no available records concerning the disease in domestic animals in that country. Cattle brucellosis is said to be absent from West New Guinea, although *Br. suis* is present in swine. Brucellosis is present in domestic animals in Papua and New Guinea. In New Caledonia, no animal cases were reported in 1959. Fiji had five human cases for 1954 to 1959. *Br. abortus* has a low incidence in cattle and other species of the organism have not been recognized. Brucellosis in cattle is said to be no longer a problem because control has been accomplished through vaccination with Strain 19. A total of 5,197 animals were vaccinated between 1953 and 1957 inclusive. For the period 1954-1959, two cases of brucellosis in man were reported from Guam and one case from French Polynesia. No information is available concerning animal infection in these areas.

Hydatid disease. There is little information available concerning the occurrence of hydatid disease in these areas. Reports at our disposal do not list the disease in either man or animals in Bhutan, Brunei, Portuguese India, Nepal or Taiwan. Its occurrence in domestic animals in the following countries is not mentioned in veterinary reports, the Animal Health Yearbook for 1959, or in questionnaires submitted for the survey: Hong Kong, Indonesia, North Borneo, Pakistan, Sarawak, Singapore, Taiwan, Vietnam, West New Guinea, Papua and New Guinea, New Caledonia and Fiji.

Information on human cases and deaths gleaned from health reports of the various countries indicates the following: Ceylon, 1 case and 1 death in 1957; India, 14,335 cases and 8 deaths in 1958; Macao, 1 case in 1957; and Vietnam, 34 cases in 1957.

The Animal Health Yearbook for 1959 provides certain data on hydatidosis in domestic animals in some countries. In Burma, infection is widespread in cattle, but has not been recorded from equines, sheep or swine. The disease is listed as having a low incidence in cattle and swine in Cambodia. It has not been found in swine in Ceylon but has a low incidence in cattle and sheep. No information is provided concerning hydatid infection in domestic animals in India, other than the camel, in which it has not been recorded. In Laos, infection is infrequent in cattle and sheep; its presence in equines is suspected but has not been confirmed. The disease is almost entirely confined to cattle imported into the Philippines, where it has not been found in horses or sheep. There is a low incidence in cattle and swine in Thailand, with no data on occurrence in equines or sheep.

From the meager statistics, it would appear that hydatidosis is of some public health importance in South Central Asia, but of limited prevalence in Southeast Asia. For the most part, tropical Oceania appears to be free of infection.

The status of other important animal diseases of the tropics. Diseases of general importance.

Diseases of general importance in the tropical world include gastrointestinal parasitic infections, nutritional deficiencies, hepatic distomatosis, anthrax and sheep pox. These diseases are widely distributed in many parts of the tropics and constitute important problems wherever they occur.

Gastrointestinal parasitic infections. Intestinal parasites are almost universally distributed in domestic animals throughout the tropical world. The economic effects are multiple and not necessarily confined to mortality in infected animals. These parasites are responsible also for retarded development of young animals, reduced yields of milk and meat, lowered wool production, and impaired working capacity of draft animals.

Climatic conditions have a profound effect on the transmission of gastrointestinal parasites for the reason that most of them do not require the intervention of a vector or intermediate host. Rainfall is especially important because moisture is required for the development of larval stages on pastures. Certain parasites are therefore not as frequently encountered in areas in which rainfall is scanty throughout the year. Conditions in the tropics are conducive under most circumstances for the transmission and perpetuation of gastrointestinal parasites; transmission can and does take place in most instances throughout the year, whereas in the temperate zones low temperatures serve as a barrier to transmission during the winter months. The lush pastures of many tropical areas tend to invite overstocking, which produces further favorable influences for the development of certain parasites. Attempts to improve breeds of livestock through the importation into tropical countries of animals with superior blood lines have possibly contributed in some areas to parasite problems, since the improved breeds frequently are more susceptible to the effects of parasitism than are native animals.

Nearly all classes of gastrointestinal parasites are represented in the infections harbored by domestic animals in the tropics. Most of these parasites are generally distributed, but certain ones are of particular importance in some areas.

Cattle are infected with various species of coccidia. Coccidiosis is responsible for a high mortality in buffalo calves in Southeast Asia, which do not respond to treatment in the same manner as do other calves. Nematode parasites of cattle include representatives of the following genera: *Neoascaris, Haemonchus, Mecistocirrus, Cooperia, Bunostomum, Oesophagostomum, Trichostrongylus, Ostertagia,* and others usually of a less damaging nature. The cestode parasite, *Thysanosoma actinioides,* is troublesome in some areas. Rumen flukes such as *Paramphistomum* and *Cotylophoron* are of frequent occurrence in certain regions; other species also are common in some areas. *Mecistocirrus digitatus* causes serious losses in young cattle in Ceylon and Burma. *Neoascaris vitulorum* is an important parasite of cattle in Southeast Asia.

Sheep and goats harbor many gastrointestinal parasites. Coccidia are of special importance in young lambs. Nematode parasites include members of the genera *Haemonchus, Cooperia, Bunostomum, Oesophagostomum, Trichostrongylus, Ostertagia, Nematodirus, Strongyloides* and *Chabertia.* Common tapeworms include *Monezia* spp. and *Thysanosoma.*

Swine seldom thrive in the tropics unless special care is taken to guard against multiple disease conditions. Parasitism is an important factor. The large intestinal roundworm, *Ascaris lumbricoides,* is extremely common. Stomach worms, such as *Ascarops strongylina* and *Physocephalus sexalatus* contribute to unthriftiness, as does the thorny-headed worm, *Macracanthorhynchus hirudinaceus.* The nodular worm, *Oesophagostomum dentatum,* is of widespread occurrence. *Strongyloides ransomi* is an important cause of losses in young pigs in parts of the tropics. While not a gastrointestinal parasite, the swine kidney worm, *Stephanurus dentatus,* is one of the chief causes of swine losses in the tropics.

Horses, mules and donkeys are commonly burdened with many varieties of intestinal parasites. In countries which depend predominantly on these animals for draft purposes, such parasites are of economic concern. The large strongyles, *Strongylus vulgaris, S. equinus* and *S. edentatus,* attach themselves to the wall of the large intestine and suck blood. One of the larval stages of the first named species produces aneurisms in the anterior mesenteric artery and its branches which may result fatally. Species of smaller, non-bloodsucking strongyles are numerous and help to contribute to malnutrition and unthriftiness.

Control of gastrointestinal parasites of livestock centers around preventive measures such as pasture rotation, moderate stocking, confinement of young animals to clean pastures, and anthelmintic medication. While control is theoretically possible, it is seldom achieved, because of lack of knowledge of methods, negligence, or economic factors which obviate the provision for adequate facilities or the properly timed administration of suitable medication. In many tropical countries, veterinary authorities carry on control campaigns against gastrointestinal parasites, one of the main features of which is the administration of anthelmintic treatments. In Basutoland, for instance, lack of progress in the effort to control internal parasites of livestock led in 1958 to employment of 100 "Small Stock Assistants" for giving treatments. Other countries maintain similar programs.

Nutritional deficiencies. Soils in many parts of the tropics are lacking in certain of the elements required for adequate nutrient intake by domestic animals. There are, on the contrary, areas in which there is an excess of such elements, in which event certain pathological manifestations may be evidenced. Minerals mostly involved are selenium, fluorine and molybdenum. Required mineral elements are numerous; lack of iodine may produce congenital goiter in calves, low intake of magnesium, copper or cobalt, as well as other minerals, is responsible for retarded development and emaciation. A Ca/P imbalance frequently leads to the development of osteoporosis and osteomalacia in cattle. There is undoubtedly a catalytic or complementary action on the part of certain trace minerals one with another.

Avitaminoses occur in many parts of the tropics. Deficiencies of vitamins A and D are most frequent and associated with the lack of such vitamins in pasture plants and feed crops. Stiff lamb disease and white muscle disease in calves are associated with vitamin E deficiency.

Protein deficiency has been noted in tropical countries. This is responsible for retarded growth, lowered milk yields, and other manifestations. Such deficiency is more apt to be found after the prolonged dry seasons which characterize many tropical areas.

The nutritional diseases of livestock in the tropics are many and varied. For the most part, they are not regional in character but are localized in their distribution. Remedial measures are generally available, but in many instances their employment is not economically feasible.

Hepatic distomatosis. Liver fluke infection is of common occurrence in ruminants in many parts of the tropics and may be found in swine also. Two species, *Fasciola hepatica* and *F. gigantica*, are widespread. *Stilesia hepatica* is a problem in parts of Africa and southern Asia. The parasites are most troublesome in countries with high rainfall or those in which irrigation is practiced so that low, wet pastures provide suitable conditions for the intermediate hosts, which are various species of lymnaeid snails. Sporadic infections with these trematode parasites also occur in man.

In domestic animals, liver flukes are responsible for considerable economic losses. These losses are represented by retarded growth of young animals and malnutrition and loss of weight in older sheep and cattle. In countries which maintain meat inspection services, the condemnation of livers for fluke infection constitutes an important economic loss.

For the reason that hepatic distomatosis is seldom responsible for direct death losses, it frequently goes unrecognized and its importance unrealized. Effort has been made to arrive at some determination of the relative importance of the infection in the tropical areas embraced within this survey. However, this is a difficult task because of the generally meager reporting of animal diseases. Questionnaires received from various countries indicate that liver fluke disease is of importance in 7 of 20 countries in the Caribbean, Central and South America, 8 of 13 countries in Africa, and 2 of 3 countries in Southwest Asia. In Oceania, it is not believed to be present or, if so, is not regarded as an important problem.

An analysis of the data with regard to hepatic distomatosis in the Animal Health Yearbook for 1959 indicates that in the Caribbean, Central and South America infection is widespread in 4 of 22 countries, viz., Argentina, Uruguay, Chile and Cuba. In 9 other countries, infection is confined to certain parts of the country, but in these areas it is of local importance.

Of 35 countries reporting from Africa, hepatic distomatosis is widespread in 11 countries, as follows: Former French West Africa, Nigeria (Federation), Sierra Leone, Ethiopia, Kenya, Uganda, the former Belgian Congo, Ruanda-Urundi, Nyasaland, Southern Rhodesia and the Union of South Africa. The disease has limited distribution in 8 other countries.

In Southwest Asia, liver fluke infection constitutes an important problem in 6 of 11 countries reporting to FAO; these countries are Afghanistan, Turkey, Syria, Lebanon, Jordan and Iran. The disease is of local concern in several other countries. The report indicates lack of evidence concerning its occurrence in Aden Colony and Protectorate and Cyprus. However, it is of concern in the latter country, where a control campaign has been carried on for many years.

In 7 of 16 countries reporting to FAO from South Central and Southeast Asia, hepatic distomatosis is of widespread occurrence; these countries are India, Laos, Cambodia, Thailand, North Borneo, Indonesia and the Philippines. In addition, the disease is of local importance in certain parts of Pakistan, Ceylon, Burma and in Hong Kong.

There are no reports of liver fluke infection in those parts of Oceania included in the current survey.

Sheep pox. It is a question whether this disease should be classified with those of general importance. The disease is of great economic consequence in many sheep raising countries, but its distribution is somewhat limited, and it is not of major concern in all of the geographical areas of this survey.

Of countries in the Caribbean, Central and South America reporting to FAO in 1959 and 1960, sheep pox was listed as occurring only in British Guiana. However, these reports are now declared to be in error since the disease has never existed there.

In Africa, the disease is of importance in the northwest—in Morocco, Algeria, Tunisia and Libya, and in Ethiopia. In 18 of 35 countries reporting in 1959, the disease was not recorded that year.

Possibly the geographical area in which sheep pox is most widely distributed, and therefore of considerable economic importance, is Southwest Asia. Of 13 countries reporting in 1959, the disease was listed as being extensively distributed. It was not reported from Aden Colony or Protectorate or from Cyprus, although the latter country suffered a severe outbreak in 1957. The disease occurs in Israel, but strict quarantine measures and immunization of exposed flocks have resulted in its control.

India is the only country in South Central and Southeast Asia reporting extensive outbreaks of sheep pox. The disease also occurs sporadically in Pakistan, where its appearance is largely seasonal.

Sheep pox is not of importance in Oceania.

Table 39. The incidence of foot-and-mouth disease and the distribution of the immunological types in South America[1]

COUNTRY	INCIDENCE	TYPES
Venezuela	Variable, usually low, some areas free	O, A
Colombia	Enzootic, but low incidence in some areas, other areas free	O, A
British Guiana	Free	—
Surinam	Free	—
French Guiana	Small outbreaks confined to Cayenne in 1954 and 1958	Not typed
Ecuador	Sporadic outbreaks have been reported	A
Peru	Limited, but enzootic in a few areas	O, A, C
Brazil	Enzootic in most areas	O, A, C
Bolivia	Enzootic	O, A, C
Paraguay	Enzootic	O, A, C
Chile	Enzootic in main cattle raising areas with low incidence or freedom elsewhere	O, A, C
Argentina	Enzootic in main cattle raising areas with increasingly low incidence in southern latitudes	O, A, C
Uruguay	Enzootic in most areas	O, A, C

[1] Henderson, W. M. — 1960. Foot-and-mouth disease in the Americas. Can. Vet. J., v. 1 (11), pp. 463-470.

Diseases of importance in the Caribbean, Centra and South America

The diseases selected as being of importance in thi area are foot-and-mouth disease, rabies, equine infectiou encephalomyelitis, hydatid disease and bovine tubercu losis. Rabies and hydatid disease have already beer discussed.

Foot-and-mouth disease. Henderson[30] has recently summarized the status of this disease in the Americas and the present account is largely taken from his paper. All of the countries north of the border between Colombia and Panama are free of the disease, including the entire Caribbean area. The last outbreaks north of this line occurred in Canada in 1952, Mexico, Martinique and Aruba in 1953, and Curaçao in 1957. The disease is enzootic in South America, but the prevalence varies between countries and sometimes within the same country. Table 39 summarizes data concerning occurrence of the disease and the distribution of types of virus.

Foot-and-mouth disease in South America is largely confined to cattle, although there are potentialities for the future involvement of sheep and swine in the epizootiological picture. Pig infection is serious in Argentina. Sub-types have been found in Types O and A and the existence of such sub-types may prove to be of importance because vaccination is the chief means of controlling the disease in South America.

Vaccines from inactivated virus are employed; some of the vaccine is produced in government laboratories and part by commercial concerns. The majority are of the aluminum hydroxide and formalin type but in Argentina increasing use is being made of saponin vaccine. Virus is produced by inoculating slaughter cattle, or by culture on cattle tongue epithelium or bovine kidney cells. In most countries of South America vaccination has not been employed on a sufficient scale to change materially the epizootiology of the disease. The single exception is probably Venezuela, where vaccination programs have been carried on since 1951. Type O infection was brought under control for the most part by 1957, but the spread of Type A has necessitated the employment of a bivalent vaccine.

Equine infectious encephalomyelitis. Information concerning the occurrence and distribution of this disease is so limited that its relative importance is difficult to determine. However, the limited data do reveal that infection is widespread throughout the Caribbean, Central and South America, even though typing has not been done in many countries. Human cases have occurred in some countries also. The potential importance of the disease is no doubt great, and as time goes on facilities will probably develop whereby more detailed studies can be conducted in the several countries in which infection is known to exist.

Distribution data presented here have been taken from many sources, including the Animal Health Yearbook for 1960, questionnaires from certain countries, reports of the Caribbean Commission, reports of the Arthropod-borne Virus Information Exchange, and from the literature and other sources. In some cases, reported findings need to be confirmed.

Table 40 offers an analysis of assembled reports on occurrence of infection and the type of virus where known. Infection has been reported from 19 countries and in addition is suspected in Mexico. Reported human cases are rare and in certain areas in which equine infection has been encountered no immune antibodies have been found in the human population.

Bovine tuberculosis. The disease is not of uniform importance throughout the Caribbean, Central and South America. Beef cattle are said to be seldom infected. The highest incidence of the disease is found in dairy centers near urban areas. The disease appears to be of little importance in the Caribbean area; tuberculin testing and slaughter of reactors have resulted in practical elimination of the disease on many of the islands. In 1958, Bermuda had had no reactors for two years; the incidence in cattle in the Barbados was very low; in 1959 only a few animals were found infected in St. Vincent; and the disease was not of importance in the Leeward Islands. In the Martinique report for 1958, there was no mention of the disease; it was rare in Guadeloupe and all tuberculin tests were negative. In Jamaica, of 2,779 cattle tested in 1958, only 0.003 per cent were positive. In contradistinction to the situation in most parts of the Caribbean, bovine tuberculosis is an important problem in Cuba.

The following data are taken from the 1959 Animal Health Yearbook and indicate the status of the disease in various countries of the region.

Disease widespread	*Confined to certain regions*	*Low incidence*	*Not recorded*	*Not likely to be present*
Argentina	Brazil	British Guiana	Bahamas	Nicaragua
Chile	Costa Rica	Colombia		
Cuba	Ecuador	Dominican Republic		
Guatemala	Paraguay	Haiti		
Honduras	Peru	Jamaica		
Mexico	Uruguay	Surinam		
Venezuela		Trinidad		

Information from other sources, largely for the year 1958, may be cited as contributing to knowledge concerning the status of the disease. Limited tuberculin testing had been done in Mexico, but it was the belief that the incidence in dairy cattle would range from 16 to 25 per cent. Little testing had been done in Honduras; a rate of 5.6 per cent was obtained on a few hundred animals; the disease is thought to be of great importance. In Guatemala, the disease was believed to be widespread, although little investigative work had been accomplished. The same situation existed in Costa Rica. Between August 1958 and August 1959, 4,299 cattle were tested in El Salvador, of which 11 were positive and 15 gave suspicious reactions. The disease does not constitute a problem in Panama.

Bovine tuberculosis is not of major importance in Colombia, where the incidence is less than 1 per cent. In Ecuador, a testing program of some magnitude has been carried out. Of some 12,000 animals tested in the vicinity of Quito, 4 per cent were positive, while limited surveys near Guayaquil disclosed an incidence of 8.1 per cent. These rates were not thought to be representative and officials believed that the incidence was much higher. In the Lima Valley of Peru, reactor rates were as high as 60 per cent in some places; even in calves three to five months of age, infection was found frequently. In Bolivia, the disease is of importance. The same situation exists apparently in Paraguay where an incidence of 25 per cent has been found in dairy herds.

Diseases of importance in Africa

Animal diseases considered to be of greatest importance in Africa include trypanosomiasis, tick-transmitted protozoal diseases, rinderpest, contagious bovine pleuropneumonia, blackleg, lumpy skin disease, blue tongue, rickettsial diseases, bovine tuberculosis and sheep scab, which is of regional concern in northwest Africa.

Trypanosomiasis. This is one of the most important diseases of domestic animals in Africa, where most

Table 40. Occurrence of equine encephalomyelitis in the Caribbean, Central and South America

COUNTRY	YEAR	TYPE	ISOLATION FROM				IMMUNE REACTIONS		
			MAN	EQUINES	SENTINEL ANIMALS	VECTOR	MAN	EQUINES	OTHER ANIMALS
Argentina	1933	WEE		x					
	1960	EEE		x					
Aruba[1]	1959								
Bahamas[2]	1960								
Bolivia[2]	1960								
Brazil	1937	EEE		x					
	1955	EEE	x						
	1956	EEE			x				
	1960	EEE				x			
	1961	EEE					x	x	
	1960	WEE		x			x	x	
	1954	VEE			x				
	1955	VEE	x			x			
	1961	VEE					x	x	
British Guiana	1959	WEE-EEE		x					
Chile	1960	WEE					x		
Colombia	1954	VEE	x				x		
	1961	EEE							x
Cuba[2, 3]	1960								
Curaçao[1]	1959								
Dominican Republic[3]	1951	EEE		x			x	x	
Ecuador[3]	1946	VEE		x					
Mexico	1960	EEE-WEE							
Panama	1958	EEE					x	x	x
	1961	VEE	x			x			
Paraguay[2]	1960								
Peru	1960	VEE					x		
Surinam	1959	EEE				x	x	x	x
	1960	VEE					x		
Trinidad	1943	VEE	x						
	1959	VEE			x	x	x		
	1959	EEE				x	x	x	x
Uruguay[2]	1960								
Venezuela	1939	VEE		x					

EEE = Eastern equine encephalomyelitis; WEE = Western equine encephalomyelitis;
VEE = Venezuelan equine encephalomyelitis.

[1] Disease listed as being present in reports of Caribbean Commission.
[2] Disease listed as being present in Animal Health Yearbook for 1960.
[3] Human cases reported to have occurred.

species are cyclically transmitted by tsetse flies of the genus *Glossina*. It has been estimated that these flies occupy some 4.5 million square miles of tropical Africa, an area that is 1.5 times that of the United States. In many parts of the tsetse belt it is impossible to raise cattle, probably the most susceptible of all domestic animals to trypanosomes. In other areas, it has not been found feasible to expand the cattle industry or to improve the breed of native cattle because of the greater susceptibility of animals introduced from elsewhere. The northern and eastern limits of animal trypanosomiasis are the Sahara, Sudan and Ethiopia. On the south, the disease extends to Zululand, where it was formerly enzootic but has been eradicated.

Many species of trypanosomes infect domestic and wild animals in Africa. *Trypanosoma theileri* of cattle is not commonly regarded as pathogenic. *T. vivax* and *T. uniforme* produce disease in cattle. *T. vivax* disease runs a variable course in cattle; horses are susceptible, with the disease taking a chronic course. The goat is easily infected but recovery is frequent. Sheep may die of the infection. The pig is relatively insusceptible. *T. uniforme* infection is similar to that of *T. vivax*.

T. congolense infection is widespread in cattle, which are unusually susceptible. Horses and dogs are susceptible also. In goats the infection is usually chronic. The course is mild in sheep and pigs. In East Africa, *T. congolense* is the most important species.

T. brucei is widespread in game animals. It infects cattle but the course of the disease is relatively mild. It is fatal to horses and dogs. Goats usually make a spontaneous recovery, while infection is mild in sheep. Pigs are highly susceptible and usually succumb to the infection.

T. simiae is highly fatal to swine; it is not as common or as serious an infection in other animals.

T. dimorphon infects cattle, horses, goats, sheep, swine and dogs and produces a chronic wasting disease. *T. evansi* is found principally in the camel.

Species of tsetse flies incriminated in the transmission of animal trypanosomiasis in East Africa include *Glossina morsitans*, *G. pallidipes*, *G. swynnertoni*, *G. brevipalpis*, *G. longipennis* and *G. austeni*. In West and Central Africa, the following species are involved: *G. morsitans*, *G. longipalpis*, *G. tachinoides*, *G. palpalis*, *G. fusca*, *G. medicorum*, *G. tabaniformis* and others.

In addition to transmission by *Glossina* spp., trypanosome infection, especially *T. vivax*, can be accomplished mechanically by other biting flies.

Countries in which cattle trypanosomiasis is most widespread and troublesome include the following: Former French West Africa, Central African Republic, Nigeria, Ghana, Sierra Leone, Tanganyika, Zanzibar, Uganda, the former Belgian Congo, Ruanda-Urundi and Northern Rhodesia. Cattle trypanosomiasis is said not to be present in Algeria, Libya, Egypt, French Somaliland, the former British Somaliland, Basutoland and Madagascar. It is probably absent from Morocco and Swaziland; as previously stated, eradication has been achieved from the Union of South Africa. In other countries of Africa the disease is present but constitutes a problem of somewhat lesser magnitude than in the first named countries.

Many methods of control have been tried for cattle trypanosomiasis. These methods have been ably summarized by Nash.[31] They include prophylactic and curative drug treatment and vector control by clearing of vegetation, insecticides, destruction of game, and other methods. In most areas, tsetse control has been associated with efforts to limit human trypanosomiasis, but the results have usually been beneficial in control of the animal disease.

A large number of drugs have been employed in the treatment of animal trypanosomiasis. These include dimidium bromide, ethidium bromide, antrycide methylsulphate and berenil. Prophylactic compounds include antrycide pro-salt, prothidium and certain suramin complexes. It should be noted that no drug yet devised has proved entirely effective either as a curative or prophylactic measure. Many drugs tend to induce resistance, and antrycide not only is prone to induce resistance to itself but is liable to do so to other drugs. Because of the variability of prophylactic response, such treatment cannot be utilized for protecting cattle unless the cattle are under constant supervision, so that the treatment may be repeated if trypanosomes reappear in the blood stream. In areas in which exposure is minimal, sporadic treatment can be utilized effectively without constant vigilance.[32] In certain circumstances, chemotherapeutic treatment is used effectively as a temporary protective precaution during transit of animals through tsetse infested areas.

Tick-transmitted protozoal diseases. Many species of ticks of the family Ixodidae are transmitters of important protozoan parasites of the blood of domestic animals in Africa, as well as certain diseases of other etiology. It is probable that tick-borne diseases are of greater economic import in Africa than in any other area of the tropics.

The intra-erythrocytic parasites of domestic animals in Africa include members of the genera *Anaplasma*, *Babesia*, *Theileria* and *Gonderia*. Complete agreement is lacking concerning the classification of these organisms; the terms employed here follow the practice of the Food and Agriculture Organization.

The life cycle of the various species has been elucidated for the most part, although a complete understanding of that of the *Anaplasma* is lacking. All species of the above genera parasitize the red blood cells of the host at one period in their life cycle. *Babesia* spp. occur as irregular forms in the red blood cells, though double pear-shaped organisms are observed at a certain stage of the developmental phase. Multiplication is by binary fission into two or four daughter individuals. *Theileria parva* multiplies by schizogony in the lymphocytes and finally invades the erythrocytes, in which no further reproduction occurs. These forms are possibly gametocytes or gametes. Members of the genus *Gonderia* undergo the same type of cycle but the forms in the red blood cells reproduce by division into two or four daughter parasites.

The clinical manifestations produced by the blood protozoan parasites vary considerably, depending on a number of factors, including the degree of inherent resistance, the age and nutritional state of the animal, the presence of concomitant disease conditions, and the virulence of the strain of parasite. The disease may run a peracute, acute, subacute or chronic course. Infection with certain species may be entirely benign.

The ticks involved in biological transmission may be one, two or three host ticks. Infection may be acquired during the larval, nymphal or imago stage of the tick and transmission may occur with one or more of these stages. Transovarial passage of the parasite occurs in some species of ticks.

Anaplasmosis (Gallsickness) of cattle is caused by *A. marginale* and is widespread throughout the continent. It is an important disease in West, North and East Africa and is also rife in Swaziland and the Union of South Africa.* The benign *A. centrale* is more restricted in its distribution but is widespread in the latter two countries and in Egypt, Ethiopia, Kenya, Tanganyika, Zanzibar, former French West Africa and Ghana. *A. ovis* is a frequent infection of sheep and goats in Morocco, Egypt, Ethiopia and former French West Africa.

Species of ticks known to transmit *Anaplasma marginale* include *Boophilus decoloratus* in South Africa and *Hyalomma excavatum*, *H. lusitanicum*, *Rhipicephalus bursa* and *R. simus* in North Africa. *B. decoloratus* also carries *Anaplasma centrale* in South Africa.

Babesiosis, caused by a number of species of *Babesia*, is of economic concern in many parts of Africa.

* At this writing the Union of South Africa has become the Republic of South Africa. However, the old designation is employed in this section for the reason that the country has been referred to under its former name in all previous sections of the report.

Babesia bigemina produces a serious disease of cattle known in Africa as Redwater and in the United States as Texas fever. This parasite is widely distributed throughout East, West and South Africa and is also of frequent occurrence in former French West Africa, the former Belgian Congo and Ruanda-Urundi. *B. bovis*, a relatively benign form, is a parasite of cattle in Egypt, the Union of South Africa and Swaziland. *B. berbera* is of seasonal importance in cattle in Algeria and Tunisia.

Two species of *Babesia* occur in sheep in Africa, viz., *B. motasi* and *B. ovis*. The former is the more pathogenic species and is responsible for pyrexia, prostration, hemoglobinuria and marked anemia. Although chronic infections occur, mortality is high in many outbreaks. *B. motasi* occurs frequently in the former French West Africa and Egypt. It is present in goats in Ghana and is found in Northern Rhodesia; it probably is enzootic in other countries as well. *B. ovis* infection is characterized by jaundice and anemia but is more benign than that of *B. motasi*. Infection in South Africa is said to be subclinical. *B. ovis* is widespread in Tripolitania and Egypt.

Swine babesiosis in Africa is caused by two species, *Babesia trautmanni* and *B. perroncitoi*. The first named species is responsible for pyrexia, anemia, jaundice, hemoglobinuria and ataxia. In the past, outbreaks have occurred in the Union of South Africa, the former Belgian Congo and Southern Rhodesia. Current distribution of a sporadic nature includes former French West Africa, Ghana, Tanganyika, Northern and Southern Rhodesia, the Union of South Africa, and the Malagasy Republic. *B. perroncitoi* causes much the same disease picture as does *B. trautmanni*; the parasite probably occurs in North Africa and possibly elsewhere but seems to be of little importance.

Two species of *Babesia* occur in solipeds in Africa, *viz.*: *B. caballi* and *B. equi*. Both species are pathogenic and are responsible for peracute, acute or chronic manifestations characterized by marked anemia, pyrexia and hemoglobinuria in the more severe cases. *B. equi* infections usually assume a more benign form than *B. caballi* ones. The two species are encountered frequently in equines in Egypt, Union of South Africa and Swaziland.

Babesia bigemina is transmitted by a number of ticks including *Boophilus calcaratus* and *Rhipicephalus bursa* in North Africa, and *Boophilus decoloratus* and *R. evertsi* and *R. appendiculatus* in South Africa. *Babesia berbera* in North Africa is carried by *Boophilus calcaratus* and *Rhipicephalus bursa*. The latter species probably is responsible also for the carriage of *Babesia motasi* and *B. ovis* in North Africa. *Babesia caballi* and *B. equi* are transmitted by *Hyalomma dromedarii* in North Africa.

Rhipicephalus evertsi transmits the latter species in South Africa. There is circumstantial evidence that *B. decoloratus* may carry *Babesia trautmanni.*

Theileriasis due to *Theileria parva* is a highly fatal cattle disease commonly known as East Coast fever. Clinical manifestations include high fever, dyspnoea, dry or bloody feces, leucopenia and extreme weakness. The disease is of considerable importance in Kenya, Tanganyika and Zanzibar. In Nyasaland, Northern Rhodesia and Swaziland infection is more restricted. The former Belgian Congo, Ruanda-Urundi and Uganda are also enzootic areas. The disease has been eradicated from the Union of South Africa where the last case occurred in 1954. Tick control has reduced the disease in the Mozambique.

A considerable number of ticks have been incriminated in the transmission of East Coast fever, including *Rhipicephalus appendiculatus, R. ayrei, R. capensis, R. evertsi, R. jeanelli, R. neavei* and *R. simus. Hyalomma anatolicum, H. dromedarii* and *H. impressum* near *planum* have carried the infection experimentally.

Gonderiosis (Buffalo disease, Chisi disease, Corridor disease), caused by *Gonderia lawrencei,* while not widespread in Africa, is troublesome in some localities. Primarily a disease of the buffalo, it is transmitted to cattle under circumstances which provide for intermingling of these animals or the alternate utilization of the same pasturage. Outbreaks have occurred in the Union of South Africa, Federation of Rhodesia and Nyasaland and Kenya. Other species of *Gonderia* occur. *G. annulata* causes Mediterranean Coast fever and is found frequently in cattle in Morocco, Algeria, Egypt and former French West Africa. *G. mutans* is a benign parasite of cattle in many countries in North, East, Central and South Africa.

Two species of *Gonderia* occur in sheep and goats in Africa. *G. hirci* is a highly pathogenic form which produces in many instances an acute syndrome with a high mortality. In some cases, infection may result only in a subacute or chronic disease. *G. hirci* occurs in Egypt, Sudan and the former French West Africa.

Gonderia ovis is a benign species of sheep and goats and causes only a mild transient illness. The species is morphologically indistinguishable from *G. hirci. G. ovis* has been reported from Morocco, Egypt, Sudan, former French West Africa, Ghana, Northern Rhodesia and the Union of South Africa.

Hyalomma detritum is responsible for the transmission of *Gonderia annulata.* Laboratory observations indicate that *H. impressum* near *planum* may also be involved. *Rhipicephalus appendiculatus* and *R. evertsi* carry *G. mutans* in South Africa; *G. lawrencei* is also transmitted by the first named species. The tick vector of *G. hirci* is unknown; it is thought that *Rhipicephalus bursa* may be responsible. *Rhipicephalus evertsi* carries *G. ovis* in South Africa.

In addition to the intracellular blood protozoan parasites, species of *Eperythrozoon* are encountered in some domestic animals in Africa. For the most part, these parasites are supracellular or intercellular although occasionally they occur intracellularly. Multiplication takes place by schizogony in the histiocytes with further extracellular division in the bloodstream. Members of the genus are closely related to *Bartonella* and *Anaplasma. Eperythrozoon ovis* infects sheep and goats. Many animals exhibit considerable natural resistance. However, the parasite may produce a clinical syndrome with pyrexia, anemia and jaundice. *E. wenyoni* is an innocuous species found in cattle. *E. suis* and *E. parvum* occur in swine and are immunologically distinct. The former is fairly pathogenic but the latter causes only a benign infection. The above species of *Eperythrozoon* have been reported from the Union of South Africa; *E. wenyoni* and *E. suis* occur in Northern Rhodesia and *E. wenyoni* in Southern Rhodesia. Tick transmission is suspected but not demonstrated; other arthropods may possibly be involved.

For the control of the blood protozoan parasites of domestic animals in Africa major effort has been directed toward the tick vectors. Various chemicals have been employed both by means of spraying and through the use of dipping vats. Intervals of treatment depend on the life cycle of the tick.

Among the ixodicides, arsenic in the form of sodium arsenite, alone or mixed with sulphur and sodium oxide, has been employed extensively for many years. More recently, the newer chlorinated compounds such as DDT, gammexane, chlordane, toxaphene and dieldrin have been tried. The phosphoric esters, malathion and diazinon, are being investigated. Some of the chlorinated compounds undergo chemical changes on long standing and may become inert; this can be prevented by combining the compound with arsenic trioxide. Ticks of the genus *Boophilus* have developed marked resistance to many ixodicides in some localities; at times onset of resistance may be very rapid. Different strains of ticks may be resistant to different groups of ixodicides or to only a single compound. Thus far, resistance has not developed to organic phosphorus compounds. Methods for tick control other than application of chemicals include annual burning of pastures, pasture rotation and periodical destocking.

Other methods of control for the blood parasites include immunization where effective and feasible, treatment and quarantine.

Rinderpest. This virus disease was formerly widespread in Africa but since the development of effective vaccines, it has been eradicated from many areas. Rinderpest attacks cattle, sheep, goats and swine; its presence in wild fauna in Africa sometimes complicates the problem of eradication. At present the disease is of special importance in cattle in Nigeria, Chad and Ethiopia. It is still a problem, though one of lesser magnitude, in Somalia, the Sudan, former French West Africa, Republic of Togo, Gambia, Kenya, Tanganyika and Uganda. In 1960, the disease reappeared in the Egyptian Region of the United Arab Republic and was recorded from the Congo. In East Africa, considerable progress has been made in controlling the disease. It is now confined to the northeast corner of Uganda, the Northern Frontier Province of Kenya, northwestern Somalia, the southern Sudan and Ethiopia. Infection is enzootic in wild game in Kenya Masailand and the contiguous area of Tanganyika Masailand.

Vaccination and quarantine are the measures chiefly utilized in control. Both caprinised and lapinised vaccines are employed.

Contagious bovine pleuropneumonia. This bacterial disease, caused by *Asterococcus (Mycoplasma) mycoides*, constitutes an important economic problem in parts of Africa. The disease is widespread in former French West Africa, the Chad, Sudan and Ethiopia. It is more restricted in its occurrence but still of some importance in the northern part of the Cameroon Republic, Republic of Togo, Nigeria, Ghana, Guinea, Sierra Leone, former British Somaliland and Tanganyika. Numerous foci apparently still exist in Angola.

Various measures have been utilized in combating the disease. These include vaccination, slaughter of infected animals and quarantine. Treatment is only partially successful. Current vaccines need to be improved.

Blackleg (Black-quarter, Quarter evil). This disease, caused by *Clostridium chauvoei*, is common throughout most parts of Africa. Infection is found in cattle, sheep, goats and camels. In most countries, economic importance is associated with losses in cattle, although in Tanganyika, Bechuanaland, the Union of South Africa and Basutoland infection is widespread in sheep and goats. The following resumé refers to the cattle disease.

In North and Northeast Africa, blackleg is common in Morocco, Algeria, Tunisia, the Sudan and Ethiopia. Countries in West Africa in which the disease is of concern are the republics which constituted former French West Africa, Gambia, Nigeria and the Cameroons. In the central region, the disease occurs frequently in the former Belgian Congo, Ruanda-Urundi and the Chad. *Cl. chauvoei* infection is widespread in East Africa in Kenya, Tanganyika and Uganda. A similar situation exists in South Africa in Northern Rhodesia, the Federation of Rhodesia and Nyasaland, the Malagasy Republic, Bechuanaland, Basutoland, Swaziland and the Union of South Africa. Wholesale vaccination is said to have practically eradicated the disease from the Mozambique.

Where the control of blackleg has been achieved, quarantine measures are invoked to prevent reintroduction. However, eradication is difficult because of the persistence of the spore forms of the organism in the soil. Occurrence is seasonal in many areas and is coincidental with the rains.

Mass vaccination is the most feasible method of control and such is carried out in most countries in which the disease is troublesome. The disease tends to recur when vaccination is neglected. Various types of vaccines are employed, including bivalent ones with *Cl. septicum*.

Lumpy skin disease (Nodular dermatosis). This virus disease of cattle was first recognized in Northern Rhodesia in 1929. After smouldering there for many years, it invaded Bechuanaland in 1943 in epizootic proportions and soon spread to the Union of South Africa. In addition to these countries, it is known to exist in Basutoland, Southern Rhodesia, Swaziland, South West Africa, Mozambique, Malagasy Republic, the former Belgian Congo, Kenya and Uganda. It seems to have been well contained in the last two countries. The disease is still widespread in the Union of South Africa and Northern Rhodesia. It is confined to certain areas in the Malagasy Republic and continues at a somewhat lower ebb in Southern Rhodesia, Bechuanaland, Basutoland and Swaziland. (Figure 20.)

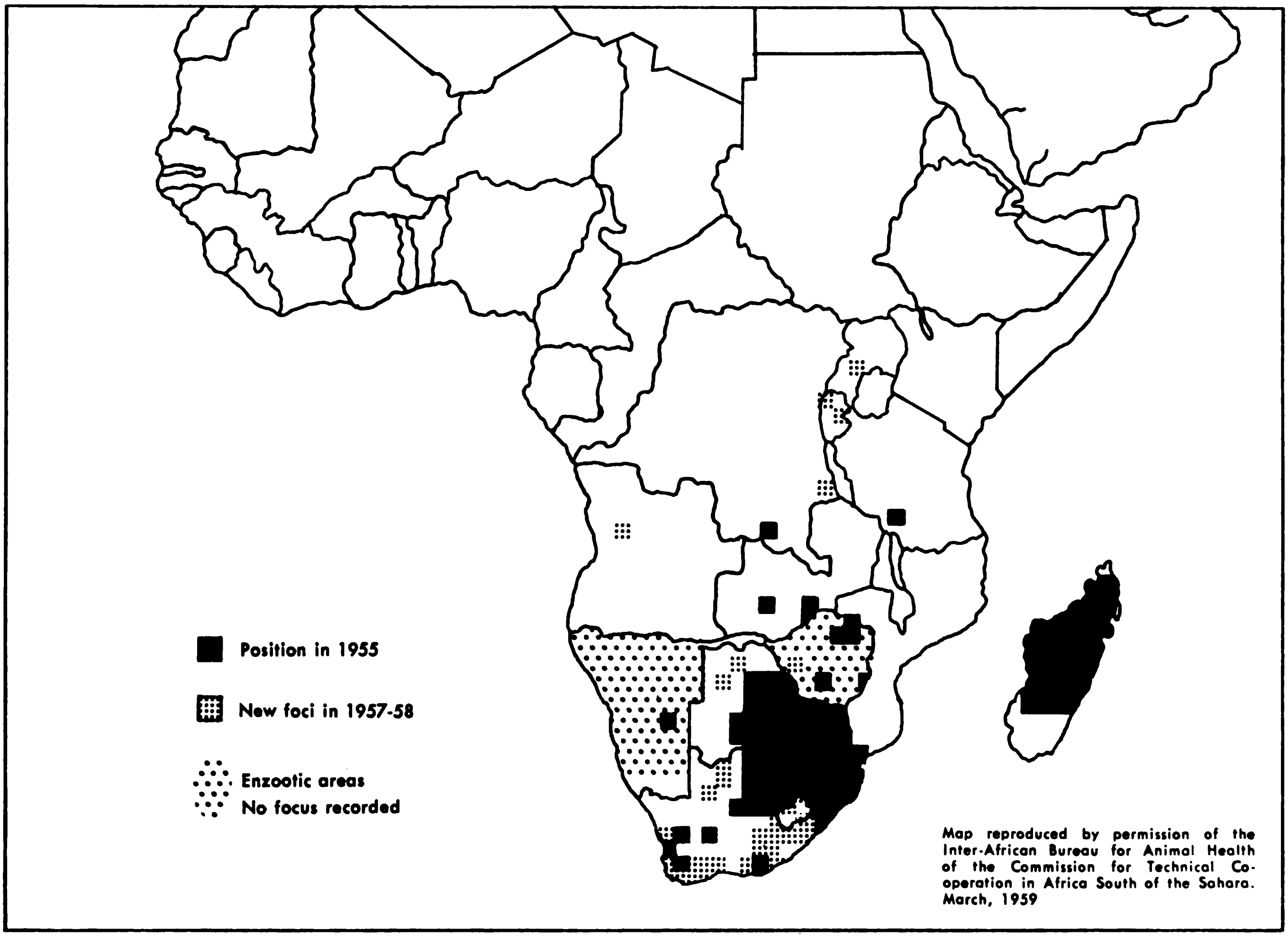
Mild cases of lumpy skin disease usually proceed uneventfully to recovery without marked loss of condition. Mortality varies considerably but may reach 95 per cent. The economic importance of the disease is mainly associated with debility, loss of condition, dysgalactia and, to some extent, damage to hides.

An effective attenuated virus vaccine has recently been developed for lumpy skin disease. Heretofore, control measures included slaughter of infected animals, quarantine and treatment.

Blue tongue. This disease is caused by a virus and affects cattle, sheep, goats and various wild fauna. The infection in animals other than sheep is usually benign. Originally confined to the African continent, in recent years the disease has spread to the United States, the Middle East, Japan, Spain and Portugal, although Portuguese authorities state that the disease has now been eradicated from their country.

Culicoides variipennis has been incriminated as a

Figure 20. Lumpy Skin Disease of Cattle—Geographical Distribution in Africa South of the Sahara



vector of the disease and other biting insects probably play a role in transmission.

Clinical manifestations of blue tongue include marked depression and debility, excessive salivation, nasal discharge and cyanosis and ulceration of the buccal mucosa and tongue.

Blue tongue occurs in former French West Africa, Tanganyika, Southern Rhodesia, Swaziland and the Union of South Africa. The disease is of considerable importance in the last two countries. A total of 27½ million doses of blue tongue vaccine were produced in the Union of South Africa in the year ending 30 June 1958. The virus can be grown in tissue culture enabling characterization of antigenic strains.

Mortality is low but the period of recovery is relatively long. There is no specific treatment. Vaccination is effective as a preventive measure. Control of the *Culicoides* vector is not practical in most enzootic areas.

"Heartwater." This disease is one of the several rickettsial diseases of domestic animals in Africa and of these probably the most important. Others are enzootic abortion of sheep, Q fever and benign bovine and ovine rickettsiosis involving, respectively, ***Rickettsia bovis*** and ***R. ovina***. "Heartwater" is caused by ***Rickettsia (Cowdria) ruminanticum*** and is transmitted by various species of ticks (***Amblyomma*** spp.). It attacks cattle, sheep, goats and wild ruminants. The disease varies considerably in intensity. Involvement of the nervous system is frequent. One of the characteristic symptoms consists of a high stepping gait with ataxia.

The distribution of "heartwater" is somewhat spotty. It is of some seasonal importance in sheep and goats in Tunisia. In the Sudan, it is found in cattle also but is confined in all domestic ruminants to certain areas. In the republics constituting former French West Africa, infection is of some importance in cattle but occurs only sporadically in sheep and goats. Infection is widespread in cattle and sheep in Ethiopia and in cattle in Uganda.

"Heartwater" constitutes more of a problem in South Africa than in other parts of the continent. The disease is extensively distributed in Northern Rhodesia and Swaziland in all domestic ruminants. In the former country, there were 86 outbreaks in 1959 as compared to 139 in 1958. The disease is widespread in Nyasaland. In Southern Rhodesia, Bechuanaland and the Union of South Africa occurrence is more restricted on a regional basis. In the Malagasy Republic, there is a low incidence in cattle but a higher incidence in goats. In sheep, infection is found mainly in imported animals.

Control measures consist of voluntary vaccination and therapy. In some countries attempts are made to control the tick vectors.

Bovine tuberculosis. Infection is not widely distributed in Africa but the disease represents a problem of importance in certain areas. In general, these are regions in which the dairy industry has been established with European breeds of dairy cattle. In most areas, native breeds are resistant to the disease although there are exceptions such as the Ankole long-horned cattle in Uganda. Some countries have dealt vigorously with the disease and the incidence has been materially reduced. One difficulty has concerned the interpretation of various types of tuberculin tests because of the relatively high percentage of non-specific reactions. Since this same difficulty is encountered with tuberculin tests in the human population in the tropics,[33] it is not surprising that cattle would be subjected to a variety of non-specific sensitizing substances.

Bovine tuberculosis has a spotty distribution in the Sudan with a higher incidence of positive reactors in Kordofan Province and in the southern part of the country. Infection is widespread in Egypt but the incidence has been reduced. As stated, the disease is frequent in Ankole cattle in Uganda where control is difficult because of the nomadic habits of the Ankole stock owners.

The disease was formerly a problem of considerable magnitude in the Southern Highlands of Tanganyika but marked progress has been made in control. Similarly, dairy cattle in Katanga Province of the Congo formerly showed a high percentage of reactors but the situation is now materially improved. However, bovine tuberculosis is still an important disease in Ruanda-Urundi.

In former French West Africa, highest tuberculosis rates are found in Upper Volta where, in 1958, 16 per cent of the cattle slaughtered in the abattoir at Bobo-Dioulasso had lesions. Infection is also considerable in the central part of the Republic of Mali. Porcine tuberculosis is rife in both of these areas.

There is considerable infection in cattle in the central area of the former French Cameroun with animals from the Maiganga area showing the highest incidence. The disease is also of importance in the British Cameroons.

In the former French Equatorial Africa, the highest infection rates are present in the Central African Republic. Red Zebu cattle are mostly involved.

Angola is another country in which bovine tuberculosis is an important problem. Rates are not excessively high but the disease is widespread. The disease is also well established in the Mozambique but during recent years progress has been made in control.

Reactors are now few in number in Northern Rhodesia where progress has been achieved in control. Southern Rhodesia is engaged in an extensive program with slaughter of reactors. These measures have been responsible for lowering the incidence of infection.

In the Malagasy Republic the disease is widespread and incidence of infection high except in the extreme south and the northeastern tip.

Indigenous cattle in the Union of South Africa are usually free of tuberculosis but imported animals and dairy herds are very susceptible. The disease is prevalent in such animals. Extensive tuberculin testing and slaughter of reactors have brought about a measurable reduction in the disease.

Sheep scab. Psoroptic mange of sheep caused by the mite, *Psoroptes ovis*, and commonly known as sheep scab, is a disease of considerable importance in the sheep-raising countries of Africa. While present in many such areas, it is of special concern in North and Northeast Africa—in Morocco, Algeria, Tunisia, Libya and in former British Somaliland. In North Africa, the disease is mostly of seasonal occurrence. Systematic dipping will control the disease. In some areas, animals are treated by means of spray pumps. Various miticides are employed; solutions of the gamma isomer of benzene hexachloride (BHC) are particularly effective.

Diseases of importance in Southwest, South Central and Southeast Asia

There are regional differences in the occurrence and the relative importance of the diseases which cause the greatest losses among domestic animals in Southwest, South Central and Southeast Asia. For the purposes of this report, these geographical areas have been treated as a unit for the reason that the diseases in question are not deterred in their spread by national boundaries, with the result that enzootic and epizootic areas tend to become confluent.

The diseases which are regarded as of greatest economic importance in this part of the tropics include African horse sickness, foot-and-mouth disease, rinderpest, hemorrhagic septicemia and swine fever (in Southeast Asia).

African horse sickness. This virus disease affecting horses, mules and donkeys has long been known in Africa and until recently has been mainly confined to that continent. In the summer of 1959, the disease made its appearance in the Baft region of southern Iran. It spread rapidly in Iran, probably through the movements of the nomadic tribes, and in September of that year appeared in Pakistan and a little later in Afghanistan. The disease was recognized in Iraq and India in April 1960; in the Syrian Region of the United Arab Republic and in Turkey in May 1960; in Cyprus in September and in Jordan and Lebanon in October 1960. At last report, infection was not recorded in Saudi Arabia in 1960, although the disease has been present in the past. Israel has not been invaded; the majority of the equine population has been vaccinated.

Mortality from African horse sickness in certain regions was very high, exceeding 90 per cent. Extent of losses is not entirely known, but it is estimated that 300,000 animals died of the disease.

The strain of virus recovered in a number of countries proved to be allied to South African Group VI, with some antigenic overlap with three other groups.

Vaccination was effective in containing the disease, once the diagnosis was established and the vaccine became available. Two kinds of vaccine were employed, including a formolised tissue vaccine with a saponin adjuvant and a polyvalent attentuated vaccine containing the South African virus strains. Severe post-vaccination reactions were experienced in some areas. In Cyprus, febrile reactions to vaccination were severe in horses, and 5 per cent of 12,000 donkeys in one district died following administration of the vaccine. Initially, the Onderstepoort Veterinary Laboratory in the Union of South Africa supplied the bulk of the vaccine, but facilities have now been established in several countries of the area to produce the polyvalent material locally. In addition to vaccination, sanitary measures, quarantine and, in a few instances, slaughter of infected animals were employed in controlling the epizootic.

Species of *Culicoides* are believed to serve as vectors for the virus of African horse sickness. Other biting insects may be involved. There is a strong suspicion that virus reservoirs exist.

A plan has been proposed for the control of horse sickness in Southwest Asia and India and for preventing the spread of infection to adjacent regions. This plan calls for routine insecticidal spraying of international airports and their environs during the insect season and the regular disinfection of international railway trains, aircraft, motor vehicles and ships at the port of entry in contact countries. Immediate vaccination of all horses, mules and donkeys within ten miles of international ports of entry in infected and in-contact countries is recommended, as well as the vaccination of all equines in buffer zones around infected areas.

Foot-and-mouth disease. Compared to other areas of the world, foot-and-mouth disease presents a special problem in tropical Asia. With the exception of a few countries or territories, the disease is enzootic throughout the continent.

Outbreaks occur most frequently in cattle and buffalo but are also observed in sheep and goats in countries where these animals are present in considerable numbers. Swine have been infected in many areas and wild pigs are said to be responsible for the spread of infection in Iraq. Foot-and-mouth disease produces more severe symptoms in cattle than in buffalo. However, the infection usually exhibits a mild course in native cattle, except when foot lesions become secondarily infected. The economic importance of the disease is associated with the loss of condition, sterility and reduction in milk yield. Imported dairy cattle are more susceptible than local stock. Outbreaks many times coincide with the period of the year when draft animals are required for cultivation; thus interference with farm operations presents a serious problem.

Virus types A, O, C and Asia I have been identified in the countries with which this report is concerned. Types of greatest prevalence vary from year to year in the same region.

Countries in tropical Asia which are thought to be free of foot-and-mouth disease are Sarawak, North Borneo, West New Guinea, Malaya, Singapore and Hong Kong.

In Southwest Asia, foot-and-mouth disease has been introduced into Cyprus in recent years and severe outbreaks have occurred. Infection is widespread in Turkey, though the number of cases recorded in recent years has been relatively few according to information furnished by veterinary authorities. There were 6,414 cases in Syria in 1959. In Lebanon, infection is widespread and seasonal. Outbreaks occur every year in Saudi Arabia. Type O virus was identified from Aden in 1959; information is lacking on the extent of the disease. In Israel, the disease is introduced frequently but is dealt with vigorously. The appearance of Asia I virus in 1958 has complicated control. The disease is seasonal in Jordan, where Asia I virus was reported in 1961. A report from Iran indicates that 349,217 cases were recorded from cattle, sheep and goats in 1959. Type A virus was identified for the first time in Iran in 1960. A total of 3,683 cases were reported in Iraq in 1959 and 6,861 in 1960. The disease is present in Afghanistan and types A, O, C and Asia I have been identified.

Infection is widespread in Pakistan and the disease represents a considerable economic burden. Types A, O, C and Asia I have been reported; type O is most common.

Except in the uninfected countries mentioned above, foot-and-mouth disease is widely disseminated throughout South Central and Southeast Asia. In India, it is generally distributed through the unrestricted movements of livestock and constitutes an economic problem of considerable magnitude. Foot-and-mouth disease is one of the major economic diseases in Burma; in 1959, 548 outbreaks were reported involving 31,842 cattle. Type O virus is mainly involved. The disease is enzootic in Ceylon. Outbreaks have occurred in Laos but the status of the disease is questionable at this writing. Infection has been reduced in Vietnam but still exists. The disease is prevalent in Thailand except in the southern provinces; types A, O and Asia I have been identified. The infection is usually mild and the chief economic concern is interference with cultivation, and the export of cattle, meat and meat products to Hong Kong. In 1958, a laboratory was established for research, typing and vaccine production.

Foot-and-mouth disease is not generally distributed in Indonesia but is regional in its occurrence. Outbreaks have occured in the Philippines from imported stock but the last case in cattle occurred in 1957. Foot-and-mouth disease was not listed as being present in China (Taiwan) in 1959.

Control of foot-and-mouth disease in tropical Asia presents many problems. The changing distribution of virus strains introduces difficulties in vaccination programs. Various vaccines have been employed but they are expensive and are not economically feasible for widespread employment, although used on valuable animals. Only vaccines against types O, A, and C have been available in the past. The Nong Serai Laboratory in Thailand is endeavoring to produce an effective vaccine against Asia I. A cheap, polyvalent vaccine would simplify control. Quarantine measures are partially effective but cannot be depended upon to obviate entirely the dissemination of the disease.

Rinderpest. The problem of rinderpest, formerly of great economic importance in tropical Asia, may be said to have been resolved in great part by extensive control and eradication programs carried on during recent years by the veterinary authorities. However, as long as foci exist, there will always be a threat of the extension of the disease.

Southwest Asia is generally free of infection, although the disease is reported to be sporadic in Saudi Arabia. Afghanistan, which for a time was free of rinderpest, experienced an outbreak in 1959. As a result of this circumstance, Iran, which had had no cases since 1950, was forced to institute an extensive vaccination program along her border with the former country. More than 400,000 cattle were vaccinated within a period of two months.

Rinderpest is regarded as the most dangerous disease of cattle in Pakistan. The number of deaths approximate those of all other infectious diseases. While the infection is enzootic in character, epizootics have swept the country at intervals of five to ten years, the last occurring in 1957. Plans have been projected for an eradication campaign through the mass vaccination of all susceptible animals.

In the past, India has been troubled greatly by outbreaks of rinderpest, which was widely distributed throughout the country. Since control measures were adopted by the several States, the disease has been on the decline. Some parts of the country are now free of infection and the disease is no longer present in the southern peninsula. The extensive vaccination program is being vigorously pursued and there is reason to believe that the disease will be under control by 1962.

Southeast Asia has been free of rinderpest for some time, with the exception of certain foci in Cambodia and Vietnam. However, methodical vaccination programs have been conducted in these areas for several years. In spite of this fact, an explosive outbreak occurred in Cambodia in July 1961 with a threat to neighboring countries.

Various types of rinderpest vaccine have been employed in different countries in tropical Asia, including formolised tissue vaccine with a saponin adjuvant, lyophilised goat tissue vaccine, lapinised-avianised vaccine and lapinised material alone. New methods of preparing the lapinised vaccine have improved its keeping qualities so that it can be transported to distant regions without loss of potency.

Hemorrhagic septicemia. This is an acute bacterial disease of special significance in cattle and buffalo but affecting swine also. Sheep and goats are resistant for the most part but may serve as reservoirs of infection. The causative agent is *Pasteurella multocida* and in most Asian countries Roberts Type I strain is involved. Transmission is by contact. It has been found experimentally in India that apparently healthy animals harbor Type I *P. multocida* in the nasopharynx and develop the disease when exposed to artificial rain.

Hemorrhagic septicemia is apparently of minor importance in many countries of Southwest Asia. However, infection is said to be widespread in Turkey. In the Syrian Region, United Arab Republic, the disease has been considerably curtailed. Outbreaks occur from time to time in Jordan. The disease is one of the most important in cattle and buffalo in Iraq. Good control has been achieved in Iran, where approximately 600,000 animals are vaccinated yearly. The disease is serious only in limited humid regions. Iran listed 1,073 cases in 1959. Distribution of the disease is regional in Afghanistan and is of seasonal occurrence in Pakistan.

In India, hemorrhagic septicemia ranks next in importance to rinderpest as a disease of large ruminants. It is chiefly prevalent in humid, tropical areas and usually follows the monsoon. Some 30,000 buffalo die each year. In Ceylon, the incidence has declined in recent years due to prompt action in the suppression of outbreaks. The disease is responsible for severe losses in Burma and is widespread throughout the country. More than 500,000 head of cattle were vaccinated in 1958-1959. Infection is frequent in Laos, Vietnam and Cambodia. A similar situation exists in Thailand with some 10,000 cases per annum in cattle and buffalo.

Hemorrhagic septicemia is considered the most important cattle disease in Malaya, where it is mainly confined to the rice growing areas. Infection is widespread in Sarawak. In Indonesia, the disease is regional in its distribution but of considerable concern in some years. Infection in North Borneo is sporadic. Although vaccination has reduced prevalence in the Philippines, the disease is still a problem; 3,244 cases were reported in the fiscal year 1958-1959. Sporadic outbreaks occur in Hong Kong. Infection is common in swine in China (Taiwan), where 26,485 cases were recorded in 1959. Singapore and West New Guinea are free areas.

Vaccination constitutes the chief weapon in the control of hemorrhagic septicemia. Broth vaccine in former use provided limited immunity and was suitable only in controlling outbreaks. Improved vaccines include Delpy saponised material, alum-precipitated vaccine and Bain's oil adjuvant vaccine. The first is reported to provide immunity for more than a year, the second for about six to eight months and the oil adjuvant vaccine for one to two years. Side reactions to the saponised vaccine have been severe on some occasions but the others are well tolerated.

Swine fever (in Southeast Asia). Swine fever or hog cholera is a virus disease of considerable economic importance in certain countries of Southeast Asia. Mortality is high and in surviving animals, recovery is a slow process.

The disease is widely prevalent in Burma, Laos, Cambodia and Vietnam. In the latter country, it is the most important disease of swine. Infection in Thailand and Malaya has been much reduced during recent years. There is a low incidence in Singapore. The disease has a seasonal occurrence in West New Guinea. It is important in Hong Kong and of widespread occurrence in the Philippines, where 13,299 cases were reported in the fiscal year 1958-1959. The disease is present in Taiwan and 1,458 cases were recorded in 1959. More recent information would indicate that control has since been achieved. Swine fever is said not to be present in Indonesia and North Borneo.

A few countries employ the slaughter method in curbing outbreaks of swine fever but most depend on vaccination. A number of vaccines have been utilized, including crystal violet vaccine and lyophilised lapinised vaccine. Both vaccines produce good immunity when used under proper conditions. However, at times the lapinised vaccine causes severe reactions in young pigs.

Personnel of Veterinary Services of National Governments in Survey Area

The annual reports which were received from many countries failed to furnish data concerning professional and other employees and access has not been had to reports from other countries, if such reports exist.

It is difficult to formulate any terminology for lay assistants and technicians which would be universally applicable. In general, the term "lay assistants" has been used to indicate non-professional employees lacking formal training or training which cannot be construed as equivalent to the professional level provided by recognized schools of veterinary medicine. In Africa and Asia, especially, it is the practice in many countries to provide some schooling of a sub-professional nature for lay personnel. The extent of such training varies considerably in different countries. As regards the term "technicians," it was the intention to reserve this designation for subprofessional laboratory personnel. In interpreting veterinary reports, it is difficult at times to appraise accurately the varying designations which would apply under the above-mentioned headings. While consistency has been sought, errors of interpretation have undoubtedly been made. For this reason, the various categories in Table 41 for other than professional personnel cannot be regarded as necessarily representing an accurate summation of the available data.

The coverage in Table 41 in terms of total livestock population is exceedingly meager for three of the areas but is of a significant quality for Africa, for which the data represent 89.2 per cent of such population, and

Table 41. Veterinary services of national governments in survey area—Personnel[1]

AREA	NUMBER OF COUNTRIES REPRESENTED	PERSONNEL				TOTAL PERSONNEL	PER CENT COVERAGE[2]
		PROFESSIONAL	LAY ASSISTANTS	TECHNICIANS	OTHER		
Caribbean, Central and South America	26	736	164	341	439	1,680	32.5
Africa	44[3]	1,099	5,325	531	4,699	11,654	89.2
Southwest Asia	8	1,010	169	1,072	493	2,744	79.6
South Central and Southeast Asia	14[4]	2,477	1,939	525	1,560	6,501	11.0
Oceania	3	14	14	4	45	77	31.6

[1] Data for various years; mainly 1958 and 1959. Coverage on professional personnel considered good; coverage on other categories of personnel inadequate in many instances.
[2] Per cent of total livestock population of area represented by that of countries included in data.
[3] Components of former French West Africa, French Equatorial Africa, and Nigeria and provinces of former Belgian Congo treated separately.
[4] Includes India in part.

Southwest Asia with a coverage of 79.6 per cent. However, the over-all coverage is so deficient that no valid conclusions can be drawn.

A perusal of many of the reports discloses a tendency to utilize lay personnel in the control of animal diseases to a greater extent than is possible in human health activities. The data in Table 41 would tend to support such a conclusion. In the event that such a practice does not significantly lower the operating efficiency of the service, it is advantageous in the tropics which have already been shown to be materially deficient in numbers of graduate veterinarians.

Budgetary Expenditures of Veterinary Services of National Governments in Survey Area

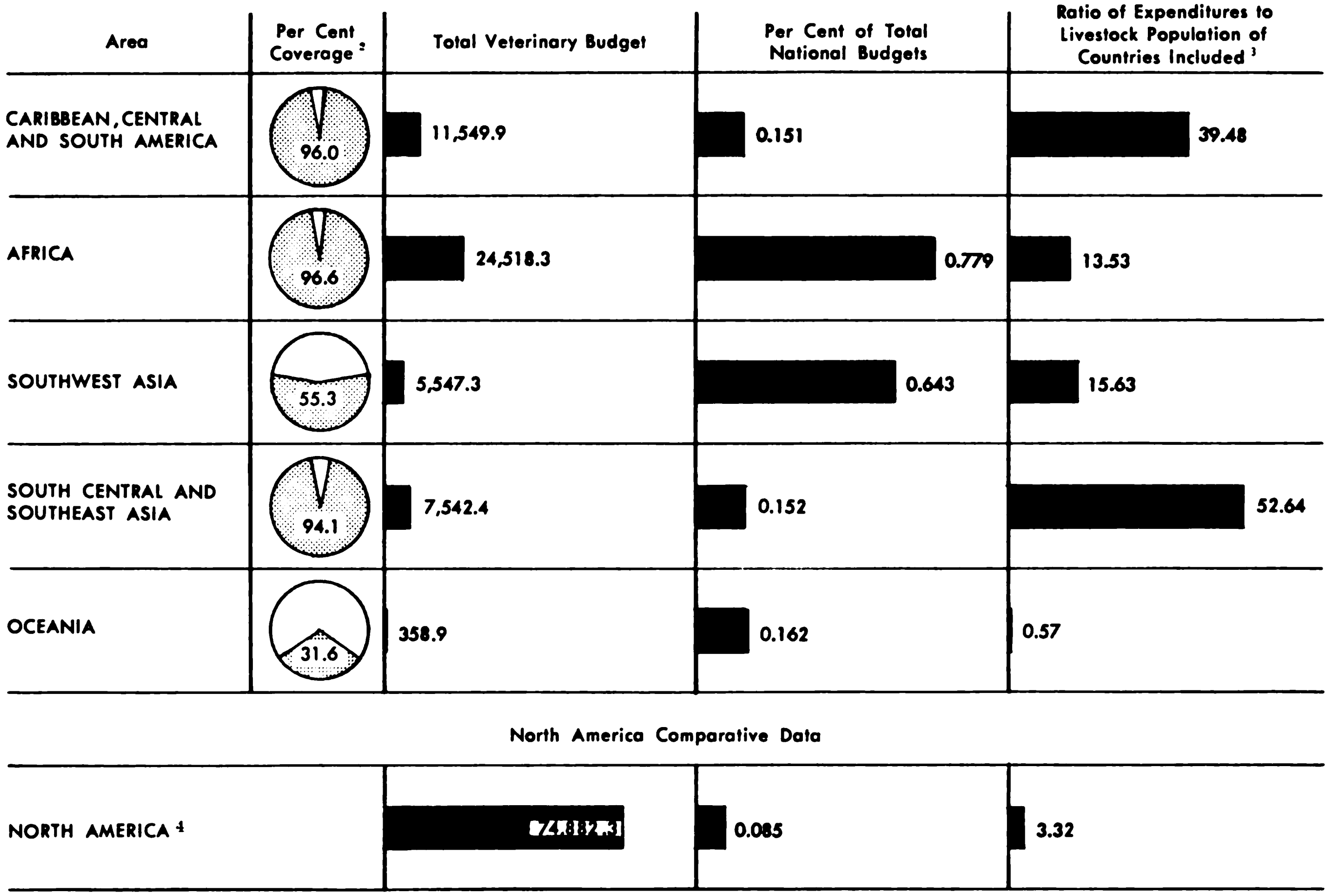
Data on this subject were secured from three main sources, viz., Annual reports of veterinary services, replies to questionnaires and annual country budgets available in the library of the International Monetary Fund in Washington. Data from the first two sources can be considered accurate; those extracted from national budgets are in part specific and in other instances represent conservative estimates. Many of the budgets do not specifically present figures for veterinary services for the reason that in many cases these data are included in total budgets for agriculture. It has been necessary to analyze such portions of the budget to determine as accurately as possible expenditures for veterinary activities. This can be accomplished with considerable facility in certain instances but with increasing difficulty in other cases. However, the estimates have been made on a conservative basis. Capital expenditures are not included.

The degree of coverage for budgetary information is much greater than in the case of personnel of veterinary services. The two areas in which the coverage is inadequate are Southwest Asia and Oceania. Most of the countries in the former area publish budgets in the native language. In order to secure data from these budgets it would have been necessary to have translators at hand at the time of examination, a thing which was not found feasible to arrange.

Figure 21 offers information on budgetary expenditures for veterinary services of national governments in the five different regions in the current survey. As indicated above, the degree of coverage in terms of the livestock population represented was of a respectable order in three regions but deficient in two regions, i.e., Southwest Asia and Oceania. In the latter region, data were secured from Fiji, New Caledonia, and Papua and New Guinea, the three largest island territories of the area. The livestock population of Oceania is distributed throughout many small islands and island chains which do not have any veterinary service. While the coverage in Oceania is limited in terms of total livestock population, it represents the main areas with veterinary services.

It will be noted that the sum of the budgets for veterinary services in terms of per cent of the total national budgets in the different areas varies from a high of 0.779 in Africa to a low of 0.151 in the Caribbean, Central and South America. South Central and Southeast Asia approaches the low point with a percentage of 0.152. The lowest budget figure was included in the former area with a percentage of 0.010, while the highest percentage figure was in Africa with 10.20. The last column in Figure 21 indicates the ratio of expenditures to livestock population of the area in terms of the number of animals per $1.00 of expenditure. The ratio differs somewhat from the relative rank of the different regions in relation to the per cent of the na-

Figure 21. Veterinary Services of National Governments in Survey Area— Per Annum Budgetary Expenditures in Thousands U. S. Dollars [1]



[1] Data for various years; mainly 1958 or 1959.
[2] Per cent of total livestock population.
[3] Number of animals per $1.00 of expenditure.
[4] For the United States, budget data for fiscal year 1961; livestock population as of 1 January 1960. For Canada, budget data for fiscal year 1961; livestock population as of 1 June 1960.

tional budgets devoted to veterinary services. The corresponding rankings in these respective categories are given below.

Veterinary Services

Rank in terms of per cent of budgets to national budgets (Highest per cent)	*Rank in terms of number of animals to $1.00 of expenditure (Lowest number of animals)*
Africa	Oceania
Southwest Asia	Africa
Oceania	Southwest Asia
South Central and Southeast Asia	Caribbean, Central and South America
Caribbean, Central and South America	South Central and Southeast Asia

The figure includes data for North America in which the total veterinary budgets constituted 0.085 per cent of the total national budgets, a figure lower than that encountered in any of the tropical regions. However, in terms of the ratio of expenditures to livestock population, North America was apparently outranked by only one of the tropical areas, i.e., Oceania. However, this conclusion may not be valid because of the peculiar distribution of the livestock population in Oceania.

As might be expected, expenditures for veterinary services are far below those for health services. The following are comparative figures giving the per cent of government expenditures for health and veterinary services, respectively, of total annual expenditures for the five survey areas: Caribbean, Central and South America (5.6 and 0.151), Africa (5.7 and 0.779), Southwest Asia (4.1 and 0.643), South Central and Southeast Asia (5.8 and 0.152) and Oceania (13.2 and 0.162).

The closest relationship is found in Southwest Asia in which the budget for health services was 6.4 times greater than the budget for veterinary services and in Africa in which the health budget was 7.3 times greater than the latter. In other areas, the gap was considerably wider. There is no corollary to be derived from this comparison. There are few who would question the need for additional funds for health services in the tropics; likewise, it is apparent that the support for veterinary services is hardly adequate in the light of the considerable losses from animal diseases. The above comparison is only partially valid because the extent of coverage for health budgets is far more complete than that for veterinary budgets. In certain regions, therefore, the difference may not be as great as indicated.

SUMMARY AND CONCLUSIONS

Effort has been made to evaluate the relation of diseases of domestic animals to health problems in the tropics. Many of these diseases are transmissible to man. In addition, disease losses in meat food animals further deprive the population of sources of dietary protein and contribute to undernourishment and the prevalence of nutritional disorders.

Information presented in this section has been derived from a wide variety of sources. Effort was made initially to secure annual reports of veterinary services from 130 countries for the years 1954-1958. Seventy, or 53.8 per cent, of the countries furnished some or all of the reports requested. In order to obtain more complete coverage for the required data, questionnaires were subsequently dispatched to 105 countries. Of these, 56, or 53.3 per cent, responded. Various reports of the Food and Agriculture Organization of the United Nations have been helpful.

In general, the reporting of animal diseases is far less efficient than that of human diseases, which admittedly are inadequately reported. For this and other reasons, the original plan for the embracement of this section had to be modified.

Data are presented concerning the ratio of fully qualified veterinarians to the livestock population of the various tropical regions. In the Caribbean, Central and South America, there was one veterinarian for 118,272 domestic animals. The ratios for the other regions were 1:160,315 for Africa, 1:106,035 for Southwest Asia and 1:51,256 for South Central and Southeast Asia. The comparable figure for the United States was 1:11,419.

Inquiry indicated that there are in the tropics a total of 59 schools of veterinary medicine, of which 26 are in the Caribbean, Central and South America, 4 in Africa, 4 in Southwest Asia and 25 in South Central and Southeast Asia. Such facilities are pitifully inadequate in Africa and Southwest Asia.

A total of 19 countries furnished estimates on the annual economic losses from animal diseases. The data are presented in Table 30. In addition to this information, the report has summarized other available data concerning such losses. These losses, both from apparent and hidden causes, are undoubtedly of great magnitude and exceed similar losses in other climatic zones.

A selection has been made of the animal diseases thought to be of greatest general importance in the tropics as well as those of greatest regional concern. An analysis has been attempted concerning the distribution and relative importance of these diseases. This analysis includes four of the zoonoses, viz., Rabies, anthrax, brucellosis and hydatid disease. Of the important diseases of domestic animals in the tropics, there is only one (sweating sickness of cattle) for which methods of control and prevention are not known.

Data were collected on the professional and other personnel employed by national veterinary services in the tropics. Useable information could be obtained for 95 of 130 countries represented in this section. The compilations are presented in Table 41. The staffing in the 95 countries included 5,336 veterinarians and other professional individuals and 17,320 other personnel. In many countries lay personnel are employed to a considerable extent in animal disease control. In certain countries, effort is made to provide some formal training for such individuals; this is especially true in Africa and Asia.

Per annum budgetary expenditures for national veterinary services were compiled from data available from 90 countries and the collated material is presented in Figure 21. The coverage in terms of per cent of the total livestock population of the areas varied from 96.6 per cent in Africa to 31.6 per cent in Oceania. For the Caribbean, Central and South America, the collected veterinary budgets constituted 0.151 per cent of the total national budgets of the countries represented. The like figure in other regions was as follows: Africa 0.779, Southwest Asia 0.643, South Central and Southeast Asia 0.152 and Oceania 0.162. The ratio of expenditures for veterinary services to the livestock population of the various regions in terms of the number of domestic animals per U.S. $1.00 of expenditure was 39.48 for the Caribbean, Central and South America, 13.53 for Africa, 15.63 for Southwest Asia, 52.64 for South Central and

Southeast Asia and 0.57 for Oceania. The comparable figure for North America was 3.32.

As might be expected, the per cent of the total budget devoted to health services was considerably in excess of that appropriated for veterinary services. However, the comparisons for the various tropical regions are not entirely valid because of the disparate nature of the coverage.

It is the impression that, in spite of the relatively modest national budgets for veterinary services in relation to the needs in many parts of the tropics, gratifying advances have been made during recent years in curbing animal diseases. It should be noted, however, that for Africa the survey covered a period in which the metropolitan powers contributed materially in funds and personnel to veterinary research and the control of disease. It is probable that the newly independent countries of Africa will find it difficult to match these services, especially because of the lack of fully qualified graduate veterinarians among their citizenry. As pointed out, veterinary educational facilities are sadly lacking in Africa and Southwest Asia, since there are only four veterinary schools in each of these regions. Undoubtedly some of the new republics in Africa will require outside assistance for a time in order to hold the line against livestock diseases and to continue much needed research in this field.

Acknowledgments

Information in this section has been gathered from a wide variety of sources and it is not feasible to mention by name all those individuals who have contributed. Appreciation is especially accorded the veterinary authorities of various countries who responded in such a gratifying manner to the several requests for data concerning their activities. Many excellent interim and annual reports were received and were of great assistance in the preparation of this section. Likewise, the completed questionnaire returned by various countries supplied specific information which could not have been obtained otherwise.

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Part III

Chapter 9

Resources for Health and Medical Care

General Medical Resources in the Tropics

Curt R. Schneider

Data from as many sources as possible were collected pertaining to the following headings under Category II.A.2. of the Plan for a Survey of Needs in the Field of Tropical Medicine (Appendix 1): a. Medical and health personnel; b. Government health services—budgetary expenditures; c. Hospitals and clinics (inpatient); d. Clinics and dispensaries (outpatient); e. Medical mission installations by United States and foreign mission boards; f. Industrial medical installations in the tropics (American firms); and g. Prevention and control—number of vaccinations and inoculations.

The sections on the medical mission installations and on industrial medical facilities were prepared as separate units and the following remarks regarding the collection of data do not apply to them.

Data were amassed from 169 tropical countries or health jurisdictions, including 58 in Africa, 46 in the Caribbean, Central and South America, 18 in Southwest Asia, 24 in South Central and Southeast Asia and 23 in Oceania. A list of these countries is included in Appendix 3.

The quantity and quality of health information offered annually by official sources varies within a wide range. Many of the newer countries are not yet properly organized to provide a regular health statistics service. Also, whereas there has been general understanding of the types of information needed, there is to be found little agreement regarding priority. Thus the making of the figures presented here from the mass of heterogeneous and often unreliable available data has not been without its hazards. It is felt that a few qualifying statements are germane. Thus when data for identical categories were to be obtained from two or more sources, there was never absolute and seldom relative agreement. Often a blind selection from two unqualified sources was required; in such a case, minimal figures were preferred. The result has been that the summarized data presented here must be accepted to represent minimal values in all categories.

Data were wholly lacking in areas of major population in only a few instances. For the most part, some sort of information was forthcoming from each country, even though often only for a single year, or even for a year outside the time scope of the survey (1954 to 1958, inclusive).

A note in the United Nations Statistical Yearbook for 1957 has this qualification concerning the list of medical personnel: "Due to the absence of adequate definitions of some of the most important terms used in the original sources, great caution should be exercised in making comparisons between countries." With few exceptions, this restriction will apply to all of the categories summarized below. For this reason, no hesitation has been felt necessary in massing and rounding off figures on the basis of the major geographical areas of the survey. Significant differences will persist.

Medical and health personnel

The purpose of this portion of the survey was to collect background information in a uniform fashion relating to medical and paramedical personnel employed in the areas included in the survey. Figures were taken largely from Annual Epidemiological and Vital Statistics 1955 and 1956 (World Health Organization). Lacunae were filled in by recourse to the various other source materials listed at the beginning of the section on Government health services—budgetary expenditures. It is felt that the coverage of this item is fairly complete.

Figure 22 shows the distribution of physicians in the major geographical areas covered by the survey. Of the total of 227,800 physicians, 96,100, or 42.2 per cent, are in the Caribbean, Central and South America, 24,500, or 10.8 per cent, are in Africa, 17,900, or 7.8 per cent,

Figure 22. Number of Physicians in Area Covered by the Survey and Ratio of Physicians to Population

Area	Per Cent Coverage [1]	Estimated Number of Physicians	Number of Persons Per Physician [2]	Region Variation: High Figure	Region Variation: Low Figure
CARIBBEAN, CENTRAL AND SOUTH AMERICA	94.5	96,100	1,900	9,000 Dominican Republic	284 Canal Zone
AFRICA	99.4	24,500	9,000	90,000 Ethiopia	2,000 Union of South Africa
SOUTHWEST ASIA	99.9	17,900	5,000	750,000 Yemen	440 Israel
SOUTH CENTRAL AND SOUTHEAST ASIA	97.2	88,600	7,000	101,000 Cambodia	2,300 Taiwan
OCEANIA	100.0	700	5,100	27,000 New Guinea	613 Nauru
TOTAL		227,800			

[1] In terms of population.
[2] Average number of persons per physician in the United States: 756; in West Germany: 530; in Italy: 800; in Switzerland: 700.

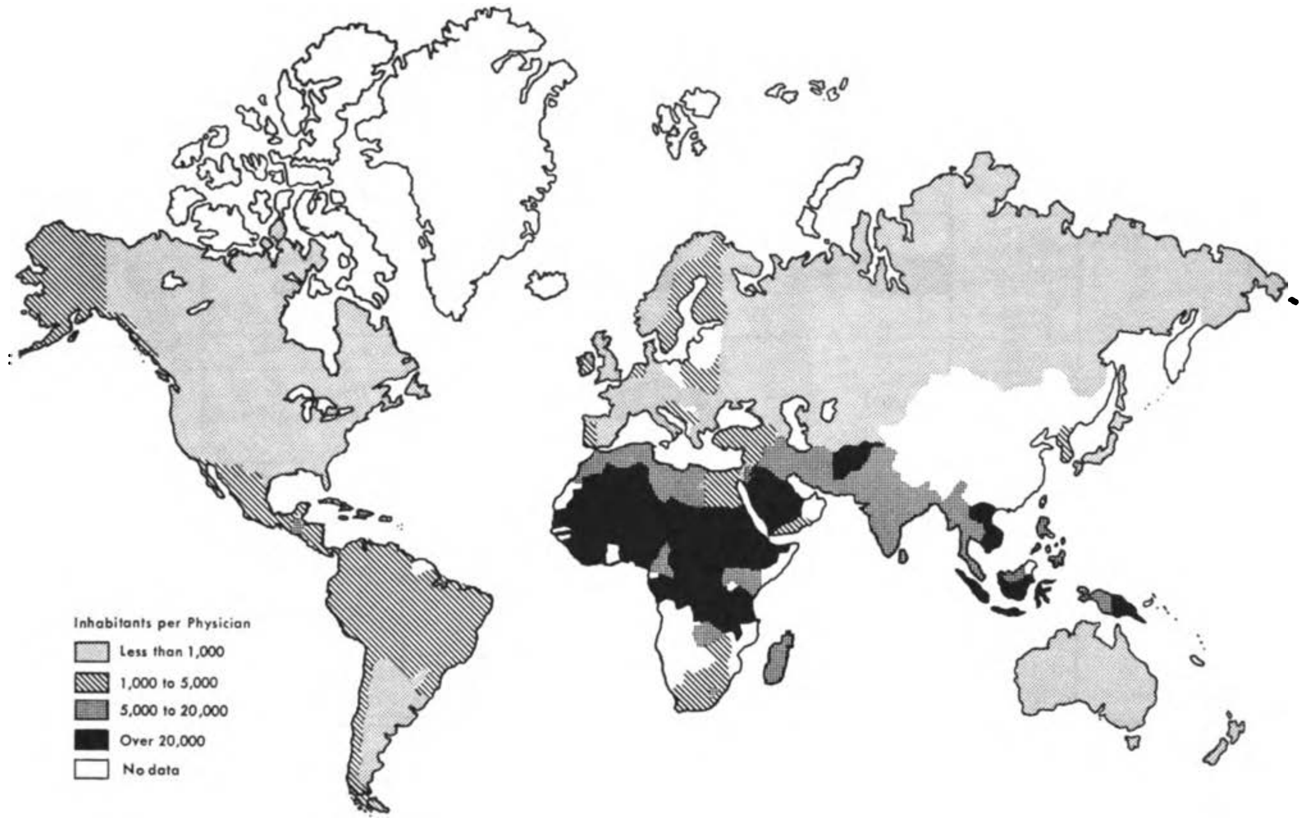
are in Southwest Asia, 88,600, or 38.9 per cent, are in South Central and Southeast Asia, and about 700, or 0.3 per cent, are in Oceania.

The relative lack of qualified medical personnel in the economically less developed countries of the tropics is presented graphically in Figure 23, which shows geographically the ratio of population to physicians in the survey areas. It must of course be recognized that the true distribution of medical personnel is not geographically homogeneous, as the map suggests, but rather is localized principally in the larger urban areas.

Figure 24 compares the proportional distribution of physicians in the geographical areas of the survey with the proportional distribution of total population in the same areas. It will be seen that Africa has 10.8 per cent of the physicians compared with almost 20 per cent of the population. The region of the Caribbean, Central and South America is more favored, with 42.2 per cent of the physicians and but 15.8 per cent of the population. The relative proportions are about equal in Southwest Asia (7.8 per cent of the physicians and 7.1 per cent of the population) and in Oceania (0.3 per cent of the physicians and 0.3 per cent of the population). The region of South Central and Southeast Asia reveals the greatest disparity; although 38.9 per cent of the physicians are included here, 57.4 per cent of the population is found here.

Figure 25 presents data on the distribution of qualified nurses in the survey areas. Of the total of 160,200, there were 48,000 in the area of the Caribbean, Central and South America, representing 30 per cent, 47,000 in Africa, or 29.3 per cent, 6,900 in Southwest Asia, or 4.3 per cent, 56,100 in South Central and Southeast Asia, or 35 per cent, and 2,200 in Oceania, or 1.4 per cent. Thus there is approximately even distribution of numbers of qualified nurses between the Caribbean, Central and South America, Africa, and South Central and Southeast Asia. The latter area suffers from the greatest scarcity of nurses. In the area of Southwest Asia there is but one nurse for every 12,100 persons and in South Central and Southeast Asia there is one nurse for every 11,700 persons. Africa has one nurse for every 4,900 persons, a figure which is comparable to that of the Caribbean, Central and South America with one nurse for every 3,800 persons. The most favored of the survey areas in this regard is Oceania, with a nurse for every 1,700 persons. However, all of these figures may be compared with the data

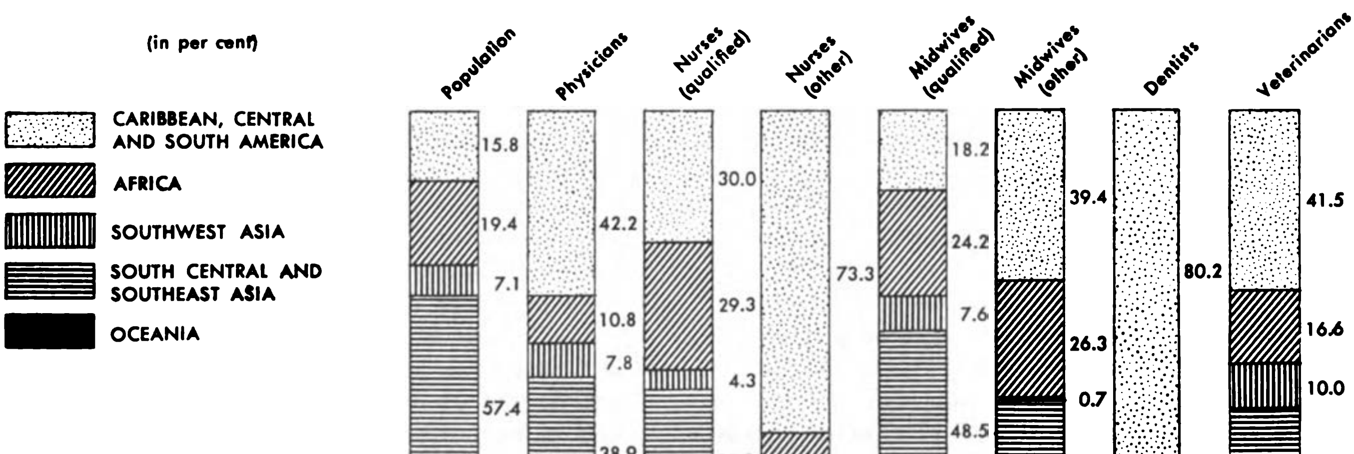
Figure 23. Ratio of Population to Physicians



Source: Statistical Office of the United Nations, December 1958—Public Health Service Records—WHO First Report on the World Health Situation 1958.

Map reproduced by permission of the Committee on Government Operations, United States Senate, and its Subcommittee on Reorganization and International Organizations.

Figure 24. Comparison of the Proportional Distribution of Population in the Geographic Areas of the Survey with the Proportional Distribution of Medical and Paramedical Personnel



[1] Based largely on figures for 1956.
[2] No significant numbers of veterinarians in Oceania. Omission from the calculation probably contributes no important error to the other figures.

Figure 25. Number of Qualified Nurses in Areas Covered in the Survey and Ratio of Nurses to Population

Area	Per Cent Coverage [1]	Estimated Number of Nurses	Number of Persons Per Nurse [2]	Regional Variations: High Figure	Regional Variations: Low Figure
CARIBBEAN, CENTRAL AND SOUTH AMERICA	99.9	48,000	3,800	30,760 Colombia	234 Canal Zone
AFRICA	95.8	47,000	4,900	43,384 Ethiopia 52,000 Spanish West Africa	293 St. Helena
SOUTHWEST ASIA	97.8	6,900	12,100	Trucial Oman and Yemen [3]	2,593 Aden Colony
SOUTH CENTRAL AND SOUTHEAST ASIA	98.6	56,100	11,700	117,770 Pakistan	1,380 Singapore
OCEANIA	100.0	2,200	1,700	14,333 Gilbert and Ellice Islands	136 Pitcairn
TOTAL		160,200			

[1] In terms of population.
[2] Comparative data for the United States: average number of persons per employed registered nurse (1958): 353.
[3] No nurses reported in Trucial Oman or Yemen.

for the United States where, in 1958, the average number of persons per employed registered nurse was 353.

The distribution of other paramedical personnel, including nurses other than qualified, qualified midwives and midwives other than qualified, dentists, pharmacists and veterinarians, in the areas of the survey is presented in Figure 26. The number of nurses other than qualified was approximately 97,300. Of this number, 71,300, or 73.3 per cent, were in the Caribbean, Central and South America (one for every 3,000 persons); 20,800, or 21.4 per cent, were in Africa (one for every 11,000 persons); 1,000, or 1 per cent, were in Southwest Asia (one for every 87,000 persons); 2,800, or 2.9 per cent, were in South Central and Southeast Asia (one for every 245,000 persons); and 1,400, or 1.4 per cent, were in Oceania (one for every 3,000 persons).

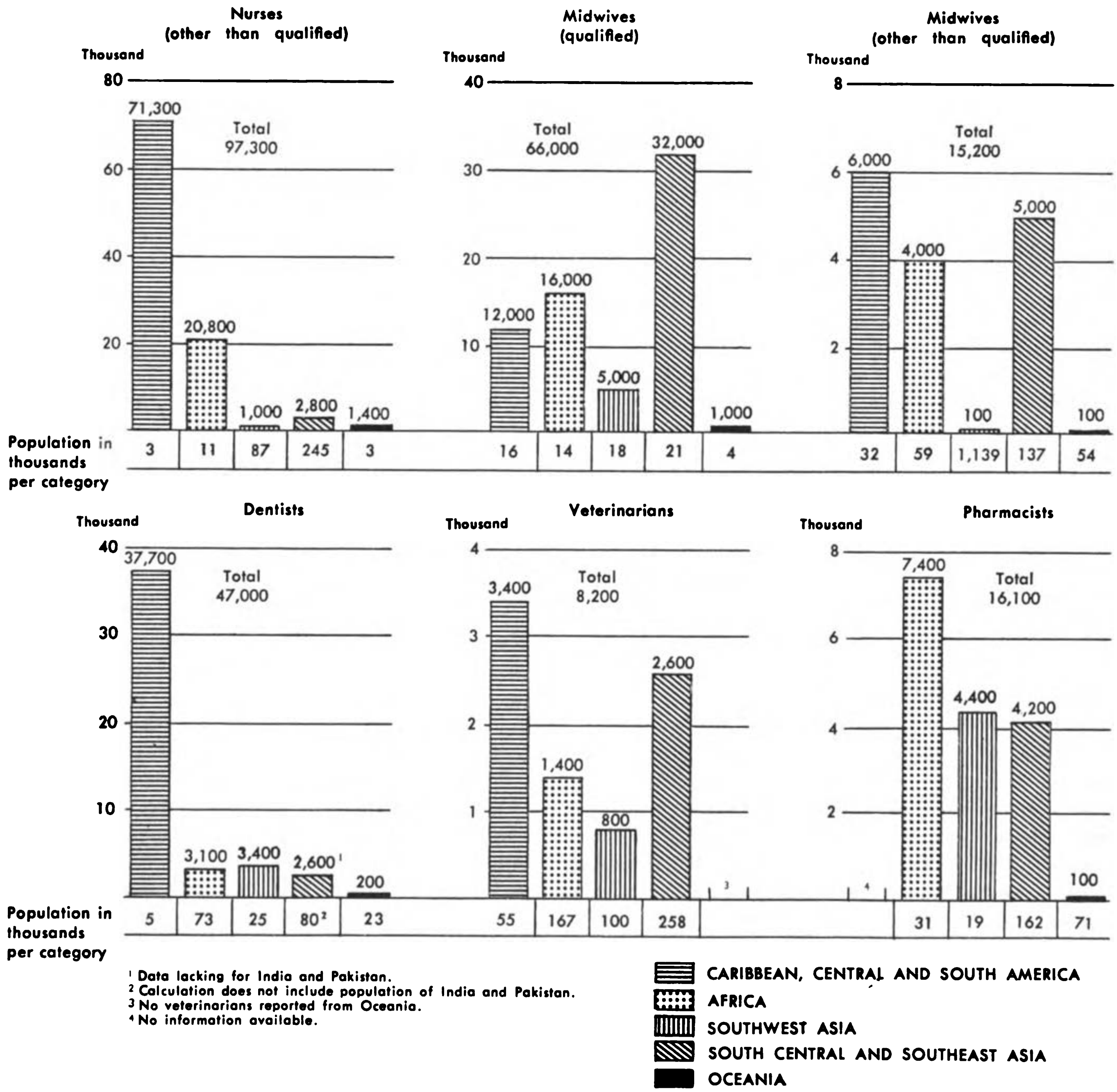
Of the total of 66,000 qualified midwives, 12,000, or 18.2 per cent, were in the Caribbean, Central and South America (one for every 16,000 persons); 16,000, or 24.2 per cent, were in Africa (one midwife for every 14,000 persons); 5,000, or 7.6 per cent, were in Southwest Asia (one for every 18,000 persons); 32,000, or 48.5 per cent, were in South Central and Southeast Asia (one for every 21,000 persons); and 1,000, or 1.5 per cent, were in Oceania (one for every 4,000 persons).

There were 15,200 midwives other than qualified. Of this number, 6,000, or 39.4 per cent, were in the Caribbean, Central and South America (one for every 32,000 persons); 4,000, or 26.3 per cent, were in Africa (one for every 59,000 persons); 100, or 0.7 per cent, were in Southwest Asia (one for every 1,139,000 persons); 5,000, or 32.9 per cent, were in South Central and Southeast Asia (one for every 137,000 persons); and 100, or 0.7 per cent, were in Oceania (one for every 54,000 persons).

Of the 47,000 dentists, there were 37,700, or 80.2 per cent, in the Caribbean, Central and South America; 3,100, or 6.6 per cent in Africa; 3,400, or 7.2 per cent, in Southwest Asia; 2,600, or 5.5 per cent, in South Central and Southeast Asia (omitting India and Pakistan because of lack of data); and 200, or 0.4 per cent, in Oceania. Thus, there were 5,000 persons for every dentist in the Caribbean, Central and South America; 73,000 persons per dentist in Africa; 25,000 persons per dentist in Southwest Asia; 80,000 persons per dentist in South Central and Southeast Asia (omitting India and Pakistan); and 23,000 persons per dentist in Oceania.

Of the 16,100 pharmacists enumerated, 7,400, or one

Figure 26. Approximate Number of Paramedical Personnel in the Survey Area and Ratio to Population



for every 31,000 persons, were in Africa; 4,400, or one for every 19,000 persons, were in Southwest Asia; 4,200, or one for every 162,000 persons, were in South Central and Southeast Asia; and 100, or one for every 71,000 persons, were in Oceania. No information was available on the number of pharmacists in the Caribbean, Central and South America.

There were 8,200 veterinarians in the geographic areas of the survey. Of these 3,400, or 41.5 per cent, were in the Caribbean, Central and South America; 1,400, or 16.6 per cent, were in Africa; 800, or 10 per cent were in Southwest Asia; and 2,600, or 31.8 per cent, were in South Central and Southeast Asia. No veterinarians were officially reported from Oceania; it is unlikely that there are more than a half dozen practicing there.

All of the figures reported here must be considered as minimal. Most of them were drawn from official reports of the World Health Organization and of the countries involved for the years 1955 and 1956, with a smaller admixture of data for 1957 and 1958. It is clear that the data would have to be augmented to bring them up to date. However, it is felt that the figures for the proportional distribution of personnel, as presented in Figure 24, remain valid over the years. Here it is seen that Africa, with almost 20 per cent of the population of the geographic areas covered in the survey, has only 10.8 per cent of the physicians and only 6.6 per cent of the dentists. Moreover, of the more than 3,000 dentists enumerated in Africa, considerably more than a third were practicing in the urban areas of the Union of South Africa. In South Central and Southeast Asia, with 57.4 per cent of the population, the disproportion in distribution of medical and paramedical personnel is equally marked. Only 38.9 per cent of the physicians, 35 per cent of the qualified nurses and 5.5 per cent of the dentists were found here. In proportion, the region of the Caribbean, Central and South America fared considerably better. With only 15.8 per cent of the population, this area enjoys the services of 42.2 per cent of the physicians, 30 per cent of the qualified nurses and 80.2 per cent of the dentists.

Government health services—budgetary expenditures

This portion of the survey was concerned with data relating to total annual government expenditures for health in the survey areas, estimated operating expenditure per inhabitant, per cent of the total annual budget represented by the total annual operating expenditures for health, and total capital expenditures for health, for the period 1954-1957 inclusive. Sources consulted have included the official annual reports of health services, country annual reports, statistical yearbooks, annual budget reports, comptrollers' reports and related documents of an official nature. Most of the preliminary work was done in the Documentation Section of the National Library of Medicine. Additional material was consulted in libraries of the Department of Health, Education, and Welfare, the Army Medical Information and Intelligence Agency, the Army Map Service, the Department of Medical Geography of the American Geographical Society, the Pan American Health Organization, the World Bank and International Monetary Fund, the Trusteeship section of the United Nations, and the World Health Organization (Geneva). In addition, letters requesting transmittal of annual health reports were sent to 150 countries. Replies were received from 83, or 55 per cent, and reports were forwarded from 68, or 45 per cent. Of the total of 150 requests, 53 were sent to countries of the British Commonwealth. The response to these was relatively more complete since 39 replies were received, or 74 per cent, and 37 countries, or 70 per cent, transmitted reports.

In summarizing the data, expenditure figures were rounded off in thousands. In calculating equivalents in United States dollars, use was made of the list of exchange rates published in the United Nations Statistical Yearbook for 1958. When a currency suffered devaluation or rapid fluctuation on the international market during the time interval of the survey a gradated conversion rate was adopted.

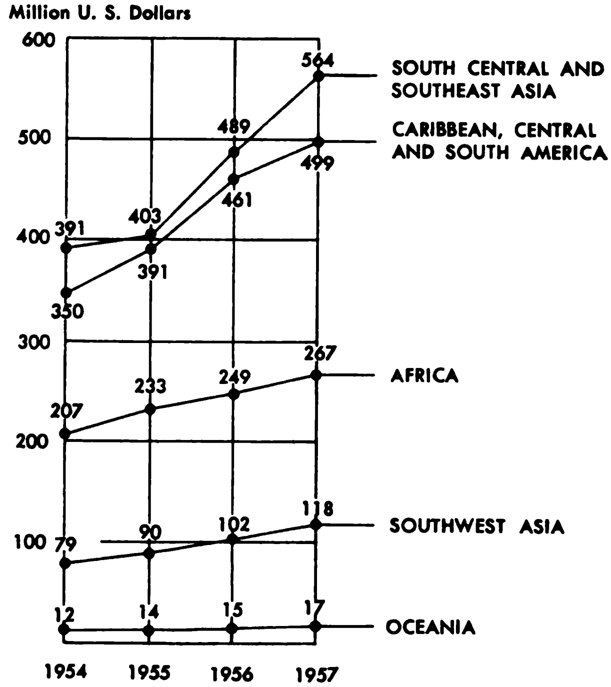
It is appreciated that there are innumerable pitfalls inherent in this type of synthesis. The difficulties cannot be over-emphasized. The data which follow must be approached with the realization that, apart from certain figures for capital expenditures which were requested by questionnaire, they represent summations only of that information on official government expenditures on health which is in the public domain. Health expenditures in the private sector were not contemplated, nor were expenditures for health or medical purposes made by branches of governments other than those identified with health, welfare and public assistance. In the present survey the subject of medical finances was never approached in a way which would permit of comparisons between specific countries. Such an approach has been begun by the World Health Organization, in cooperation with the International Labor Organization, the United Nations and the International Social Security Association, under whose combined sponsorship an Ad Hoc Inter-Agency Working Party on the Costs and Sources of Finance of Medical Care Services was established in 1958. This group has been exploring the feasibility of surveying this complex subject via questionnaire[1]. In the present survey it is hoped that a summation of the available data in terms of the five major geographical areas, represented by the Caribbean, Central and South America, Africa, Southwest Asia, South Central and Southeast Asia and Oceania, will serve to produce a useful synthesis by compensating for much of the distortion introduced by inaccuracies in information from individual countries.

It was originally intended to present data on health expenditures for the period 1954 to 1958 inclusive. Because of relative paucity of published data for 1958, the scope of the original plan was restricted to the four-year period, 1954-1957.

Total operating expenditures annually, 1954 to 1957 inclusive. All financial data which could be obtained from the countries included in the survey have been summarized in Table 42. It will be seen that a total sum approaching the equivalent of five billion United States dollars was spent by governments for health services during the four-year period 1954-1957. Of this sum, the equivalent of $1,701 million, or 34.4 per cent, was spent in the Caribbean, Central and South America; the equivalent of $956 million, or 19.3 per cent, was spent in Africa; the equivalent of $389 million, or 7.8 per cent, was spent in Southwest Asia, the equivalent of $1,847 million, or 37.3 per cent, was spent in South Central and Southeast Asia, and the equivalent of $58 million, or 1.2 per cent, was spent in Oceania.

Health expenditures in all the areas covered by the survey increased at a steady rate during the four-year period. However, there were marked differences in the rates of increase between certain of the geographical areas. Figure 27 reveals that a decided upswing in rate of spending in the Caribbean, Central and South America and in South Central and Southeast Asia between 1955 and 1957 was not paralleled in Africa or in Southwest Asia during the same period. On the other hand, the rate of spending in Oceania remained almost constant over the entire four-year period.

Figure 27. Total Expenditures for Health, by Geographic Areas, 1954-1957



Estimated operating expenditures per inhabitant, 1954 to 1957 inclusive. Government health expenditures were calculated on a per capita basis by dividing the reported annual expenditure for health by the population figure for the year. Recourse was had to all data, regardless of form. Thus some expenditures were reported on a calendar year basis and others on a fiscal year basis not identical with the calendar year. In such cases, the expenditure was credited to the calendar year in which the fiscal year ended. In general, population figures were all taken from United Nations sources, i.e., the most recent Statistical Yearbook or the most recent Demographic Yearbook. Capital expenditures, when identifiable, were excluded from the calculations. Thus, the figures reported represented *per capita operating or recurrent expenditures for health.*

Annual health expenditures of the 169 tropical countries of the survey were summed up by geographic areas. When figures were lacking for a particular year, they were taken from a preceding or a following year.

Table 42. Total government expenditures for health in the survey area for 1954-1957
(million US dollars)

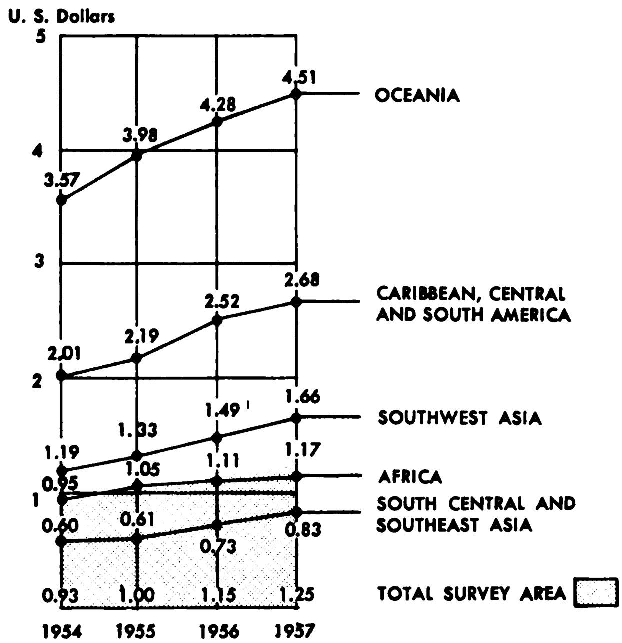
AREA	1954	PER CENT	1955	PER CENT	1956	PER CENT	1957	PER CENT	TOTALS	PER CENT
Caribbean, Central and South America	350	33.7	391	34.6	461	35.0	499	34.1	1,701	34.4
Africa	207	19.9	233	20.6	249	18.9	267	18.2	956	19.3
Southwest Asia	79	7.6	90	8.0	102	7.8	118	8.0	389	7.8
South Central and Southeast Asia	391	37.6	403	35.6	489	37.2	564	38.5	1,847	37.3
Oceania	12	1.2	14	1.2	15	1.1	17	1.2	58	1.2
Totals	1,039	100.0	1,131	100.0	1,316	100.0	1,465	100.0	4,951	100.0

In a few cases (such as Liberia and Nepal) expenditure data were available for only one of the five years included in the survey. In such cases, figures for population were always taken for the year corresponding to that during which expenditures were recorded.

The five divisions of the survey area have been presented in Figure 28 in terms of their total per capita health expenditures. Total per capita expenditure for the survey area was the equivalent of US$0.93 in 1954, US$1.00 in 1955, US$1.15 in 1956 and US$1.25 in 1957. Per capita expenditures in Oceania equaled, in terms of United States dollars, $3.57 in 1954, $3.98 in 1955, $4.28 in 1956 and $4.51 in 1957. In the region of the Caribbean, Central and South America, these figures were as follows: $2.01 in 1954, $2.19 in 1955, $2.52 in 1956 and $2.68 in 1957. In Southwest Asia, the figures were the following: $1.19 in 1954, $1.33 in 1955, $1.49 in 1956 and $1.66 in 1957. In Africa, the figures were as follows: $0.95 in 1954, $1.05 in 1955, $1.11 in 1956 and $1.17 in 1957. Finally, in the region comprising South Central and Southeast Asia, the figures were as follows: $0.60 in 1954, $0.61 in 1955, $0.73 in 1956 and $0.83 in 1957.

It will be seen that the figures for Africa approach most closely the mean figures for the entire survey area. South Central and Southeast Asia consistently display the lowest per capita figure, due, no doubt, to the size of the population which in some of its countries is admittedly disproportionate. In this regard, it is recognized that the summaries of data for the large geographical areas often are not in agreement with the particular picture for many individual countries within those areas, nor, more particularly, with the figures for the more progressive urban areas of such countries. Nevertheless, the disparity of the figures for the region of the Caribbean, Central and South America and those for South Central and Southeast Asia is taken to reflect a true need, as yet undefined, on the part of the latter area.

Figure 28. Per Capita Government Expenditures for Health, Summarized by Major Geographic Areas, 1954-1957 [1]



[1] Not including capital expenditures.

In like manner, the relatively high health budgets of certain countries of Southwest Asia, notably Israel, Cyprus and Turkey, mask the relative lack of medical facilities in the Arabian Peninsula, notably in the Yemen and the sheikdoms of the Persian Gulf.

The favored position of Oceania reflects the requirement for certain basic medical services in island countries, even when the population is relatively restricted. On many of the islands of Oceania the medical establishment is minimal, with a correspondingly small annual expenditure for health, yet the resulting per capita expenditure is relatively high.

It may be considered that the countries of Oceania are all colonial territories, possessions or trust areas with health services provided by the metropolitan country. However, their advanced position with regard to per capita health expenditures is most probably a reflection of their insular, rather than colonial, nature. A comparison of per capita expenditures for health of the independent countries of the survey with the same figures for mainland colonies and possessions and island colonies and possessions is presented in Table 43. In terms of United States dollars, the per capita expenditures by independent countries amounted to $0.86 in 1954, $0.91 in 1955, $1.06 in 1956 and $1.17 in 1957. Similarly, the data for all mainland colonies, territories or possessions with health services provided by the metropolitan country are as follows: $0.91 in 1954, $1.04 in 1955, $1.10 in 1956 and $1.18 in 1957. It will be seen that the figures for the mainland colonies of the survey, taken in the aggregate, do not differ markedly from those for the independent countries. On the other hand, the data for island colonies, territories or possessions with health services provided by the metropolitan country are obtrusively high by comparison: $6.18 in 1954, $6.68 in 1955, $7.08 in 1956 and $7.59 in 1957.

The annual government per capita expenditure for health in the survey areas has been in the neighborhood of a dollar during the time period 1954-1957 (Figure 28). It would be expected, then, that population figures and figures for expenditures for health would be in close

Table 43. Comparison of per capita expenditures for health by political and geographical areas, 1954-1957, inclusive

(US dollars)

	1954	1955	1956	1957
Independent countries of the survey	0.86	0.91	1.06	1.17
Mainland colonies, territories or possessions with health services provided by the metropolitan country	0.91	1.04	1.10	1.18
Island colonies, territories or possessions with health services provided by the metropolitan country	6.18	6.68	7.08	7.59

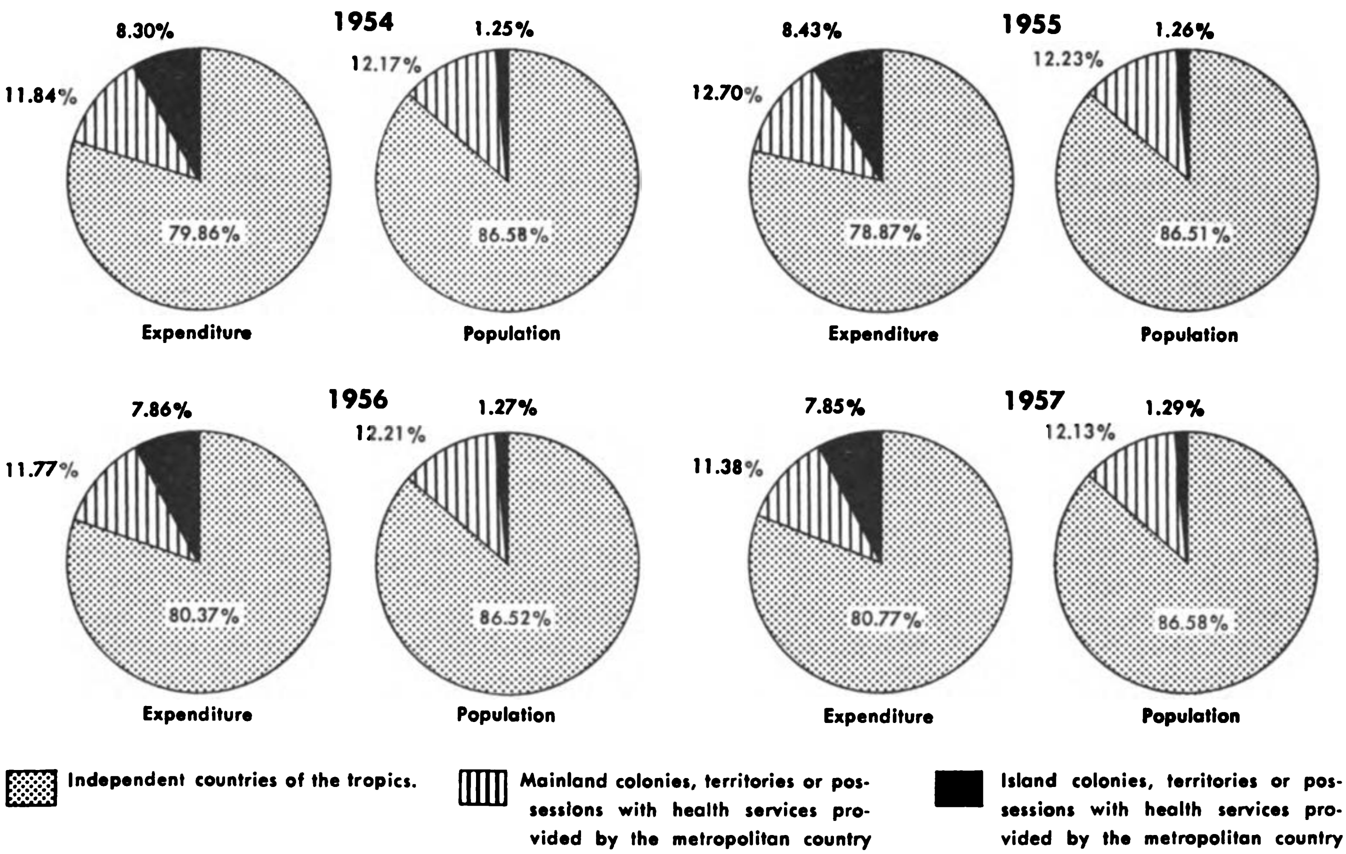
agreement. It will be seen from Figure 29 that this is the case except, again, for the insular colonies, where expenditures are almost seven times greater, in terms of numbers, than population.

The rate of increase in per capita spending for health was not identical in the major areas of the survey. Figure 28 reveals a similarity, during the period 1954-1957, between Southwest Asia, South Central and Southeast Asia and Africa, but the rates of increase displayed by these areas were much less than those of the Caribbean, Central and South America or of Oceania.

Per cent of the total budget annually, 1954 to 1957 inclusive. The ratio of ordinary, recurrent, or operating expenditures by government for health to total government expenditures was obtained for each country in the survey and, in so far as possible, for each year in the five-year period 1954-1958. Health expenditure ratios were prepared by calculating the average total annual expenditure and the average health expenditure, using all data available from the period 1954-1958, of the individual countries or health jurisdictions; summing the figures in both categories and calculating the ratio of health expenditure to total expenditure in per cent. In like manner, the health expenditure ratio for the entire survey area was also calculated.

The per cent ratios are presented in Table 44. In the entire survey area, 5.6 per cent of government

Figure 29. Relationship of Health Expenditures to Population, According to Governmental and Geographical Areas



expenditures were made for health. There is very close agreement between this figure and those for the region of the Caribbean, Central and South America (5.6 per cent), Africa (5.7 per cent) and South Central and Southeast Asia (5.8 per cent). The ratio for Southwest Asia is somewhat lower, 4.1 per cent. The only remarkable difference occurs in Oceania, where the ratio is 13.2 per cent.

In Africa, 31 out of 35, or 88.6 per cent, of the countries with ratios above the mean for the area are colonies, protectorates or possessions or held such status in 1958 or before. Six, or 60 per cent, of the 10 countries falling below the area mean are or were colonies or protectorates.

Perhaps more indicative of a trend are the data from the region of the Caribbean, Central and South America, where it is seen that all 19 colonies for which data were available fall above the area mean. The total number of countries above the mean is 28 and the total number below is 9.

Most of the countries of Southwest Asia are independent and a comparison of them with colonial possessions is not meaningful. In this area, 8 of the countries fall above the mean and 4 fall below it. However, in South Central and Southwest Asia, 7, or 13.6 per cent, of 11 countries above the mean are or were colonies, whereas but 1, or 11.1 per cent, of 9 below the mean had this status.

All of the countries of Oceania fall within the category of colony. Here there is the most even distribution on either side of the mean, with 11 countries falling above and 9 countries falling below.

It must be emphasized here that these ratios are based upon figures which are in the public domain and are available. No attempt has been made to check their accuracy. Indeed, in some instances, certain of them are very strongly felt to be biased. Nevertheless, the ratios represent the best use of available material and are significant in so far as they point out the relative support for health in relation to total government budgets.

Other sources of variability in the figures may be stated. In several cases, not enumerated, capital expenditures were included with operating expenditures to present a heightened over-all figure for the health budget. Where capital expenditures could be identified, they were excluded from the calculations. Again, certain of the figures represent sums spent for public health and preventive health measures only, excluding costs of medical care, hospital operations, and the like, when these services are not provided by a central authority.

Regardless of these qualifications, it is strongly felt that the resulting distortion in the general picture produced by these variables is small.

Table 44. Ratios of government expenditures for health to total annual expenditures. Summary of information available between the years 1954 and 1958

AREA	RATIO	NUMBER OF COLONIES OR PROTECTORATES ABOVE THE MEAN[1]	PER CENT	NUMBER OF COLONIES OR PROTECTORATES BELOW THE MEAN[1]	PER CENT
Caribbean, Central and South America	5.6	19 / 28	67.9	0 / 9	0.0
Africa	5.7	31 / 35	88.6	6 / 10	60.0
Southwest Asia	4.1	2 / 8	25.0	1 / 4	25.0
South Central and Southeast Asia	5.8	7 / 11	63.6	1 / 9	11.1
Oceania	13.2	11 / 11	100.0	9 / 9	100.0
Total Survey Area	5.6	81 / 98	82.7	8 / 36	22.2

[1] In relation to the total number of countries falling above or below the mean.

Annual capital expenditures on health, 1954 to 1958 inclusive. Data were collected in this category in order to supply background information on building programs and additions to existing health facilities. Capital expenditures are understood to refer to those portions of non-recurrent or extraordinary budgets devoted to construction. In those instances in which a metropolitan country supplied capital investment funds to a colonial country, the entire amount was taken to represent construction, since a breakdown of the disposal of expenditures was rarely available.

Many countries include capital expenditures with ordinary expenditures when reporting health budgets. The British colonies, on the other hand, tend to omit entirely all information on capital expenditures in their annual health reports.

Because of gaps such as these, a supplementary questionnaire was devised which requested specific information on capital expenditures. This questionnaire was prepared in three languages (English, French and Spanish) and was transmitted to the appropriate health authorities in 155 countries. At the time of writing (approximately six months later) 36 replies, or 23.2 per cent of the queries sent, had been received and a total of 25, or 16.1 per cent, of the questionnaires had been returned in varying states of completion. While this response is admittedly disappointing, it is no more so than can be expected from any request for information via a questionnaire. The information thus acquired has been most helpful in filling in the gaps in this category.

The relative completeness of the data presented here will permit only a very general view of capital investment for health in the survey areas. The per capita figures presented below must be taken to represent minimal values. The conviction has been acquired, however, that more complete data would alter the picture only in a small way.

Table 45 summarizes the amount of capital expenditure data available in terms of the total number of fiscal years represented. In the region of the Caribbean, Central and South America, data were available for 74, or 32.2 per cent, of the 230 fiscal years possible in the five-year period 1954-1958. Likewise, in Africa there were 250 possible fiscal years; data were available for 102, or 40.8 per cent, of these. In Southwest Asia, figures were found for 26, or 28.9 per cent, of the 90 fiscal years possible. In South Central and Southeast Asia, figures were available for 35, or 29.2 per cent, of the total of 120 fiscal years possible. Finally, in Oceania, data were obtained for 54, or 47 per cent, of the total of 115 fiscal years possible.

Table 45. Total number of fiscal years in the period 1954-1958 in relation to the number of fiscal years for which capital expenditure data are available

AREA	NUMBER OF POSSIBLE FISCAL YEARS 1954-1958	NUMBER OF FISCAL YEARS FOR WHICH DATA ARE AT HAND	DEGREE OF COMPLETENESS (PER CENT)
Caribbean, Central and South America	230	74	32.2
Africa	250	102	40.8
Southwest Asia	90	26	28.9
South Central and Southeast Asia	120	35	29.2
Oceania	115	54	47.0

One of the advantages of working with the colonial countries is the relative efficiency of their statistical reporting services which are guided by the example of the metropolitan country. Thus the data from Oceania are more complete than those from the areas of Asia and tropical America.

Table 46 presents in summarized fashion the data which were available relative to capital expenditures for health in the survey areas. In the region of the Caribbean, Central and South America, the sum of US$26,809,000 was spent during the period 1954 to 1958 inclusive, representing a mean expenditure per fiscal year of US$362,000. The data were supplied by 20 of the 46 countries of the area, representing 58.4 per cent of its population. In Africa, US$88,776,000 were spent during the same period, representing a mean expenditure per fiscal year of US$870,000. These figures were supplied by 32 of the 50 countries in this area, representing 44.5 per cent of the area population. In Southwest Asia, the amount of US$121,157,000 was spent during the five-year period referred to above, equaling a mean expenditure per fiscal year of US$4,660,000. These data were forthcoming from 6 of the 18 countries of this area, containing 69.8 per cent of the area population.

In the region of South Central and Southeast Asia, US$1,270,840,000 were spent on capital improvements during 1954 to 1958 inclusive, representing a mean expenditure per fiscal year of US$36,310,000. The data are for 10 of the 24 countries in this geographic area, representing 77.4 per cent of the population.

Table 46. Capital expenditures for health by area, 1954-1958, inclusive (US dollars)

AREA	TOTAL CAPITAL EXPENDITURES BY AREA (THOUSANDS)	TOTAL NUMBER OF FISCAL YEARS REPRESENTED	MEAN EXPENDITURE PER FISCAL YEAR (THOUSANDS)	NUMBER OF COUNTRIES REPRESENTED[1]	PER CENT OF POPULATION INCLUDED IN DATA
Caribbean, Central and South America	26,809	74	362	20 / 46	58.4
Africa	88,776	102	870	32 / 50	44.5
Southwest Asia	121,157	26	4,660	6 / 18	69.8
South Central and Southeast Asia	1,270,840	35	36,310	10 / 24	77.4
Oceania	15,484	54	287	15 / 23	97.5

[1] In relation to the total number of countries in the area.

In Oceania, US$15,484,000 were spent during the same period, equaling a mean expenditure per fiscal year of $287,000. The data are for 15 of the 23 countries of Oceania, containing 97.5 per cent of the total population.

On a per capita basis, the capital expenditures during 1954 to 1958, inclusive, calculated on the basis of data available, may be expressed as follows (see Figure 30): In the Caribbean, Central and South America the figure was US$0.25. The comparable sum was US$0.87 in Africa. In Southwest Asia, the figure was US$2.09; in South Central and Southeast Asia US$2.43; and in Oceania US$4.46.

Capital expenditures for health are governed by a number of factors and may and do vary from year to year depending on the economy of the country, the political climate, and the need for capital investment in other government-sponsored programs. Thus Iran, medically underdeveloped for years, now is investing a very large proportion of oil wealth in its national health establishment as clearly indicated by the large capital expenditure for health. The same may be said of the sheikdoms of Bahrain and Kuwait on the Persian Gulf. On the other hand, relatively large expenditures, out of proportion to the population and the needs, may be occasionally revealed in response to unusual events. For example, the government of the Gilbert and Ellice Islands in the Western Pacific Ocean made a heavy capital investment in new hospital buildings between the years 1955 and 1958, when temporary wartime hospitals were being replaced by permanent installations. But it was anticipated that this period of increased activity would soon be supplanted by a protracted period of consolidation with only minor capital expenditures being made. In the Ryukyu Islands, the occurrence of destructive typhoons is so dependable that certain types of building costs are practically thrust into the category of recurrent expenses.

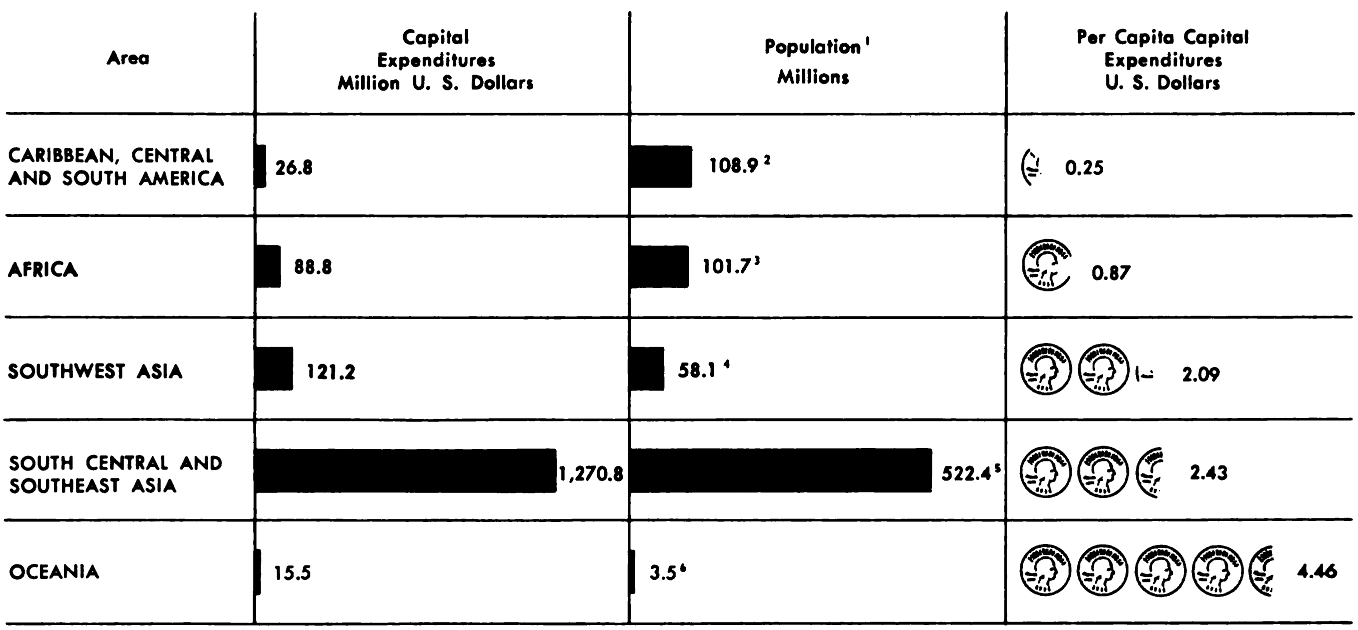
Hospitals and clinics (inpatient)

Most of the data in this category were derived from United Nations sources, particularly *Annual Epidemiological and Vital Statistics*, which were supplemented by various sources, including personal communications. For the most part, the figures are representative of the period 1955-1957.

Table 47 presents data regarding the number of hospitals of all types, distributed by area. Presented also are figures for the percentage of the total that the numbers represent.

It will be seen that almost 20,000 hospitals of every type are recorded from the areas covered by the survey. More than 12,000 (62.6 per cent) of these are described

Figure 30. Capital Expenditures for Health in Relation to Population, 1954-1958, inclusive



[1] Generally refers to midyear 1956.

[2] Includes 20 out of 46 countries, with 58.4 per cent of area population.

[3] Includes 32 out of 50 countries, with 44.5 per cent of area population.

[4] Includes 6 out of 18 countries, with 69.8 per cent of area population.

[5] Includes 10 out of 24 countries, with 77.4 per cent of area population.

[6] Includes 15 out of 23 countries, with 97.5 per cent of area population.

Table 47. Numbers and types of hospitals and clinics (inpatients) in the survey area

TYPE	CARIBBEAN, CENTRAL AND SOUTH AMERICA		AFRICA		SOUTHWEST ASIA		SOUTH CENTRAL AND SOUTHEAST ASIA		OCEANIA		TOTALS	
	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT
General	3,320	50.1	3,296	69.0	653	56.1	4,838	70.4	247	84.3	12,354	62.6
T. B.	234	3.5	123	2.6	30	2.6	331	4.8	11	3.8	729	3.7
Leprosaria	79	1.2	224	4.7	5	0.4	81	1.2	18	6.2	407	2.1
Maternity	237	3.6	499	10.5	45	3.9	1,015	14.8	8	2.7	1,804	9.1
Mental	197	3.0	48	1.0	43	3.7	80	1.2	7	2.4	375	1.9
Pediatric	97	1.5	8	0.2	14	1.2	9	0.1	1	0.3	129	0.7
Infectious	18	0.3	44	0.9	13	1.1	10	0.1	1	0.3	86	0.4
Other	406	6.1	486	10.2	202	17.3	36	0.5	—	—	1,130	5.7
Undescribed	2,035	30.7	47	0.9	159	13.7	476	6.9	—	—	2,717	13.8
Totals	6,623	100.0	4,775	100.0	1,164	100.0	6,876	100.0	293	100.0	19,731	100.0

as general hospitals. About 2,700, or 13.8 per cent, were not described but may be assumed to represent general hospitals. Of the more than 4,600 remaining hospitals (23.6 per cent of the total), 729, or 3.7 per cent, were described as tuberculosis sanatoria; 407, or 2.1 per cent, were leprosaria; 1,804, or 9.1 per cent, were maternity hospitals; 375, or 1.9 per cent, were mental hospitals; 129, or 0.7 per cent, were pediatric hospitals; 86, or 0.4 per cent, were hospitals devoted to treatment of infectious diseases; and 1,130, or 5.7 per cent, were described as "other".

In general, the proportional distribution of hospitals by type within the survey areas was in agreement with proportional distribution of population. A major exception involved maternity hospitals in Africa and South Central and Southeast Asia; many of these, however, probably represent "cottage" hospitals of ten beds at the most, usually with but two or three.

Of those hospitals for which information was available, more than half were reported to be government operated (see Table 48). This figure must be viewed with caution, however, since most of the countries of the survey have some form of centralized medical and public health direction and the distribution of information on government facilities in official reports might be expected to be more complete than comparable reporting on pri-

Table 48. Distribution of tropical hospitals by directional authority

AREA	NUMBER OF COUNTRIES INCLUDED	NUMBER OF HOSPITALS INCLUDED	GOVERNMENT		PRIVATE		MISSION		INDUSTRIAL	
			NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT
Caribbean, Central and South America	7	669	329	49.2	298	44.5	—	—	42	6.3
Africa	17	1,033	689	66.7	204	19.7	135	13.1	5	0.5
Southwest Asia	13	709	339	47.8	335	47.3	12	1.7	23	3.2
South Central and Southeast Asia	7	373	139	37.3	223	59.8	10	2.7	1	0.2
Oceania	16	256	166	64.8	7	2.7	79	30.9	4	1.6
Totals	60	3,040	1,662	54.7	1,067	35.1	236	7.8	75	2.4

vately operated facilities. Of the 3,000 hospitals included in the 60 countries whose reports specifically identified hospital ownership, 54.7 per cent were listed as "government", 35.1 per cent were "private", 7.8 per cent were "mission", and 2.4 per cent were "industrial".

Figure 31 presents information on the number of inpatient hospital beds in the survey areas and the relationship of these numbers to population. The region of the Caribbean, Central and South America, with 575,000 beds, or 39.1 per cent of the total for the survey areas, has 3.2 beds per thousand of population. Africa, with 395,000 beds, or 26.9 per cent of the total, possesses 1.9 beds per thousand. Southwest Asia has 89,000 beds, or 6.1 per cent of the total, and 1.1 beds per thousand. South Central and Southeast Asia, with 393,000 beds, or 26.7 per cent of the total, has only 0.6 bed per thousand. Finally, Oceania, with 17,000 beds, or 1.2 per cent of the total, has 4.8 beds per thousand.

Table 49 contains data regarding total annual patient loads in the hospitals and inpatient clinics of the areas covered by the survey. Official figures sometimes included data only for government hospitals, or (more rarely) only for mission hospitals. Such incomplete figures were accepted in the calculations but provide a source of error. Another commonplace in official reports was the custom of reporting annual inpatient and outpatient attendances as a single number. When such data were presented without breakdown they were omitted from the calculations.

It will be seen that the data are relatively sparse from the Caribbean, Central and South America (information for only 3.1 per cent of all hospitals) and relatively complete from Oceania (information for 91.8

Table 49. Annual patient loads in hospitals in survey area

AREA	NUMBER OF HOSPITALS INCLUDED	PER CENT OF TOTAL HOSPITALS IN AREA	ANNUAL PATIENT LOAD	MEAN ANNUAL LOAD PER HOSPITAL
Caribbean, Central and South America	208	3.1	277,000	1,332
Africa	1,011	21.2	1,038,000	1,027
Southwest Asia	440	37.8	316,000	718
South Central and Southeast Asia	1,323	19.2	2,114,000	1,598
Oceania	269	91.8	277,000	1,030
Totals	3,251		4,022,000	1,237

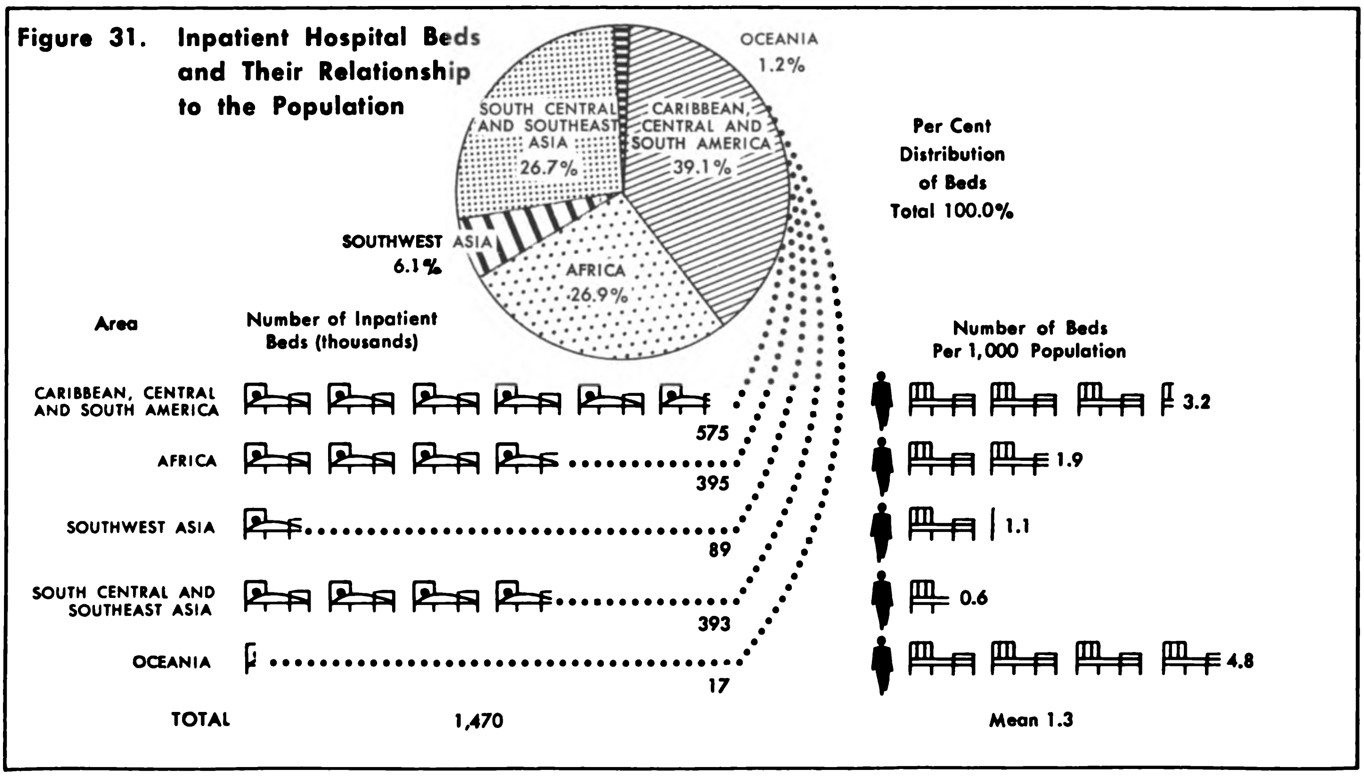


Figure 31. Inpatient Hospital Beds and Their Relationship to the Population

per cent of all hospitals). The 208 hospitals from the Caribbean, Central and South America represent but 3.1 per cent of all the hospitals in this area, and the figure for annual patient load of 277,000 is presented with some hesitation; however, the resulting mean annual load per hospital of 1,332 is in rather close agreement with other figures in this column. In Africa, slightly more than a thousand hospitals carried an annual load of more than a million patients, representing a mean annual load per hospital of more than a thousand. Southwest Asia, with 440 hospitals for which data were available (37.8 per cent of the total number of hospitals) had an annual patient load figure of 316,000, or a mean annual load per hospital of 718. Relatively few hospitals in South Central and Southeast Asia provided data (1,323, or 19.2 per cent of the total); the figure of 2,114,000 for annual patient load equals a mean annual load per hospital of 1,598. In Oceania, 269 hospitals (representing more than 90 per cent of all hospitals) had a total annual patient load of 277,000, or a mean load per hospital of 1,030.

The mean annual load per hospital of all areas covered by the survey proved to be 1,237.

There is remarkable uniformity in the figures from most of the survey areas. The fact that the mean annual patient load per hospital in South Central and Southeast Asia is almost half again as high as comparable figures from the Caribbean, Central and South America, Africa and Oceania probably indicates a stress situation. The low figure from Southwest Asia may indicate lack of familiarity with available facilities, or distrust of Western medicine.

It is important to add that almost all of the facilities reported here are located in urban areas. Peoples who are largely rural or nomadic in their habits cannot be expected to participate as fully in the use of these hospitals as urban dwellers may do.

Table 50. Outpatient clinics and dispensaries in three of the survey areas

AREA	TOTAL NUMBER OF OUTPATIENT ESTABLISHMENTS	TOTAL NUMBER OF RESTING BEDS	ANNUAL NUMBER OF OUTPATIENT CONSULTATIONS	ANNUAL CONSULTATIONS PER ESTABLISHMENT
Africa	10,000	42,900	34,000,000	3,400
South Central and Southeast Asia	11,000	3,200	43,000,000	3,900
Oceania	1,000	400	3,000,000	3,000

Clinics and dispensaries (outpatient)

The lack of acceptable definitions contributes materially to the incompleteness of data in this category. Indeed, data from the Caribbean, Central and South America and from Southwest Asia were so incomplete that they could not be included here.

The annual health reports of some countries print figures for outpatient attendances which exclude those attending the outpatient departments of hospitals. Or, figures for all outpatient attendances, including those of hospitals, may be presented without breakdown. Some reports lump outpatient and inpatient figures together, and do not distinguish between them; such figures would not be included either in the inpatient section or the outpatient section of the present report.

Certain countries publish data pertaining to government services only. Such figures were included in the present report but their inclusion augments the minimal character of the summarized data.

Some reports published figures for outpatient attendances at urban clinics and dispensaries but made no effort to include comparable figures from rural areas; in most cases, moreover, such statistics were simply not maintained.

Unless otherwise stated, it was assumed that attendance figures published in annual reports represented numbers of outpatient visits rather than numbers of individual patients.

Table 50 presents the data pertaining to outpatient establishments in the areas covered by the survey. The number of such establishments in Africa was 10,000. With 34,000,000 annual outpatient consultations, the annual number of consultations per clinic is 3,400. In South Central and Southeast Asia, the outpatient facilities enumerated totaled 11,000, with 43,000,000 annual visits, or 3,900 annual visits per facility. In Oceania, 1,000 outpatient establishments had a total of 3,000,000 annual visits, or 3,000 per establishment.

Attention is drawn to the similarity between the figures for number of annual visits per outpatient establishment. No comment is offered.

The number of resting beds reported is relatively larger in Africa than in South Central and Southeast Asia, although the number of establishments is similar in both areas. This suggests that, in Africa, perhaps a different need is provided for by these establishments.

Prevention and control—number of vaccinations and inoculations

The collection of information under this category, from all of the areas included in the survey, was particularly subject to the confusion provided by reports of data on the same subject from different sources. Even figures forthcoming from identical sources at separate intervals were often at variance. In order to achieve a degree of homogeneity in the presentation of these data, the most complete data (usually for from two to four years) were extrapolated to produce country-wide figures on number of inoculations for the five-year period 1954-1958. These were rounded off in thousands and grouped to give the total number of vaccinations and inoculations by major geographic area for the same five-year period (see Table 51). Most of the extrapolations were based on figures for the years 1954 and 1955. Since there tends to be a steady increase in numbers of preventative inoculations, and since extrapolation does not take into account the sudden increases in numbers of inoculations during the occasional preventive health campaigns, the figures presented in Table 51 must be regarded as minimal.

The most common source of error, and the easiest to identify, resulted from the use of data which were acknowledged to be incomplete at the time of publication. The official intent was usually to publish more complete figures at a later date, but these were often not available. The collection and presentation of health statistics with this kind of limitation seems to be particularly common in the so-called medically underdeveloped countries.

According to Table 51, there were 531.5 million smallpox vaccinations performed in the areas covered by the survey during the five-year period 1954-1958. Few countries separated the data to indicate the number of these which were re-vaccinations. The distribution of smallpox vaccinations by area is as follows: The Caribbean, Central and South America, 54.5 million; Africa, 158 million; Southwest Asia, 54 million; South Central and Southeast Asia, 191 million; and Oceania, 74 million.

There were 27.4 million inoculations against typhoid and paratyphoid fevers, of which 8 million were performed in the Caribbean, Central and South America, 200,000 in Africa, 17 million in Southwest Asia, 2 million in South Central and Southeast Asia, and 200,000 in Oceania.

Of the 25.6 million immunizations against diphtheria, 5 million were performed in the Caribbean, Central and South America, 6 million in Africa, 3.6 million in Southwest Asia, 11 million in South Central and Southeast Asia, and 17,000 in Oceania.

Table 51. Number of vaccinations and inoculations performed in the survey area, 1954-1958 (in thousands)

TYPE	TOTAL SURVEY AREA	CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA
Smallpox, total	531,500	54,500	158,000	54,000	191,000	74,000
T.A.B.	27,400	8,000	200	17,000	2,000	200
Diphtheria	25,617	5,000	6,000	3,600	11,000	17
Pertussis	8,334	6,000	350	1,000	960	24
B.C.G.	95,068	27,000	4,000	10,000	54,000	68
Yellow fever	46,037	14,000	32,000	37	.05	—
Poliomyelitis[1]	9,000					
Influenza	[2]					
Typhus	5,000					
Plague	18,000					
Cholera	52,000					
Rabies	237					
Tetanus	23,000					

[1] For years 1956-1957-1958 only.
[2] None reported.

There were 8.3 million immunizations against whooping cough, of which 6 million were done in the Caribbean, Central and South America, 350,000 in Africa, 1 million in Southwest Asia, 960,000 in South Central and Southeast Asia, and 24,000 in Oceania.

Of the total of 95 million B.C.G. inoculations, 27 million were in the Caribbean, Central and South America, 4 million in Africa, 10 million in Southwest Asia, 54 million in South Central and Southeast Asia, and 68,000 in Oceania.

There were 46 million inoculations against yellow fever, including 14 million in the Caribbean, Central and South America, 32 million in Africa, and 37,000 in Southwest Asia.

Data on the next list of inoculations were too scattered or insufficient to permit recording by area. In the entire survey area, 9 million poliomyelitis immunizations were practiced in the years 1956, 1957 and 1958.

Table 52. Proportional distribution of vaccinations and inoculations in the survey area during the period 1954-1958, inclusive

(per cent)

TYPE	CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHWEST ASIA	SOUTH CENTRAL AND SOUTHEAST ASIA	OCEANIA	TOTALS
Smallpox, total	10.3	29.7	10.2	35.9	13.9	100.0
T.A.B.	29.2	0.7	62.1	7.3	0.7	100.0
Diphtheria	19.5	23.4	14.1	42.9	0.1	100.0
Pertussis	72.0	4.2	12.0	11.5	0.3	100.0
B.C.G.	28.4	4.2	10.5	56.8	0.1	100.0
Yellow fever	30.4	69.5	0.1	—	—	100.0

No record of influenza vaccinations was found. Five million typhus immunizations were recorded. There were 18 million plague immunizations, 52 million cholera inoculations and 23 million tetanus immunizations. Some 237,000 rabies immunizations were performed.

Table 52 shows the proportional distribution, on a percentage basis, of the vaccinations and inoculations for which a breakdown by major survey area was available. Of the smallpox vaccinations, 10.3 per cent were performed in the Caribbean, Central and South America, 29.7 per cent in Africa, 10.2 per cent in Southwest Asia, 35.9 per cent in South Central and Southeast Asia, and 13.9 per cent in Oceania. Of typhoid-paratyphoid inoculations, 29.2 per cent were done in the Caribbean, Central and South America, 0.7 per cent in Africa, 62.1 per cent in Southwest Asia, 7.3 per cent in South Central and Southeast Asia, and 0.7 per cent in Oceania. Of diphtheria immunizations, 19.5 per cent were performed in the Caribbean, Central and South America, 23.4 per cent in Africa, 14.1 per cent in Southwest Asia, 42.9 per cent in South Central and Southeast Asia, and 0.1 per cent in Oceania. Of whooping cough immunizations, 72 per cent were in the Caribbean, Central and South America, 4.2 per cent were in Africa, 12 per cent were in Southwest Asia, 11.5 per cent were in South Central and Southeast Asia, and 0.3 per cent were in Oceania. Of B.C.G. inoculations, 28.4 per cent were in the Caribbean, Central and South America, 4.2 per cent were in Africa, 10.5 per cent were in Southwest Asia, 56.8 per cent were in South Central and Southeast Asia, and 0.1 per cent were in Oceania. Of yellow fever inoculations, 30.4 per cent were in the Caribbean, Central and South America, 69.5 per cent in Africa, and 0.1 per cent in Southwest Asia.

It is seen that comparatively few immunizations against typhoid are practiced in Africa.

The large percentage of pertussis immunizations performed in the Caribbean, Central and South America (72 per cent) attests to the popularity this procedure has always enjoyed in this hemisphere.

SUMMARY

Data pertaining to the number of medical and paramedical personnel, government expenditures for health services, number and types of hospitals, clinics, and outpatient facilities, and an analysis of preventive medicine programs in the countries of the survey have been presented.

In general, it may be assumed from the data that there presently exists a distressing lack in numbers of medical and paramedical personnel of all categories in the survey areas. It was estimated that these areas were able to utilize the services of approximately 227,800 physicians and 160,200 qualified nurses in 1956. The number of persons per physician in the Caribbean, Central and South America was estimated to be 1,900; in Africa, 9,000; in Southwest Asia, 5,000; in South Central and Southeast Asia, 7,000; and in Oceania, 5,100. A perspective of the need which these figures represent may be offered by the analogous figure of 756 persons per physician in the United States in 1957. In like fashion the numbers of nurses and other paramedical personnel were found to be exceedingly small in the survey areas, the deficiencies being aggravated by the concentration of medical services in the larger urban areas to the detriment of many rural areas.

The analysis of government expenditures for health in the four-year period 1954-1957, in which official reports were utilized as sources, must be approached with much trepidation. It is clear that such sources are not uniform. There is little or no international agreement regarding items which must be included in the health budget. It is anticipated, however, that some service will be performed by summarizing the available data in terms of the five major geographical areas of the survey. Total government operating expenditures for health in these areas amounted to the equivalent in United States currency of $5 billion during the period 1954-1957. But, in individual terms, the per capita expenditures for one year (1957) were as follows: in Oceania, $4.51; Caribbean, Central and South America, $2.68; Southwest Asia, $1.66; Africa, $1.17; and South Central and Southeast Asia, $0.83. A comparison by political and geographical areas would indicate that the ratio between figures for population and health expenditures in independent countries and mainland colonies was virtually unity, but there was a disparity in these figures in the case of island colonies, as the cost of maintaining an adequate medical establishment cannot fall below a certain level, no matter how geography limits the population served. Island administrations tend to benefit from this. In most areas of the survey, health expenditures comprised approximately 5 or 6 per cent of the total budget, the notable exception being Oceania, composed of island colonies, where the ratio was 13.2 per cent.

The data suggested a general inadequacy of hospital beds in the survey areas. In 1955-1957 there were 3.2 hospital beds per 1,000 population in the Caribbean, Central and South America. In Africa the comparable figures were 1.9; Southwest Asia, 1.1; South Central and Southeast Asia, 1.64; and Oceania, 4.8. The figures may be compared with that for the United States in 1957, which was 9.01 per 1,000. Data were also compiled on the numbers and types of hospitals, clinics, and outpatient facilities, the distribution of facilities by directional authority and the amount of annual patient loads. Since the figures are relatively incomplete, only the most general of conclusions can be drawn from them. Indeed, data from the Caribbean, Central and South America are so sparse as to preclude comparisons with other survey areas. The data suggest that hospital bed space is not adequate to the need in Africa, Southwest Asia and South Central and Southeast Asia. Needs are greatest in South Central and Southeast Asia. In Southwest Asia, low annual patient loads may reflect a low degree of exposure to or utilization of Western concepts of medical care.

Although based on admittedly incomplete data, an extrapolative analysis of preventive medicine programs for the period 1954-1958, as exemplified by immunizations against certain diseases, indicated that the major programs were directed against smallpox, tuberculosis, cholera and yellow fever. The magnitude of these and other immunization procedures varied with the geographical region. For instance, the largest number of yellow fever inoculations were carried out in Africa; Southwest Asia listed the greatest number of T.A.B. vaccinations, while the highest proportion of diphtheria inoculations were given in South Central and Southeast Asia. Undoubtedly, many factors controlled the utilization of such procedures, although to a certain extent the distribution of vaccinations would indicate the degree of importance of the disease in a given region.

The data presented above were derived from a large variety of sources. It would serve no useful purpose to present them in any perspective other than that of this report, where they are useful in defining background conditions in the areas included in the survey.

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The assistance of many persons in collecting the data for this section is gratefully acknowledged here. To their names below should be added the long list of health officials in the many tropical countries concerned who cooperated in transmitting official documents and who were generous in answering queries and questionnaires.

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- Dr. B. Pirc, Chief Epidemiologist, Consolidation of Health Statistics
- Dr. Ruth Puffer, Chief, Epidemiologic and Statistics Section, Pan American Health Organization (Western Hemisphere Regional Office, WHO)

Reference

1. World Health Organization documents WHO/OMC/30 Rev. 1 and WHO/OMC/31.

Medical Mission Installations by United States and Foreign Mission Boards

Willard H. Wright *Martha S. Jones* *Edna M. Mullin*

Medical missions of many faiths provide considerable medical care for populations in the tropics and in many cases operate facilities in areas in which no other such care is available. For these reasons it was the view that no survey of tropical medicine would be complete without some attention being paid to this important segment.

In an effort to secure preliminary data, letters were addressed to many Protestant mission boards in the United States early in 1959. The nature of the replies indicated that a more specific and broader effort would have to be made to obtain significant coverage in this category. During the preliminary survey, it was learned that a directory of Protestant medical missions was being compiled as a joint project of the Christian Medical Council for Overseas Work and the Missionary Research Library. A copy of this report was eventually secured. However, by this time plans to circularize a questionnaire had taken shape and it was decided to proceed in the hope of augmenting the data in the above-mentioned directory. A list of mission boards and their addresses throughout the world was compiled from many different sources.

In the meantime effort was being made to secure information on medical missions operated by Roman Catholic organizations. Through the National Catholic Welfare Conference in Washington, it was learned that the last directory of Catholic missions, "Le Missioni Cattoliche," was published in 1950, although it was thought that a revision was in process of preparation in the Vatican. Various efforts were made to secure information concerning such revision but it was not until a visit to La S. Congregazione "de Propaganda Fide" in Rome in October 1960 that it was learned that a revision was not contemplated. Data were secured on various Religious Orders and Congregations which had members working in the mission field. However, time was not available after this date to undertake the task of securing the necessary information from the Apostolic Nuncios and Delegates in tropical countries. In the meantime, a number of attempts were made to secure the cooperation of the Catholic Medical Mission Board, Inc., in New York City. However, these efforts were unsuccessful. A few Catholic medical mission installations are included in the data to be presented but the number is small and in no way representative of the substantial contributions which this religious faith has made in this field. It is regretted that better coverage could not have been secured.

Inquiry among various Jewish organizations elicited the information that there was no comparable medical mission effort among organizations of this religious faith.

The questionnaire was dispatched to 796 mission boards and missions in 22 of the United States and 89 foreign countries. Of this number, 180 were returned in completed form; 28 were undeliverable; 71 indicated that the organization had no medical mission installations; and 481 or 60.4 per cent did not reply. In most instances, the completed questionnaires supplied data on more than one medical installation and some furnished information for an entire tropical country. Data were secured from 74 of the 89 countries represented in the circulation of the questionnaire. The following countries were not represented in the replies:

The Americas: Cuba, Dominican Republic, and Haiti.

Africa: Basutoland, Gambia, Sierra Leone, Chad, Gabon, and Middle Congo.

Southwest Asia: Aden Protectorate, Bahrain, Israel, Kuwait, Muscat and Oman, and Turkey.

The 74 countries represented in the returns are divided geographically as follows: Caribbean, Central and South America, 19; Africa, 29; Southwest Asia, 5; South Central and Southeast Asia, 14; and Oceania, 7. A list of the 89 countries will be found in Appendix 5.

While the survey failed in its effort to secure the desired coverage, as represented by replies to the questionnaire, it did add materially to information available from the Directory of Protestant Medical Missions.

Presentation of the data

The data represent the period 1957 to 1959. The Directory of Protestant Medical Missions was planned in 1957 and published in February 1959. Most of the information received was probably applicable to the year 1957. The main bulk of questionnaires in the present survey was dispatched in July 1959. A few replies were received as late as January 1961 but most of the data are for 1958 or 1959.

Hospitals and clinics, number of beds, annual patient loads and total operating funds. The data in Table 53 and Figure 32 represent those published in the Directory of Protestant Medical Missions and those collected in the present survey. They therefore include all material available to us with respect to Protestant missions and contain also information collected on a relatively small number of Catholic medical mission installations.

Represented in the available data are 1,280 hospitals and 1,897 inpatient and outpatient clinics, with a total of 86,971 beds. The annual patient load of these hospitals was 1,902,837 and that of the clinics 15,100,823. The total operating funds represent costs applicable to both hospitals and clinics because in many instances budget figures were not reported separately. The total annual operating funds reported for 1,045 installations were $28,365,688.

Africa was represented by the largest number of medical installations, including 620 hospitals and 1,068 clinics. South Central and Southeast Asia followed a close second with 500 hospitals and 571 clinics. However, total operating costs for this region exceeded those for Africa and in fact were almost double, suggesting more generous support for mission activities in this part of Asia. As might be expected, the remainder of the geographical regions was represented by a considerably smaller number of medical mission installations.

With respect to financing, if the data for the Catholic missions (Table 55) are subtracted from the totals in Table 53, there would be represented 3,091 Protestant missions, of which 1,038, or 33.6 per cent, furnished information concerning costs of operation. On the basis of this coverage, it is probably safe to predict that the annual funds devoted to medical care by the Protestant missions represented are probably of the order of 80 to 85 million dollars. Since the total number of Protestant medical mission installations is unknown, it is not possible to project a figure for total mission effort on the part of these faiths.

Table 53. Medical mission facilities in survey area—Number of hospitals and clinics (inpatient and outpatient), number of beds, annual patient loads and total operating funds

AREA	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN AREA	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN AREA	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
Caribbean, Central and South America	62	2,269	84,877	153	81	601,237	$ 4,455,593	70
Africa	620	34,585	902,434	1,068	3,272	7,793,658	7,449,273	506
Southwest Asia	23	1,451	36,346	10	0	158,701	919,532	18
South Central and Southeast Asia	500	40,013	799,214	571	791	5,520,744	15,138,876	403
Oceania	75	4,489	79,966	95	20	1,026,483	402,414	48
Totals	1,280	82,807	1,902,837	1,897	4,164	15,100,823	$28,365,688	1,045

Figure 32. Medical Mission Facilities in Survey Area—Number of Hospitals and Clinics (Inpatient and Outpatient), Number of Beds, Annual Patient Loads and Total Operating Funds

HOSPITALS AND CLINICS OPERATING FUNDS

Area	Number of Institutions Reporting	Total Operating Funds (million dollars)
CARIBBEAN, CENTRAL AND SOUTH AMERICA	70	4.5
AFRICA	506	7.4
SOUTHWEST ASIA	18	0.9
SOUTH CENTRAL AND SOUTHEAST ASIA	403	15.1
OCEANIA	48	0.4
TOTAL	1,045	28.3

HOSPITALS

Area	Number in Area	Number of Beds	Annual Patient Load (thousands)
CARIBBEAN, CENTRAL AND SOUTH AMERICA	62	2,269	84.9
AFRICA	620	34,585	902.4
SOUTHWEST ASIA	23	1,451	36.3
SOUTH CENTRAL AND SOUTHEAST ASIA	500	40,013	799.2
OCEANIA	75	4,489	80.0
TOTAL	1,280	82,807	1,902.8

CLINICS

Area	Number in Area	Number of Beds	Annual Patient Load (thousands)
CARIBBEAN, CENTRAL AND SOUTH AMERICA	153	81	601.2
AFRICA	1,068	3,272	7,793.7
SOUTHWEST ASIA	10	0	158.7
SOUTH CENTRAL AND SOUTHEAST ASIA	571	791	5,520.7
OCEANIA	95	20	1,026.5
TOTAL	1,897	4,164	15,100.8

Table 54. Medical mission facilities in survey area—Hospitals and clinics not listed in Directory of Protestant Medical Missions

AREA	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN AREA	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN AREA	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
Caribbean, Central and South America	12	866	17,148	53	19	336,290	$1,303,027	22
Africa	90	4,667	106,434	226	264	1,560,817	1,058,307	156
Southwest Asia	1	24	13	1	0	9	1,747	2
South Central and Southeast Asia	29	3,287	39,280	77	62	803,090	308,186	42
Oceania	27	1,508	33,786	66	0	643,829	175,049	33
Totals	159	10,352	196,661	423	345	3,344,035	$2,846,316	255

Table 54 offers information concerning medical mission facilities not represented in the Directory of Protestant Medical Missions. These data were obtained from replies received in response to the survey questionnaire. It will be seen that there have been added to the information available in the above-mentioned directory data on 159 hospitals and 423 clinics, with respective patient loads of 196,661 and 3,344,035, and total operating funds of $2,846,316 for the 255 installations reporting.

Table 55 supplies data concerning Catholic medical mission facilities. As indicated previously, the coverage was exceedingly meager and is in no way indicative of the total effort of the Religious Orders and Congregations of this faith.

Table 56 shows the distribution of mission hospitals by type. The great majority were general hospitals but 232 leprosaria are included. This figure is 18.1 per cent of the total number and would certainly indicate a special humanitarian interest on the part of the many Christian faiths in alleviating the sufferings of the victims of this disease.

Of some interest is the fact that 10 of the 62 hospitals reporting from the Caribbean, Central and South America were in Brazil. In Africa, the former Belgian Congo has the largest representation with a total of 190 hospitals, followed in order by Nigeria with 68 and Tanganyika with 57. In South Central and Southeast Asia, 327 of the 500 hospitals were in India and 61 in Indonesia. Detailed data by country are included in Appendixes 5-8.

Table 55. Medical mission facilities in survey area—Catholic hospitals and inpatient and outpatient clinics

AREA	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN AREA	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN AREA	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
Caribbean, Central and South America	4	487	8,014	31	[1]	317,242	$748,000	1
Africa	4	290	4,633	13	13	239,025	[1]	[1]
Southwest Asia[1]								
South Central and Southeast Asia	13	1,324	31,159	16	20	535,162	20,000	1
Oceania	5	[1]	[1]	[1]	[1]	[1]	118,050	5
Totals	26	2,101	43,806	60	33	1,091,429	$886,050	7

[1] No data reported.

Table 56. Medical mission facilities in survey area—Type of medical installation

AREA	GENERAL HOSPITALS	MATERNITY HOSPITALS	TUBERCULOSIS SANATORIA	LEPROSARIA	OTHERS	TOTAL HOSPITALS
Caribbean, Central and South America	53	[1]	[1]	9	[1]	62
Africa	480	17	5	114	4	620
Southwest Asia	22	[1]	[1]	1	[1]	23
South Central and Southeast Asia	368	15	13	99	5	500
Oceania	62	4	[1]	9	[1]	75
Totals	985	36	18	232	9	1,280

[1] None reported.

Table 57. Medical mission facilities in survey area—Personnel of hospitals and clinics not listed in Directory of Protestant Medical Missions

AREA	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
Caribbean, Central and South America	115	1	157	157	16	369
Africa	82	3	497	699	81	675
Southwest Asia	[1]	[1]	2	1	[1]	1
South Central and Southeast Asia	128	6	250	177	44	1,024
Oceania	12	1	43	210	3	68
Totals	337	11	949	1,244	144	2,137

[1] None reported.

Personnel of hospitals and inpatient and outpatient clinics. Figure 33 summarizes collected material concerning personnel of medical mission establishments. It indicates that the 1,280 hospitals and 1,897 clinics were staffed by 2,696 physicians, 31 dentists, 5,738 qualified nurses, 6,631 nurses helpers, 529 technicians and 8,282 other employees. The dentists are represented to an insignificant degree. A considerable proportion of the outpatient clinics were operated by nurses. Many of these clinics were small installations in isolated areas and were visited at intervals by a doctor from a base hospital. The number of physicians seems small in comparison with the total number of installations but this may be accounted for in part by the abovementioned facts.

Table 57 shows the personnel of hospitals and clinics not listed in the Directory of Protestant Medical Missions. The list included 337 physicians, 11 dentists, 949 nurses, 1,244 nurses helpers, 144 technicians and 2,137 other personnel.

Figure 33. Medical Mission Facilities in Survey Area—Personnel of Hospitals and Inpatient and Outpatient Clinics

Area	Physicians	Dentists	Nurses	Nurses Helpers	Technicians	Others
CARIBBEAN, CENTRAL AND SOUTH AMERICA	335	5	448	270	23	939
AFRICA	748	12	2,148	2,628	250	2,748
SOUTHWEST ASIA	68	[1]	119	96	6	114
SOUTH CENTRAL AND SOUTHEAST ASIA	1,509	13	2,895	3,336	247	4,223
OCEANIA	36	1	128	301	3	258
TOTAL	2,696	31	5,738	6,631	529	8,282

[1]—None reported.

Table 58 provides data on the personnel of the Catholic hospitals and clinics represented in the survey. The 26 Catholic hospitals and 60 clinics were staffed with 171 physicians, 5 dentists, 246 nurses, 248 nurses helpers, 36 technicians and 1,305 other personnel. Detailed data by country can be found in Appendixes 9-11.

Discussion

The main objective of this portion of the survey concerned an assessment of the role of medical missions in providing medical care in the tropics. It is apparent that this goal cannot be achieved because of the very material deficiencies in the data, especially as concern Catholic medical mission installations. The coverage of Protestant installations is believed to be of a respectable order. Mr. Arthur W. March, Research Associate of the Missionary Research Library, who compiled the Directory of Protestant Medical Missions, expressed the view that the data represented in that publication were probably 75 per cent complete. We have added considerably to his totals. The actual number of medical facilities operated by missions is of course not known.

Even with deficient data, it is apparent that there is considerable geographical variation in the extent to which missions contribute to medical care. It is probable that in the Caribbean, Central and South America, such missions perform a relatively minor service in comparison with facilities operated by other agencies. In Africa and in South Central and Southeast Asia, medical missions play a more significant role in this respect, although in these areas their contribution in certain countries is greater than that in other countries. For instance, the survey includes data from 190 medical mission hospitals in the former Belgian Congo. This number represents 36.4 per cent of the total of 522 hospitals in the Congo at that time. In India, 321, or 9.7 per cent, of the 3,317 hospitals are represented in this medical mission survey. In both countries, only Protestant installations are included in this reckoning. The proportion of medical care supplied by missions in these countries would no doubt be considerably higher if Catholic installations were included.

In many parts of Oceania, medical missions contribute materially to medical care. This is particularly true in the New Hebrides, British Solomon Islands, and the Trust Territory of Papua and New Guinea.

This survey points to certain basic differences in medical mission operations in the two great areas of mission endeavor, Africa and South Central and Southeast Asia. The distribution of doctors and nurses is not

Table 58. Medical mission facilities in survey area—Personnel of the Catholic hospitals and clinics represented

AREA	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
Caribbean, Central and South America	89	1	87	107	13	297
Africa	7		21	40	6	120
Southwest Asia[1]						
South Central and Southeast Asia	75	4	138	101	17	888
Oceania[1]						
Totals	171	5	246	248	36	1,305

[1] No figures available.

in keeping with the number of hospitals in these regions. Even though Africa was represented by more hospitals, it had only 27.7 per cent of the physicians and 37.4 per cent of the nurses. South Central and Southeast Asia with fewer hospitals had the services of 56 per cent of the physicians and 50.5 per cent of the nurses reported for the entire survey.

The differences are exemplified further by additional comparisons. In medical missions in Africa, there is an average of one physician to every 50.6 beds and in South Central and Southeast Asia one physician to every 27 beds. Data concerning nurses indicate one nurse to every 17.6 beds and 14.1 beds, respectively.

In Africa, the survey shows one physician to 11,-625.8 patients per annum and in South Central and Southeast Asia one physician to 4,188.2 patients per annum. There is an average of one nurse to every 4,048.5 patients in Africa versus one nurse to every 2,183.1 patients in South Central and Southeast Asia.

It is not possible to hazard any opinion concerning the reasons for the marked basic differences concerning medical mission facilities in the above-mentioned regions. Obviously, the differences are not related to the population of the respective areas. It has already been pointed out that medical missions in South Central and Southeast Asia had almost twice the budget of those in Africa in spite of the fact that fewer hospitals were involved. It would appear that this part of Asia is a more popular mission field medically than is Africa and for this reason receives greater support of such activities.

SUMMARY AND CONCLUSIONS

A survey was made of medical missions in an effort to assess their role in the problem of medical care in the tropics. Questionnaires were sent to 796 mission boards and missions in 22 of the United States and 89 foreign countries. Data were secured from 74 of these countries. Information was obtained also from the Directory of Protestant Medical Missions which became available after the present survey had been inaugurated. Unfortunately, relatively few Catholic medical mission installations are represented in the returns due to the lack of an up-to-date directory of such missions and inability to secure cooperation of certain organizations.

Available data are presented in three ways, viz: (1) total returns from questionnaires and data from the Directory of Protestant Medical Missions; (2) data from the questionnaires concerning Protestant medical missions; and (3) information from the questionnaires on Catholic medical mission installations. For the most part, the data represent the period 1957 to 1959.

Data from all sources represented 1,280 hospitals and 1,897 inpatient and outpatient clinics with a total of 86,971 beds. The annual patient load of the hospitals was 1,902,837 and that of the clinics 15,100,823. It is calculated that the annual operating funds of the Protestant institutions represented are of the probable order of 80 to 85 million dollars. Africa was represented by the largest number of medical missions, including 620 hospitals and 1,068 clinics. South Central and Southeast Asia followed next with 500 hospitals and 571 clinics. A considerably smaller number of facilities were reported from the remainder of the geographical regions of the survey area.

The above-mentioned medical missions were staffed by 2,696 physicians, 31 dentists, 5,738 qualified nurses, 6,631 nurses helpers, 529 technicians and 8,282 other employees.

There did not appear to be a consistent pattern either in the geographical distribution of medical missions or in their staffing or financing. Installations in certain countries were relatively numerous and constituted a goodly proportion of medical care facilities. On a regional basis, installations in Africa were understaffed and underfinanced in comparison with a smaller number in South Central and Southeast Asia.

It can be concluded even from incomplete data that medical missions contribute significantly to medical care in the tropics. The relative extent of this contribution cannot be determined accurately because of lack of knowledge concerning the total mission effort in this respect. The contribution varies considerably from country to country and from region to region. There is no doubt, however, that medical care in tropical countries, as limited as it is in comparison with more privileged areas of the world, would be much more deficient if it were not for the service rendered by mission organizations and their devoted and self-sacrificing personnel.

Acknowledgments

It is not possible to mention by name the many hundreds of individuals who responded to requests for information. Without their assistance such material as has become available could not have been secured, and deep gratitude is expressed for their courtesy in supplying aid. Special thanks are due to the following individuals who were particularly helpful and who took a great deal of time and trouble in furthering our objective.

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Industrial Medical Installations in the Tropics (American Firms)

Willard H. Wright *Jane Rust*

The objective of the study was to obtain as complete data as possible on the medical contributions of American firms in the areas covered by the survey. Initially, it was necessary to compile a list of United States industrial firms with medical installations in the tropics. The American Foundation for Tropical Medicine and numerous other organizations, public and private, were consulted in the hope that a list of this kind might be available but unfortunately none was forthcoming. After our inquiry, the Foundation decided to compile such a list. In the meantime, not immediately aware of the cooperative effort of the Foundation, the Survey staff distributed a questionnaire in an attempt to secure the information. The Foundation's inquiry went to 238 firms and the survey questionnaire to 246.

The data secured from the Foundation's questionnaire and our preliminary inquiry disclosed a total of 83 American corporations with medical facilities in the areas covered by the survey. On 29 July 1959, a questionnaire (Appendix 12) was sent to the 83 companies. Of these, 37 failed to respond; 24 returned the questionnaire; and the remaining 22 were unable for various reasons to supply the information requested. Some of the latter 22 companies utilized local medical facilities or maintained first-aid units which have not been included in our compilations. Of the 24 questionnaires returned, some were only partially completed.

The type of business represented by the 24 firms replying to the questionnaire was as follows: Oil, 9; mining, 5; rubber, 3; chemical, 2; and miscellaneous, 5. Operations of the 24 companies were distributed over 27 countries divided geographically as follows: the Caribbean, Central and South America, 18; Africa, 2; and Southwest and Southeast Asia, 7. South Central Asia and Oceania were not represented. Southwest and Southeast Asia have been combined in presenting the data because of the relatively few installations reported from the former.

The number of medical programs (defined as separate hospital or clinic installations) maintained in 1958 by the 24 reporting firms totaled 49, of which 34 were in the Caribbean, Central and South America; 4 were in Africa; and 11 were in Southwest and Southeast Asia.

Presentation of the data

Table 59 presents an analysis by geographical area of the main data received from the 24 companies on their overseas medical installations in areas covered by the survey.

A. ***Expenditures.*** The total expenditure reported for 1958 by the 24 firms for the operation of the medical programs in the survey areas was $26,842,228.48, of which $1,138,618.72 was spent for preventive medicine projects. The amount as indicated as spent for medical care totaled only $13,447,190.52, leaving unaccounted for the figure of $12,256,419.24. As indicated in footnote[1] of the table, it is a safe assumption that this figure also represents the cost of medical care, although it has not been added to the medical care total for the reason that it was not so designated by the reporting companies. The total expenditures represent only a portion of the actual amount spent by the commercial organizations represented for the reason that four companies did not report expenditures represented in nine different programs.

On the basis of the available data, the average expenditure per employee per annum was $99.80. As one might expect, such expenditure varied markedly in the three geographical areas, being lowest in Africa and highest in Southwest and Southeast Asia. These differences, of course, do not reflect basic costs, but are no doubt influenced considerably by the nature of the business and the policies of the firms involved.

B. and C. ***Inpatient and outpatient facilities.*** These portions of Table 59 report data on hospitals and outpatient clinics and dispensaries. There were 58 hospitals and 218 outpatient establishments operated by the 24 corporations reporting. Total beds provided were 5,105, of which 5,074 were hospital beds and 31 were clinic beds. Hospital beds averaged 18.87 per 1,000 employees. Total patient load for the year 1958 was 3,493,583 of which 275,125 were hospital inpatients and 3,219,458 were outpatients.

The professional personnel included 313 physicans, 33 dentists and 853 nurses. A total of 417 technicians was on duty, and there were 2,829 other employees.

D. ***Projected expansion of facilities.*** Replies indicated that seven new hospitals and eight new clinics were planned at a total cost of $9,197,887, a figure which would seem to represent a considerable capital expenditure.

E. and F. ***Economic benefits attributable to medical programs.*** These portions of the questionnaire were designed to secure data which might aid in evaluating the economic benefits to be derived from medical care and preventive medicine programs. There is little information of this sort available and such information is

Table 59. Analysis of medical operations of 24 American business firms in survey area in 1958

	CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	SOUTHEAST AND SOUTHWEST ASIA	TOTALS
A. EXPENDITURES FOR MEDICAL PROGRAMS				
1. Amount for medical care	$ 6,055,823.71	$694,400	$6,696,966.81	$13,447,190.52[1]
2. Amount for preventive medicine	$ 500,256.72	$ 67,400	$ 570,962.00	$ 1,138,618.72[2]
3. Total expenditure	$18,549,256.57	$953,150	$7,339,821.91	$26,842,228.48[3]
4. Average expenditure per employee	$ 91.81	$ 25.80	$ 244.92	$ 99.80[4]
B. HOSPITALS AND CLINICS (INPATIENT)				
1. Number of establishments	45	4	9	58
2. Total beds	3,437	309	1,328	5,074
3. Number of beds per 1,000 employees	17.39	8.36	44.31	18.87
4. Total patient load[5]	127,928	8,457	137,740	274,125
5. Number of staff members				
Physicians	184	12	41	237
Dentists	16	0	2	18
Nurses	429	19	345	793
Technicians	206	6	161	373
Other	2,017	45	705	2,767
C. CLINICS AND DISPENSARIES (OUTPATIENT)				
1. Number of establishments	140	44	34	218
2. Total beds	22	0	9	31
3. Number of beds per 1,000 employees	.11	0	.30	.12
4. Total patient load[5]	2,089,295	639,068	491,095	3,219,458
5. Number of staff members (outpatient care only)				
Physicians[6]	26	4	46	76
Dentists	2	1	12	15
Nurses	28	7	25	60
Technicians	18	2	24	44
Other	56	6	0	62
D. PROJECTED EXPANSION IN OVERSEAS MEDICAL FACILITIES				
1. Number of new hospitals planned	4	1	2	7
Estimated cost	$ 8,385,000	$100,000	$ 410,000	$ 8,895,000
2. Number of new clinics or dispensaries planned	3	4	1	8
Estimated cost	$ 267,887	$ 35,000	[7]	$ 302,887

[1] In 18 of the 49 medical programs reported on, no figure was given for the amount of medical care. It is assumed that in nine instances, total cost figures reported probably represent the cost of medical care; however, the amounts in these nine instances have not been added to the medical care expenditures.
[2] In 22 programs, no figure was given for preventive medicine.
[3] In nine programs, no expenditure figures were furnished.
[4] In 11 programs, no figure was given for average expenditure per employee. In some cases, companies included dependents in the figure given.
[5] The total patient load reported by some companies does not represent employees only but also includes dependents and other non-employees. One company gave figures for its entire personnel in medical installations in three countries. Another company reported a figure for the entire population in the area embraced in its operations. The latter figures are not included in the table.
[6] Some of the physicians represented worked on a part-time or an "on call" basis.
[7] Cost combined with figure for new hospital.

difficult to secure from health programs operated by governments. Unfortunately, the inquiry elicited only a meager response. Only 10 of the 24 reporting corporations answered Questions E and F, in whole or in part.

Table 60 gives the results of these two inquiries. For purposes of comparison, the table contains information on the area of operations of the company, the number of hospitals, number of clinics, total expenditures for the medical program and average expenditure for employee, as well as the estimated reduction in man-days lost and the estimated annual monetary savings. It is obvious that there is no correlation between these factors. Extreme variability characterized the replies and marked differences are noted in the reduction in man-days lost and the monetary savings. In certain instances, no reduction occurred in man-days lost over the five-year period. One can only conclude from the meager data that in certain instances there have been benefits in terms of both the amount of working days lost and the amount of money actually saved.

Table 60. Summary of replies to Parts E and F of questionnaire to American business firms concerning savings from medical programs for 1958

AREA	NUMBER OF HOSPITALS	NUMBER OF CLINICS	TOTAL EXPENDITURES U.S. DOLLARS	AVERAGE EXPENDITURE PER EMPLOYEE U.S. DOLLARS	ESTIMATED REDUCTION MAN-DAYS LOST PER CENT	ESTIMATED ANNUAL MONETARY SAVINGS U.S. DOLLARS
Caribbean, Central and South America	3	5	617,230	306.66	3	500,000
	2	5	[1]	[1]	0	[1]
	3	7	797,749	141.39	31.38	[1]
	1	0	1,282,630	201.99	7	[1]
	9	8	792,493	53.83	14.2	73,000
Seven countries[2]	0	7	105,052	[1]	1 to 20	1,109 to 7,440
Southeast and Southwest Asia	0	1	6,237	21.35	0	0
	2	0	139,705	69.85	[1]	125,000
	3	11	1,800,000	200.00	50[3]	250,000[4]
	1	2	135,000	130.00	0	[1]

[1] Not furnished.
[2] Includes Argentina, Brazil, Colombia, Mexico, Panama, Philippines and Turkey.
[3] Increase; however, frequency rate is 300 per 1,000 employees, or about one-fifth that of many other corporations.
[4] Estimated saving in salaries alone.

Variable factors in medical operations of American companies

Figure 34 illustrates the wide differences in the extent of operations of different companies in the geographical areas of the survey, as indicated by the high and low figures for average annual expenditure per employee, number of beds per thousand employees and the number of inpatients and outpatients.

Such variations are not surpising when consideration is given to the differences in the area of operations, the kind of business, and the established policies of the firms involved. No general conclusions can be drawn from such figures, and it is probable that more extensive data would also have demonstrated wide differences.

Relative proportion of expenditures for preventive medicine

Table 61 presents information on the total expenditures for preventive medicine by geographical area and the percentage for this purpose of the total expenditure. The data cover only those programs for which preventive medicine expenditures were reported. The relative proportion is about the same for the three geographical areas. It would appear that there is considerable uni-

Figure 34. Variability of Medical Operations of 24 American Business Firms Abroad in 1958

Area	Number of Programs	Average Annual Expenditure per Employee		Number of Beds per 1,000 Employees		Annual Patient Load: Number of Inpatients		Annual Patient Load: Number of Outpatients	
		Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest
CARIBBEAN, CENTRAL AND SOUTH AMERICA	34	388.27[1]	4.00[2]	56.4	1.10	43,872	122	589,995	154
AFRICA	4	225.00[3]	3.11	15.4	3.08	6,515	144	570,144	200
SOUTHWEST AND SOUTHEAST ASIA	11	305.30	21.35	25.0	5.50[3]	81,017[4]	1,340	467,042	166

[1] Dependents not included.
[2] In terms of employee family.
[3] Per employee and dependents.
[4] Inpatients and outpatients; not separated in the questionnaire.

formity in the contributions to preventive medicine by the various companies involved in these calculations.

Relationship of medical expenditures by U. S. companies to national health expenditures in country of operations

An analysis has been made of the relationship of medical expenditures of various American corporations to the health budgets, both total and per capita, of the 27 countries in the survey area in which operations were conducted in 1958.

In 7 of the 27 countries, the expenditures for 1958 of the American firms represented in this survey were over 10 per cent of the total national health budget of the countries involved. In five countries, these expenditures amounted to over 20 per cent of the respective national budgets. The figures are not entirely comparable in three of these countries, since 1958 budgets were not available and the respective years 1954, 1955 and 1957 were taken. However, it is hardly likely that 1958 budget data would materially change the relationship. On the basis of 1958 figures, the expenditures of American companies represented in one country 46.3 per cent of the national health budget and in another country they actually exceeded local health funds.

In all of the 27 countries, the expenditure per employee greatly exceeded the national health per capita expenditure.

From these data, the inevitable conclusion is derived that American commercial firms operating in the tropics make material contributions to medical care and preventive medicine. If expenditures per employee are an indication, the employee receives better medical care than does the average citizen.

Table 61. Expenditures of American business firms operating in survey area for preventive medicine and per cent for that purpose of their total medical expenditures for 1958

AREA	TOTAL MEDICAL EXPENDITURE	EXPENDITURE FOR PREVENTIVE MEDICINE	PERCENTAGE OF TOTAL EXPENDITURE USED FOR PREVENTIVE MEDICINE
Caribbean, Central and South America (7 Companies and 19 medical programs)	$5,892,526.00	$500,256.72	8.49
Africa (2 companies and 2 medical programs)	$ 716,800.00	$ 67,400.00	9.40
Southeast and Southwest Asia (5 companies and 6 medical programs)	$7,200,117.00	$570,962.00	7.93

SUMMARY AND CONCLUSIONS

Questionnaires were sent to 83 American corporations with medical programs in the survey area. Of these, 37 did not respond, 22 were unable to furnish any data, and 24 replied to the questionnaire in whole or in part.

The 24 firms operated 49 medical programs in 27 countries; 34 of these programs were in the Caribbean, Central and South America, 4 in Africa and 11 in Southwest and Southeast Asia.

The total medical expenditures reported by 20 companies for 40 programs was $26,842,228.48. Of this amount, $1,138,618.72 was spent for projects in preventive medicine. The average expenditure per employee was $99.80.

A total of 58 hospitals with 5,074 beds and 218 outpatient installations was maintained, staffed by 313 physicians, 33 dentists and 853 nurses.

Few replies were made to questions seeking data on the economic aspects of medical programs.

Contemplated expansion of medical activities included provision for seven new hospitals and eight new dispensaries at a total cost of $9,197,887.

Medical expenditures by the American corporations replying to the questionnaire were equivalent to a sizeable proportion of the national health budget in some countries. In all 27 countries, the per capita expenditure per employee far exceeded the per capita expenditure of the national health budget. It is concluded that the American companies represented in this survey are making considerable contributions to medical care and preventive medicine in their operating areas.

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Appreciation is accorded the medical directors of concerns replying to the questionnaire. In many cases it was obvious that they went to considerable trouble to compile the data requested.

Environmental Sanitation

Curt R. Schneider

Summarized accounts of water supply systems in the areas included in the survey are almost entirely lacking. A notable exception is provided by the work of Wolman (1959)[1] on water supplies in urban areas of the Caribbean, Central and South America, which data are utilized below. Other sources of information have proved disappointing. Annual reports and health reports customarily offer information regarding water supplies and other sanitary facilities couched in extremely general terms. The words "adequate" or "inadequate" are favored and supplementary accounts, in quantitative terms, are rarely supplied. Or, if they are, they are given in terms of gallons/per capita of consumption. Such data are calculated by and for engineers but have little significance for health.

Attempts have been made by certain official agencies, in recent years to amass data on this subject by the questionnaire-survey method. Data from one such survey, directed by the Eastern Mediterranean Office of the World Health Organization, are presented below. The Technical Resources Division of the International Cooperation Administration circulated a questionnaire early in 1960 among its staff members located in countries of Africa and Asia which are receiving technical assistance. Response, however, was fragmentary and the result of this endeavor was to illustrate again the difficulties attending efforts at securing quantitative data which are at once uniform and worldwide.

Presentation of available data

In connection with a study of technical, financial and administrative aspects of water supply in the urban environment in the Caribbean, Central and South America, Wolman has presented the following figures: Of an estimated population of almost 150,000,000 persons distributed in 18 countries of the Caribbean, Central and South America, 34,848,000, or 23.3 per cent, reside in cities of 50,000 or more inhabitants. Of this segment, 7,813,000, or 22 per cent, lack water services. It was considered that a house or a patio lacked water service if it was not connected by pipe to a pressurized community supply. In addition, 12,639,000 persons, or 8.5 per cent, live in cities of 10,000 to 50,000 inhabitants and of these, 5,907,000, or 47 per cent, are without water service. Finally, some 12,581,000 persons, or 8.4 per cent, inhabit communities of 2,000 to 10,000 persons, in which 8,861,000, or 70 per cent, are without water service. The data are presented *in toto* in Tables 62 and 63.

In most countries of the Caribbean, Central and South America, with few exceptions, the population is predominantly rural. (See Table 64.) Yet the data presented here represent only urban areas. Wolman points out that the work of sanitation has advanced from the principal urban areas to the rural areas, and never the reverse. Since these data indicate that a large segment of the urban residents of the Caribbean, Central and South America (39.1 per cent) lack supplies of clean-piped water, the rural population may be assumed to exist under at least an equal state of deprivation, and actually surely much greater.

In 1961, the Eastern Mediterranean Office of the World Health Organization conducted a survey of piped water supplies in urban areas of the countries under its purview. The resulting data, compiled from various sources, are presented in Table 65. Although incomplete, some comparative figures were forthcoming from all countries with the exception of Yemen.

The data draw attention to the essentially rural nature of the total population of this area. In only three countries, Israel, Lebanon and Kuwait, does the urban population exceed the rural, while in Tunisia the urban population is 50 per cent of the total. Again, the same three countries have 90 per cent or more of the total population supplied with piped water. In Egypt, 83 per cent of the population is reportedly supplied with piped water. Only in Israel is a large proportion (95 per cent) of the population reported to have house connections for their piped supplies. In all other countries, the data indicate an impressive lack of piped water supplies to large parts of the urban population and to the greater part of the rural population.

DISCUSSION

Because of the dearth of comparable figures from other of the survey areas, the figures from the Caribbean, Central and South America must serve as typical of the situation with regard to water supply. However, it would be most unwise to attempt an extrapolation to cover the remainder of the survey areas. The Caribbean, Central and South America are more advanced in many ways than the countries of the other major geographic areas of the survey. Although it has not proved feasible to gather equivalent data for the remainder of these areas, the assumption may be made that such data would support the proposal that the Caribbean, Central and South America represent the most developmentally advanced of all the survey areas.

Specific and quantitative data on sewerage systems in the survey areas is even more sparse than data on

Table 62. Total estimate and percentage of population without water service[1] in the cities of 18 Latin American countries[2], by size of city (data from Wolman, 1959)

	ESTIMATED POPULATION 1 JULY 1958 (THOUSANDS)	CITIES OF 50,000 OR MORE PERSONS					CITIES OF 10,000 TO 49,999 PERSONS					CITIES OF 2,000 TO 9,999 PERSONS				
		NUMBER	TOTAL POPULATION		POPULATION WITHOUT WATER		NUMBER	TOTAL POPULATION		POPULATION WITHOUT WATER		NUMBER	TOTAL POPULATION		POPULATION WITHOUT WATER	
			NUMBER	PER CENT	NUMBER	PER CENT		NUMBER	PER CENT	NUMBER	PER CENT		NUMBER	PER CENT	NUMBER	PER CENT
Totals	149,509	114	34,848	23.3	7,813	22	507	12,639	8.5	5,907	47	2,402	12,581	8.4	8,861	70
Argentina	20,256	26	9,158	45.2	1,241	14	84	2,241	11.1	732	33	375	2,053	10.1	1,439	70
Bolivia	3,305	4	557	16.9	160[3]	29[3]	4	118	3.6	83	70	40	182	5.5	136[4]	75
Brazil	62,725	33	12,259	19.5	3,006	25	187	4,973[5]	7.9	3,039	61	950	5,260[5]	8.4	4,153	79
Chile	7,314	9	2,457	33.6	1,035	42	39	1,050	14.4	488	46	80	474	6.5	238	50
Colombia	13,522	14	3,189	23.6	669	21	42	923	6.8	266	29	254	949	7.0	413	44
Costa Rica	1,072	1	135	12.6	3	2	6	92	8.6	—	0	16	73	6.8	1	1
Dominican Republic[6]	2,791	2	429	15.4	99	23	7	146	5.2	72	49	27	166	5.9	103	62
Ecuador	4,007	3	839	20.9	126	15	9	174	4.3	63	36	49	257	6.4	157[7]	61
El Salvador	2,434	2	289	11.9	62	21	10	164	6.7	59	36	43	181	7.4	142	78
Guatemala	3,549	1	370	10.4	74	20	4	83	2.3	59	71	83	418	11.8	314	75
Haiti	3,426	1	199	5.8	88	44	6	82	2.4	37	45	22	110[8]	3.2	105	95
Honduras	1,822	1	97	5.3	52	54	4	88	4.9	54	61	29	136	7.5	94	69
Nicaragua	1,376	1	175	12.7	63	36	8	169	12.3	83	49	21	107	7.8	75	70
Panama	995	2	198	19.9	—	0	3	45	4.5	23	50	21	92	9.2	30	32
Paraguay	1,672	1	240	14.4	100	42	3	51	3.1	51	100	40	168	10.0	161	96
Peru	10,213	3	1,437	14.1	114	8	22	762[9]	7.5	134	18	151	962	9.4	735	76
Uruguay	2,710	1	850	31.4	150	18	28	594	21.9	218	37	43	187	6.9	123	66
Venezuela	6,320	9	1,970	31.2	771	39	41	884	14.0	446	50	158	806[10]	12.8	442	55

1. A house or patio is considered to lack water service when it is not connected by pipe to the water supply system.
2. Excepting Mexico, for which data were lacking according to size of the city, and Cuba, for which data were lacking.
3. Estimate based on information from three of the four cities.
4. Estimate based on information from 22 of the 40 cities.
5. Population estimated by supposing an annual increment of 4.5 per cent in the census population.
6. Population estimated by supposing an annual increment of 10 per cent in the census population of cities larger than 50,000 and 5 per cent in all the other cities of more than 2,000 inhabitants.
7. Estimate based on information from 12 of the 49 cities.
8. Population estimated by supposing an annual increment of 2.5 per cent in the census population.
9. Population estimated by supposing an annual increment of 4 per cent in the census population.
10. Estimate based on the proportion of the total population of this group in the last census.

water supplies. It has been said that the presence of a water supply system in a community makes necessary the installation of a sewerage system, but this is probably not true in the majority of underdeveloped tropical communities.

From the point of view of the epidemiologist, sewerage systems have great public health significance. The careless disposal of waste contributes to the situation which makes a piped water supply a necessity. However, it must be pointed out that the public health significance of sewerage is not on a level with a safe, piped water supply easily available to the home. In the United States and the rest of the western world, sewerage lagged behind water installations by at least ten years or more. At

Table 63. Total and percentage of population without water service in four territories of the Americas, by size of city, 1958

(data from Wolman, 1959)

	ESTIMATED POPULATION 1 JULY 1958	CITIES OF 50,000 OR MORE PERSONS					CITIES OF 10,000 TO 49,999 PERSONS				
		NUMBER	TOTAL POPULATION		WITHOUT WATER		NUMBER	TOTAL POPULATION		WITHOUT WATER	
			NUMBER	PER CENT	NUMBER	PER CENT		NUMBER	PER CENT	NUMBER	PER CENT
Barbados	231,000	1	100,000	43.3	61,000	61	3	62,600	27.1	44,500	71
British Guiana	533,000	1	99,200	18.6	—	0	1	14,700	27.6	—	0
French Guiana	31,000	0	—	—	—	—	1	15,000	48.4	2,000	13
Surinam	241,000	1	100,000	41.5	18,200	18					
[1]							4	15,200	6.3	7,000	46

[1] Data for cities of 2,000 to 9,999 persons in Surinam.

Table 64. Population of urban zones[1] and rural zones estimated in thousands and estimated number and percentage of urban residents without water service[2] in 19 countries of Latin America in 1958

(data from Wolman, 1959)

	TOTAL POPULATION	URBAN POPULATION			RURAL POPULATION	
		TOTALS	WITHOUT WATER		TOTALS	PER CENT OF TOTAL
			NUMBER	PER CENT		
Totals	181,857	74,746	29,209	39.1	107,111	58.9
Argentina	20,256	13,452	3,412	25.4	6,804	33.6
Bolivia	3,305	857	379	44.2	2,448	74.1
Brazil	62,725	22,492	10,198	45.3	40,233	64.1
Chile	7,314	3,981	1,761	44.2	3,333	45.6
Colombia	13,522	5,061	1,348	26.6	8,461	62.6
Costa Rica	1,072	300	4	1.3	772	72.0
Dominican Republic	2,791	741	274	37.0	2,050	73.5
Ecuador	4,007	1,270	346	27.2	2,737	68.3
El Salvador	2,434	634	263	41.5	1,800	74.0
Guatemala	3,549	871	447	51.3	2,678	75.5
Haiti	3,426	391	230	58.8	3,035	88.6
Honduras	1,822	321	200	62.3	1,501	82.4
Mexico	32,348	14,678	6,628	45.2	17,670	54.6
Nicaragua	1,376	451	221	49.0	925	67.2
Panama	995	335	53	15.8	660	66.3
Paraguay	1,672	459	312	68.0	1,213	72.5
Peru	10,213	3,161	983	31.1	7,052	69.0
Uruguay	2,710	1,631	491	30.1	1,079	39.8
Venezueia	6,320	3,660	1,659	45.3	2,660	42.1

[1] Ordinarily urban zones are composed of cities of 2,000 or more inhabitants; in Mexico, 2,500 or more.
[2] It is considered that a house or patio does not have water service when it is not connected to the pipeline of the water distribution system.

the same time, enteric death rates declined rapidly. In the western world, the drop in enteric death rates can be correlated with the installation of safe water supplies alone.

Most of the major urban centers of the tropics would seem to possess some measure of a water-borne sewerage system. On the other hand, sewers are for the most part non-existent in most rural communities of the tropics of 2,000 to 10,000 population, the exceptions being elementary in form and restricted in coverage.

SUMMARY

Of the more than 74,000,000 urban residents of the Caribbean, Central and South America, representing about 40 per cent of the total population, about 39 per cent lacks piped water supplies. When considered by size, the greatest proportional lack is revealed in the smaller communities. Thus, 70 per cent of communities of 2,000 to 10,000 inhabitants lacks piped supplies, compared with 22 per cent of residents in communities of 50,000 or more population.

Observation is made of the fact that the figures at hand have been obtained from the most materially developed of all the major survey areas. The data may be expected, then, to represent in the aggregate the most advanced situation with respect to safe piped water supplies in all of the five major survey areas.

In a similar vein, data from the countries under the purview of the Eastern Mediterranean Office of the World Health Organization convey the impression that even the urban communities of this region are deficient in supplies of safe water. These data, however, are probably not to be compared with those obtained from the Caribbean, Central and South America.

Data on water-borne sewerage systems, in conformity with the revised Plan of the Survey, were not available for the survey areas.

Reference

1. Wolman, Abel—1959. Aspectos técnicos, financieros y administrativos del abastecimiento de agua en el medio urbano en las Américas. Bol. Of. Sanitaria Panamericana, v. XLVII (5), pp. 375-400.

Table 65. Data on piped water supplies in the countries of the eastern Mediterranean region

COUNTRY	TOTAL POPULATION	URBAN POPULATION		PERCENTAGE OF TOTAL POPULATION SUPPLIED		CONSUMPTION IN LITRES PER CAPITA PER DAY	
			PER CENT OF TOTAL	WITH PIPED WATER	WITH HOUSE CONNECTIONS	URBAN	RURAL
Cyprus	500,000	190,000	38.0	38.0	34.0	85-140	
Ethiopia	20,000,000	1,200,000	6.0	2.5	1.0	125[1]	
Iran	20,000,000	9,000,000	45.0	15.0	7.5		
Iraq	7,000,000	2,000,000	29.0		29.0	110-180[2]	
Israel	2,000,000	1,500,000	75.0		95.0	275[3]	
Jordan	1,600,000	640,000	40.0		24.0	50	
Kuwait	230,000	195,000	85.0	90.0	9.0	210[4]	
Lebanon	1,500,000	990,000	66.0	90.0		40-120	
Libya	1,100,000		25.0-30.0			110-150[5]	
Pakistan, East	42,000,000	2,600,000	6.0	3.8	0.3	40	
Pakistan, West	40,000,000	7,250,000	18.0	11.0	7.0		
Saudi Arabia	8,000,000	2,000,000	25.0	31.0	6.0		
Somalia	3,000,000	600,000	20.0		2.0	30	
Sudan	10,250,000	750,000	7.5	6.5	4.0	130[6]	
Syria	4,500,000	1,700,000	38.0	32.0	26.0	70-180	15-50
Tunisia	3,800,000	1,900,000	50.0	40.0		40-136	
U.A.R.—Egypt	26,000,000	8,000,000	32.0	83.0	28.0	80-210	9-50
Yemen	4-7,000,000						

[1] Planned consumption in Addis Ababa.
[2] Consumption in the capital reaches 270 lpcd (litres per capita per day).
[3] Includes also industrial consumption. Standard minimum consumption: 90 lpcd.
[4] Of the total consumption, 100 lpcd represents fresh water and 110 lpcd represents brackish water.
[5] Consumption in Benghazi and Tripoli.
[6] Consumption in Khartoum; 23 per cent of rural areas are supplied through boreholes, haffirs, and government wells.

Part IV

Chapter 10

Tropical Health and the Economy of the United States

Willard H. Wright

There has been presented in Parts I and III of this report a summation of the disease picture in the tropics and an accounting of health resources. It is obvious from the data that the resources are failing in most sectors to meet the needs. The situation cannot but be reflected to some extent on the interests of the United States and its economy, as related to its trade with tropical countries and its dependence on the tropics for many of its strategic materials. It is the purpose of this section to analyze, insofar as data are available, the impact of low health standards in the tropics on our internal economy.

The Extent of Health Needs

As pointed out in Part I, the measurement of health needs in the tropics presents a difficult task. It is not possible to obtain a true picture of the extent of disease because epidemiological services for many parts of the area are non-existent or are only poorly developed. The reporting of vital statistics from these areas is very incomplete. For instance, the data relative to infant and neonatal mortality are lacking for many countries. Certain of the infectious diseases are generally notifiable but a large number are not reportable in most countries. These include many of the parasitic, mycotic and viral diseases.

An accurate evaluation of the nutritional disease problem is almost impossible at this time. There is no complete information on composition of diets in various tropical countries and no complete coverage of caloric and protein intake. Information is especially needed on sources of protein.

Protein malnutrition may not only lead to serious disease and death in young children; there is evidence that it may also leave sequelae which adversely influence health in later life. This and other nutritional deficiencies affect both physical and mental development. The relationship between mortality in a given age group and malnutrition is invariably complex, because of numerous factors other than nutrition which influence the health of the individual. Information concerning the incidence of malnutrition which any available figures can provide cannot be regarded as more than suggestive.

Health problems in many parts of the tropics are intimately linked with other factors. These factors are multiple and it is difficult to assess their influence on disease *per se*. Such factors include social mores, native cultures, religion, education, food production and distribution, transportation facilities, sources of energy, general economic levels, and others. All of these are more or less intertwined with disease problems.

In the less developed areas, the illiteracy rate is 65 per cent in contradistinction to only 5 per cent in the more developed areas of the world. There are only 75 miles of road per 1,000 square miles of area in the tropics as against 1,000 miles in the same area in developed countries. Gross national product per capita in dollar equivalents runs about $120 for the tropics, whereas it is approximately $1,400 for Western Europe and the United States and Canada.[1] In only 1 of the 169 countries in this survey is it greater than $700.

There are other indices which point up striking differences. For instance, with 43 per cent of the world's population in 1957, tropical countries produced only 29.86 per cent of the world's electric energy, had only 12.15 per cent of world railway traffic, and possessed only 9.4 per cent of the world's automotive vehicles.[2]

Even though it is not possible to portray the true extent of disease in the tropics, there are certain criteria which give some inkling of the seriousness of public health problems in this part of the world. Three of these indices comprise infant mortality, proportionate mortality (the percentage of deaths under five years of age), and life expectancy at birth. These indices in the tropics may be compared with similar ones in the United States and certain northern European countries.[3]

The highest infant mortality rates per 1,000 births occur in Africa, followed by Asia, South America, Oceania, Central America and the Caribbean area. In only two countries in this vast area is the reported rate lower than that of 26.3 in the United States; these countries are Lebanon with a rate of 12.1 and Guam with a rate of 24.

In the case of proportionate mortality, the rate is again highest in Africa (64) followed by slightly lower rates in Asia, the Caribbean area, Central America, and South America in that order. In no tropical country does the rate parallel that for the United States (8). Even lower rates are found in northern European countries, such as Sweden with 3.3.

In the United States, life expectancy at birth was 69.6 years in 1956. In no tropical country is the average life span as high; in most, it is much lower.

The remarkably high mortality rates among infants in the tropics are associated mainly with infectious and nutritional disorders. The infectious diseases are the chief cause of general mortality. Among 20 countries in the Americas, they are the main cause of death in 16.[4]

Summary of Health Resources

Health resources in the underprivileged countries of the tropics are scarcely comparable with similar resources in the countries of Europe and North America. A wide gap exists in the tropics between health needs and resources.

For instance, there are in the United States 756 persons per physician. For Africa, the figure is 9,000; for South Central and Southeast Asia 7,000; for Southwest Asia 5,000; for Oceania 3,800; and for the Caribbean, Central and South America 1,900.

In the case of graduate, registered nurses, there was in the United States in 1958 one employed nurse for each 353 inhabitants. For 1957, the following are the figures for the number of persons per nurse in various tropical areas: Southwest Asia 12,100; South Central and Southeast Asia 11,700; Africa 4,900; the Caribbean, Central and South America 3,800; and Oceania 2,100.

In the United States, there are 9.01 hospital beds per 1,000 population. In South Central and Southeast Asia the figure is 0.64; in Southwest Asia 1.24; in Africa 1.79; in the Caribbean, Central and South America 3.16; and in Oceania 6.01.

The Federal Government per capita expenditure for health in the United States in the fiscal year 1957-58 was $11.60. In 1957 the corresponding figure for South Central and Southeast Asia was $0.83; for Africa $1.21; for Southwest Asia $1.66; for the Caribbean, Central and South America $2.68; and for Oceania $4.51. These figures do not include capital expenditures.

Material Interests of the United States in the Tropics

The tropics constitute vast reservoirs of raw materials in many of which this country is deficient. The industrial machine of the United States would be subjected to heavy strain if the steady flow of strategic raw materials from the free nations of Africa, Asia and Latin America were cut off or seriously reduced. We import from these areas 100 per cent of natural rubber, tin, industrial diamonds, graphite, abaca and quebracho; 86 per cent of manganese ore; 78 per cent of bauxite; 60 per cent of cobalt; and considerable amounts of chromite, tungsten, platinum, mercury and other materials.[5] To make a certain type of jet plane, we need to import 90 per cent of the chromium, 91 per cent of the nickel, 84 per cent of the aluminum (bauxite), 30 per cent of the copper and 90 per cent of the cobalt.[6] Most of these materials come from tropical countries.

It is probable that our dependence on tropical areas for raw materials will increase as time goes on. The President's Materials Policy Committee, headed by William S. Paley, estimated that by 1975 United States consumption of raw materials will increase by 53 per cent, with increases in total minerals of 90 per cent, nonferrous metals 85 per cent, mineral fuels 97 per cent and other nonmetallic minerals 133 per cent. Most of these materials will have to come from foreign areas outside the continental limits of the United States and a large proportion of them will be obtained from tropical countries.

Not only is this country dependent on tropical areas for strategic materials, but tropical countries absorb a considerable proportion of our exports. Likewise, we import from these nations many items which we cannot well do without, but which cannot be directly associated with our defense effort. Our trade with tropical countries varies from year to year. Actually, there has been a percentage decrease during the past ten years, as Europe has increased her industrial capacity. For instance, imports from the tropics in 1949 represented 59 per cent of total imports; in 1953 they amounted to 51.5 per cent; and in 1959, 40.8 per cent. A slight increase was recorded in 1960 with a figure of 41.2 per cent.

Exports to countries represented in this survey have been declining on a percentage basis, although monetary value has shown a substantial increase. In 1953, 42 per cent of our exports went to these countries; in 1959, 38.5 per cent; and in 1960, 35.3 per cent. The total value of exports in millions of dollars to the above-mentioned countries was as follows: In 1953, $4,986.5 million; in 1959, $6,084.1 million; and 1960, $6,632.2 million.

It is thus evident that economically we have a very large stake in the tropics. It seems probable that our trade in this area will increase throughout the coming years as standards of living are improved and the underdeveloped countries are able to raise their gross national product. It has been pointed out that, as production rises in the industrial countries, there is a growing need for the products of the less developed countries. The trade of the United States is greatest with those countries which one would suppose to be its fiercest competitors, namely, Canada and Western Europe.

United States private investment abroad is increasing year by year. In Latin America alone in the last 30 years, it has increased from $3,600 million to $8,730 million.[7] At the end of 1960, total United States direct investment abroad was $32,744 million, of which $12,599 million, or 38.5 per cent, was in Latin America, Africa, Asia and Oceania.[8] The returns on this investment are affected by tropical diseases, just as these diseases add to the cost of imports from these areas which are mainly in the tropics.

In one of its special survey reports, the magazine *Business Week* estimated that by 1975 United States investments abroad will amount to $75,000 million of which approximately $55,000 million will be invested in Latin America, the Middle East and Africa.[9]

The underdeveloped countries offer huge market potentials for United States goods. It has been estimated[6] that our 1959 exports to these countries instead of $6.4 per capita would have been $15.4 per capita if the rate had been only one-half of that to the developed countries.

The National Planning Association[10] foresees that United States exports at 1958 prices will increase from $27.0 billion in 1957 to $44.7 billion in 1970. At the same time imports will rise respectively from $19.2 to $36.2 billion, leaving a net balance of exports over imports of $8.5 billion.

Paul G. Hoffman[11] makes the assumption that over the ten-year period 1961-1970 there will be a doubling of the per capita income growth rate in 100 of the less developed countries, a rate which would lead to import requirements in the neighborhood of $440 billion. To bring about this increase, the underdeveloped nations will require additional foreign exchange on the average of $7 billion a year. This amount is about $3 billion more a year than flowed to the less developed areas in 1957-1958. If the developed countries in the 1960's furnish the same proportion in relation to the total imports of the less developed countries that they did in the 1950's, their total exports to the latter areas might come to around $320 billion over the ten years, of which $110 billion might represent the United States share.

The Cost of Tropical Diseases

Unfortunately, when it comes to the economics of tropical disease, we have few factual data upon which to draw conclusions. Some of the data are no doubt suspect.

It has been stated that annual expenditures on medical services by the Standard-Vacuum Oil Company in Indonesia, an amount equivalent to 10 per cent of total wages and salaries, have paid off in an extremely low "noneffective sickness rate."[12] The figures on absences caused by malaria are particularly impressive. In 1940, the average absences because of malaria were over 8 per cent of total employment, while in 1956 the figure was down to 0.3 per cent. In addition, a well-planned anti-tuberculosis program has resulted in a reduction in annual occurrence of new cases to a low rate of less than 1 per cent.

Since malaria is one of the few tropical diseases in which spectacular advances in control have been achieved in recent years, it is pertinent to estimate savings from such control.[13] Malaria is said to have cost Afghanistan $20 million per year and Ceylon about $30 million. In India, the disease exacts a toll of about $500 million per year, a sum about two and one-half times the calculated price of eradication. The annual loss from malaria in Mexico is reported to be $174 million; the estimated cost of eradication is approximately $20.5 million.

Calculated costs of a malaria epidemic in 1953 in Kao-shu Township in southern Taiwan amounted to $29.64 per person, whereas the per capita cost of malaria control in Taiwan at that time was below $2.28. In Thailand before 1950 malaria is said to have been responsible for an annual loss of 50 million agricultural-worker days, an amount of labor sufficient to produce 150,000 metric tons of milled rice with an export value of $15 million.

Attempts have been made to estimate the economic loss due to schistosomiasis in certain areas.[14] The World Health Organization Leyte schistosomiasis project in the Philippines calculated the annual wage loss for 125,000 infected persons at $1,350,000. The total medical expenditure for 100,000 persons who showed definite symptoms was $5,282,500. In Japan the economic loss, plus the cost of treatment for sufferers in an area of 90 square miles, was reckoned at $3 million per year, and the loss for the Island of Kyushu at $2,500,000. In Egypt, where the disease is hyperendemic, the reduction in total economic productivity is estimated to be some 30 per cent, and the financial loss $57 million annually. Medical treatment for 1,700 American soldiers infected in Leyte during World War II cost $3 million, and it was calculated that 300,000 working days were lost. In *Schistosoma japonicum* infections the working ability of patients is reported to be reduced by 15 to 18 per cent in mild cases, by 50 to 57 per cent in moderate cases, and by 72 to 80 per cent in severe cases.

Some of the cost of tropical diseases is passed along to the ultimate consumer of the products or goods produced. It has been estimated that such products are priced at least 5 per cent higher than need be if it were not for the cost of malaria.[15] The total value of United States imports from malarious areas in 1958 was $2,156,180,500. A 5 per cent added cost for these imports would amount to $107,809,025. Acceptance of figures such as these must of course be tempered with judgment and certain reservations.

Health and the Local Economy

For many reasons the economic value of health is difficult to measure. The state of health of the individual varies from day to day or from time to time and can only be evaluated in the aggregate. Over fixed periods of time the general health status of a population can be gauged with some degree of satisfaction provided adequate data are collected and properly collated. This is seldom done in most of the tropical countries with which this survey is concerned.

Many factors other than health are of concern in the economy of peoples and nations. Political stability is almost a *sine qua non.* Good financial management is important. The type of economy looms large in determining the welfare of any nation. An economy based on agriculture, primitive or modern, in this day and age is at a disadvantage in most areas. Those nations which have managed to industrialize or which have leavened their agriculture with a balance of industrialization have generally been in a more favorable situation in the modern world. Capital and productivity play a large role in promoting the standard of living and increasing the per capita income. Education is of importance. With these and other component considerations operating in devious ways, it is hazardous to attempt an analysis of the role of health in the general economic welfare. Yet there is good evidence that low health standards and the prevalence of disease act as impediments to the ability of peoples to achieve a better standard of living to which all human beings aspire. It is mainly in the tropical countries that the economy is at a low level, and it is not entirely accidental that in these same countries morbidity, mortality and life expectancy compare unfavorably with the more fortunate areas of the world. It is only when one attempts to apply a yardstick and to produce factual data applicable to the situation that difficulties are encountered.

In recent years, an alarming finger has been pointed at the rate of population increase in some of the underdeveloped countries and only cataclysmic results have been visualized in event that the increase is allowed to continue unabated. However, there is no such thing as "over-population" in the absolute sense and the rate of natural increase cannot be considered alone and without reference to the development of economic resources. Population pressures are not uniform throughout the area with which this survey is concerned. The section on Government health services in Chapter 9 presents information on vital statistics which indicates that Southwest Asia and South Central and Southeast Asia are witnessing the greatest "explosions" in population. Latin America follows next in order. At present, at least, Africa presents no problem. Thus, there is little virtue in generalizing with regard to the inherent dangers in population increases. The problem presents different aspects in different geographical regions and even in different countries in the same part of the world.

There are of course grounds for concern in some countries, a good example of which is India. However, it is felt that disturbing predictions do not always give proper weight to mitigating factors. The difficulty in feeding the increased populations has been stressed without due regard, it is believed, to the remarkable scientific advances in the field of agriculture which have resulted in some countries in such increased production that food is actually a drug on the market. These advances have come from many directions. Among them are mechanization, better fertilizers and their increased utilization, better seeds, disease resistant varieties of crop plants, and more efficient insecticides for disease control and more effective large scale methods for their application. While all of the new developments do not lend themselves to application to all types of agriculture, the potential still remains for similar progress elsewhere.

Again, India may be referred to as a country in which population increase has been especially noteworthy. The economic case for India has been examined exhaustively and authoritatively by Coale and Hoover.[16] These authors point out that for some decades prior to 1950, Indian agriculture had shown signs of failure to keep pace with the growth of population. The land under cultivation had slowly increased but not at a rate in keeping with the increase in the farm population or the total population. Per capita food supply diminished substantially between the years just prior to World War II and the end of the 1940's. Even by 1957-1958, it was markedly substandard. The following are the estimated caloric and protein content of national average food supplies per capita for 1957-1958, as compared with those of the United States for 1958-1959:[17]

	Calories	*Total protein grams*	*Animal protein grams*
India	1,800	47	6
United States	3,100	93	65

Under the First Five-Year Plan, programs for increased agricultural production were given first rank. The overall official index of such production was 100 in 1949-1950. By 1955-1956 it was 115.[16]

This achievement was reached through an extension of land under cultivation, increased irrigation, improved seeds, improvements in livestock, improved methods of cultivation and increased use of fertilizers. There is still need for additional employment of fertilizers and the use of green manure is being promoted and commercial fertilizer production increased. In 1958-1959, the amount of nitrogenous fertilizers used in the United States was 9.13 times that employed in India.[17] However, the amount of land under cultivation was somewhat less in India.

Coale and Hoover[16] have stated the following:

> "With a liberal margin for the uncertainties of estimate and the vicissitudes of Nature, it appears reasonably safe to say that India's output of food and other agricultural products can, for the next two or three decades, increase at least as fast as the maximum rate of growth of the consuming population (78 per cent in 25 years)."

Regardless of India's ability to feed her increasing population within the immediate future, her chances of achieving a more productive economy during the next few decades will be considerably enhanced if fertility is reduced. Some progress is being made in this direction following the establishment of a Family Planning Board in the Ministry of Health in 1956. Family planning units have been incorporated in numerous rural and urban health centers and evidence indicates that the program is gaining momentum. However, it is still true that many Indians consider the number of children their only form of old age security. Time will tell whether the motivation is sufficiently strong to reduce the birth rate within a short enough period to increase substantially the economic growth and relieve some of the population pressures.

A pessimistic note is expressed by Thompson.[18] He doubts that the rate of agricultural production achieved during the First Five-Year Plan can be sustained and points out that in three of the five years there were good monsoons, which "must be regarded as a windfall of very great importance." Thompson questions whether India has more than well begun to work on her agricultural problems and regards the lack of vigorous efforts to acquaint the people with the need for a slower growth of population as a piece of indirect evidence that the difficulties confronting agricultural improvement are being underestimated.

Mexico offers an interesting and encouraging example of the possibilities of an accelerated expansion of agricultural production through the application of modern techniques. Over the past two decades food production in Mexico has increased at a rate of almost 4 per cent per annum and has outpaced the growth rate in gross national product and population.[19] This represents, as far as is known, the highest sustained rate of increase in agricultural production that has yet been achieved.

Frederiksen[20] has offered evidence to refute the oft repeated assertion that health improvements spell economic disaster. His data concern Ceylon, a country which is situated in the tropical region witnessing at this time the greatest relative increase in population and considered to be the most dangerous "population explosion" area. Frederiksen states in part, as follows:

> "The death rate in Ceylon declined from 19.8 to 14.0 per 1,000, or 29 per cent, in the year from 1946 to 1947. Being most abrupt, this decline in the death rate has given rise to postulations that advances in public health techniques permit significant reductions in the death rate, independently of economic development. Thus, the application of public health measures would increase the rate of population growth and economic development lags. Frequently cited, such postulations may have been accepted as descriptive of the relationship between health and economic development in underdeveloped areas. However, these hypothetical determinants and consequences of mortality trends in Ceylon are not confirmed by the sequence of events."

By 1958, the mortality rate had been reduced to 10.1 per thousand. Accompanying this decline was a reduction in the birth rate which was 35.8 per 1,000 population as against a postwar peak of 39.8. In the 20 years from 1938 to 1957, the population of Ceylon increased 63.5 per cent; during the same period the gross national product per capita rose 57.7 per cent. Substantial increases also took place in food production.

The role of improved health in bringing about increased productivity would appear to have been slurred over by many individuals who have been especially concerned over population increase. The individual suffering from the chronic manifestations of malaria, schistosomiasis or hookworm disease with a low caloric and protein diet simply cannot muster the energy required for an adequate day's work. It is thus certainly obvious that ill health or lack of good health lowers the working ability of the individual. If this is so, general low levels of health in any working population will affect the potential output of that population. In discussing the population problem of India, Coale and Hoover [16] were of the opinion that "any greater improvement in health would tend to have a positive effect on productivity." These authors state also that "better health is itself an achievement at least on a par with increases in income as recorded by conventional statistics."

In many of the underdeveloped countries with low health standards, the average productive working life of the individual is markedly restricted. Even if he begins to contribute significantly to the work load of the community at as young an age as 15, his total contribution in many areas is limited to 20 to 30 years. In contrast, in most of Europe and in North America, the productive life of the individual is probably around 40 to 45 years even if he begins to work much later. This considerable difference in the contribution of the average individual to the productivity of the community cannot be totally disregarded.

It has been aptly said that in most underdeveloped countries, money invested in people is likely to prove as materially profitable as money invested in other resources. Investments in public health and education frequently result in a greater expansion of goods and services than similar capital investments. Health measures that directly increase human productivity are those directed at the reduction of disease and improvement in diets. These measures lie mainly in the field of preventive and not curative medicine. The elimination of malaria, yellow fever, typhoid and paratyphoid, and many other infectious diseases has been almost complete in many areas. Less progress has been made in improving nutritional levels. Even in countries which provide an adequate number of calories per person on the average, great differences in economic conditions between classes of people suggest that a large segment of the population is not receiving even a minimum number. Furthermore, the average diet is not well balanced and lacks the essential amino acids found most abundantly in protein foods from animal sources. The reduction in the debilitating infectious diseases and improvements in diet increase the capacity of the population for work and represent an economic contribution to the welfare of the country.[19]

It is a problem to find an area of experience in which recent events would provide emphasis for this thesis. Possibly, one of the better examples is Puerto Rico, although there are certain factors which make the island something other than a typical example.

During the past two decades marked progress has been made in the advancement of public health and the improvement has no doubt influenced the productivity of the worker and the rate of economic growth. The death rate has dropped from 19 to 7 per thousand in the past 20 years with a gain in life expectancy from 41 years in 1930 to more than 68 at present, a figure close to that for life expectancy in the United States. Another encouraging sign in the Puerto Rican picture is a reduction in the birth rate, which averaged more than 39 per thousand in the 1935-1939 period. The rate reached a peak of over 42 in 1957 but has since decreased to 32 per thousand. Undoubtedly this change has been due in part to rising economic levels and family limitation practices, although migration to the mainland of a considerable number of persons of reproductive age has played a role.

It will be shown that with health improvement and the remarkable drop in the death rate, economic progress on the island has been exceptional. As stated, certain extraneous factors may have had some bearing on this achievement. The island has had since 1933 an unusual amount of aid of various kinds from the United States and this economic assistance spread out over this period of time represents an atypical situation as compared with many other so-called underdeveloped areas. In fact, much assistance has been given to Puerto Rico since 1898 when the country was taken over from Spain. There has been considerable migration from Puerto Rico during the last decade. This migration has tended to balance to some extent the increase in population. The island is the second most densely populated in the Caribbean and unfortunately has a relatively small proportion of arable land. Formerly, sugar constituted the chief export commodity, supplemented by needlework, the value of which was relatively small. Under the protection of the United States tariff system, sugar, which was of secondary importance under Spanish rule, grew rapidly until it dominated the economy. By 1940, the rising rate of population growth made necessary an increase in production of 2 per cent a year merely to maintain a constant income per head.[21] A single crop was inadequate to sustain such a population.

While the Puerto Rican economy has achieved a rapid growth rate since 1940, the greatest acceleration has taken place during the last ten years. This growth was influenced by a number of moves to bolster the economy, including the formation of the Puerto Rican Industrial Development Company, the creation of a Land Authority, the organization of the Planning Board and other steps.

As a result of these combined efforts, industrial output surpassed agriculture for the first time in 1955 and has been setting the pace of economic growth since then. Gross national product exceeded $1.4 billion in 1959, an increase of 6 per cent over 1958. For the fiscal year ending 30 June 1961, it was nearly $1.5 billion. Basic changes have taken place in agriculture with a considerably higher income per worker. By 1958, the market value of livestock products amounted to $76 million or almost 90 per cent of the farm value of sugar. In 1950, it was only 45 per cent of the sugar sales value.

Per capita income in Puerto Rico has also advanced. In 1940, it was $125. By 1950, it had increased to $300 and by 1959 exceeded $500, or over four times the average for the tropics as a whole.[22] Latest data indicate a figure of $622 for the fiscal year of 1961.[23]

Whether the economic improvements in the island can be sustained at the same rate of increase remains to be seen. Certain factors may tend to slow the momentum. However, public health improvements have no doubt influenced materially the productivity of the worker and the rate of progress to date.

The Economic Cost of Illness

The economic consequences of illness can be divided into three categories, viz: Resource use, resource transfer and resource loss.[24] These concern the nation as well as the individual.

Resource use includes the cost of public health and medical care programs. It has already been observed that these programs in the 169 countries embraced in this survey are inadequate to meet the needs, although heroic efforts have been and are being made to raise health standards. However, the standards have been elevated to the extent that the social scientists are pointing accusing fingers at health authorities for having saved lives and thus precipitating population crises. Little mention is ever made that the saving of lives is a worthwhile and humanitarian effort. Resource use also embraces the payments of the individual to the persons and the institutions ministering to him during his illness. In the developed countries, he pays the physician, the nurse, the pharmacist, the hospital and the private laboratory. In many of the underdeveloped countries, the sick person cannot command all of these services. Regardless of the type of ministration, however, he still pays for services, even though it may be only the services of the tribal medicine man or witch doctor.

Resource transfer refers to the cash payments for the time loss occasioned by illness. In the developed countries it is convenient to measure the magnitude of this transaction by having recourse to the records of social security programs. In the countries in the present survey, this particular category has little application. Most of these countries do not have social security programs. Indeed, it must be considered that in the underdeveloped countries, there is little or no form of monetary recompensation for illness; such as exists must be classified as extremely variable.

Resource loss is also of importance and includes the economic consequences of work days lost and decrease in productivity. In countries with social security and other systems of health insurance, factual data can be produced to indicate the extent of resource loss. However, it is extremely difficult, if not impossible, to measure resource loss in the areas of the present survey. It might be measured in part if data were available concerning the relative productivity of labor in various countries but such information is not at hand for most of the tropical countries. Again one might attempt to show the disparity between the percentage of active work force to total populations in advanced and backward nations that is importantly affected by life expectancies. While information is available in the Year Book of Labour Statistics of the International Labour Office, the data are not significant because in the less developed countries the tendency is to continue to work at more advanced ages than is the common practice in the industrialized nations of Western Europe and North America. In other words, the percentage of the working population over 65 in many tropical areas exceeds that in the United States. Since the individual is not under social security or other retirement system in the majority of countries represented in this survey, he must continue to work as long as possible in order to be able to eat and to avoid becoming a complete economic burden on his family.

There are, however, data to indicate that the percentage of economically active males is lower in some tropical areas than in the economically developed countries. In the countries of Asia and the Far East for which data are available, except the Philippines, 50 to 59 per cent of the males are economically active. In selected Latin American countries, the activity rates are around 55 to 57 per cent. The activity rates are considerably higher in the selected industrialized countries, being 65 to 67 per cent in Australia, France and the United Kingdom and 58 per cent in the United States.[25] The proportion of the population which falls into the most productive age group is determined by fertility and mortality. Thus the difference in rates cannot be wholly attributed to the aggregate state of health, although such has a considerable bearing.

A third line of investigation into the economic cost of illness in the tropics would be to gauge the amount and value of time lost from gainful occupation. Data from the International Labour Office have been examined but unfortunately such facts are available only for a few tropical countries. Actually, the number of days paid under social security programs for sickness per participant is on the average less in the tropics than for the United States and countries of Western Europe. It is obvious that the coverage varies in degree, or that the provisions of the various programs are different, or that the reimbursement in the tropics is on such a low scale that it pays the worker to remain on the job in spite of his illness. Other differences may be involved.

It would be helpful also if there were some way of estimating the loss of worker efficiency through debilitating diseases which are so prevalent in the tropics and which probably represent the chief cause of low productivity. Here again, the basic information is not available. Only a few illustrative examples can be cited.

In his admirable monograph "The Cost of Sickness and the Price of Health", Winslow [26] has cited examples of the relative economic loss from illness and malnutrition.

For instance, before the malaria control programs in the Transvaal and in Natal, 30 to 40 per cent more workers were recruited than necessary in order to allow for a margin of absenteeism on account of sickness. Following the elimination of malaria, it was found not necessary to maintain the reserve labor force.

In the Copperbelt area of Northern Rhodesia prior to the control of malaria, the number of working days lost was 2,030 for the year 1945. In 1946, following drainage and the use of DDT, there was a steady decline in days lost with a reduction by 1949 to 270.

In the Philippines, school absenteeism was reduced from 40 to 50 per cent daily to 3 per cent daily in three years from 1946 to 1949 in which intensive malaria control measures were in force. During the same time, daily time loss among workers in industrial enterprises was reduced from 35 per cent to 2 to 4 per cent. The same amount of output was possible in 1949 with only 75 to 80 per cent of the 1946 labor force.

Winslow has cited data on the increased work load possible with an increased caloric diet. Studies carried out in the Ruhr during World War II showed that 20 men constructing an embankment by dumping debris from railroad cars dumped 1.5 tons per hour when on a diet supplying only 820 calories per day in excess of the 1,600-1,800 calories needed for resting metabolism. When given a diet designed for workers in heavy industry, output increased to 2.2 tons per hour.

In a second study, 31 miners on a food allowance of 2,800 calories produced 7 tons of coal per day. An increase to 3,200 calories resulted in an output of 9.6 tons per day but also a decrease in weight. When the caloric allowance was increased further by 400 calories, production was raised to 10 tons per day and the body weight returned to normal.

SUMMARY AND CONCLUSIONS

Effort has been made to evaluate the impact of low health standards in the tropics on the internal economy of the United States. The extent of health needs in tropical countries and the resources available to meet these needs have been reviewed briefly as a means of orientation to the problem.

This country has many material interests in the tropics and is dependent on many tropical areas for a large share of its important strategic materials. Indications are that this dependence will increase rather than decrease as time goes on.

Foreign trade with tropical countries constitutes a substantial portion of our total imports and exports. As the European economy has improved during recent years, the percentage of trade with countries represented in this survey has declined. For instance, exports to these countries in 1953 comprised 42 per cent of total exports, whereas in 1960 the proportion had dropped to 35.3 per cent. However, the total value of these exports had materially increased over this period of time. The underdeveloped countries offer huge market potentials for United States goods and it is anticipated that trade with these areas will materially increase during the next ten years.

United States private investment abroad is increasing from year to year. At the end of 1960, direct investment abroad was $32,744 million, of which 38.5 per cent was in Latin America, Africa, Asia and Oceania. A national business magazine has estimated that by 1975 United States investments in foreign countries will amount to $75,000 million of which approximately $55,000 million will be invested in Latin America, the Middle East and Africa.

Effort has been made to assemble data on the cost of tropical diseases. Reliable information is meager. Available material consists mostly of estimates unsubstantiated by economic surveys.

The relationship of health to the economy of tropical areas has been discussed. Many factors other than health are involved in the economy. Yet it cannot be entirely accidental that a low per capita income coincides with high morbidity and mortality and a low life expectancy. In only one of the 169 national health jurisdictions represented in this survey is the per capita income more than $700 per annum. In most of the countries, it is much lower.

Some analysis has been attempted of the perennial question concerning the economic threats which will allegedly ensue from the saving of lives with a resulting lower morbidity and mortality and a longer expectancy of life. Examples are cited of India, Puerto Rico, Mexico and Ceylon, countries in which remarkable health advances have been made, advances which have been accompanied by economic improvement and increased agricultural production. Undoubtedly, however, a continued high rate of natural increase in certain countries will be of concern unless effort is made to reduce the birth rate or unless the rate is naturally lowered concurrently with health and economic improvement, a thing which has transpired in many areas in the past. There is no doubt, however, that a reduction in debilitating infectious diseases and improvements in diet will increase the capacity of tropical populations for work and represent an economic contribution to the welfare of the nation.

Difficulty has been encountered, however, in attempting to measure the impact of inadequate diets and debilitating infectious diseases on the working capacity of the individual. A discussion has been presented of the general economic consequences of illness, which can be divided into the three categories of resource use, resource transfer and resource loss. It is the latter which is of greatest importance in tropical countries in relation to the lowered working capacity of the individual and the low levels of labor productivity. Unfortunately, statistics are not available to provide for a satisfactory evaluation of resource loss in the tropics. Only a few meager citations can be offered.

It is quite apparent that authoritative studies are needed on the relationship of low health standards on the working capacity of the individual and on group performance. It was hoped that reliable information of this sort could be secured from business firms operating over long periods in the tropics but the data from such sources as reported in Chapter 9 were extremely disappointing. Data derived from adequate studies would materially strengthen the hands of health authorities and would be of considerable aid in securing necessary support for needed health improvements in tropical countries.

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Chapter 11

The Impact of Travel and Migration on Tropical Disease Problems

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In this section consideration has been given to illustrating by one or two examples the various categories under which the above topic may be discussed. No attempt has been made to explore the subject exhaustively, an effort which would have exceeded the time available.

The association between large population movements and the spread of those diseases which require only human contact to maintain transmission is of primary importance in epidemiologic science and many historical, well-documented accounts exist. There is less information regarding the spread of those diseases which need a specific vector or intermediate host. Because appropriate vectors or intermediate hosts may have a limited distribution in the new location, the transplanted diseases may not achieve a wide distribution. This seems to be the case with onchocerciasis and schistosomiasis in the Western Hemisphere. However, when unusually efficient intermediate hosts or vectors become well established, as in the case of *Anopheles gambiae* in Brazil, or were previously available in large numbers, as in the case of the *Haemagogus* mosquitoes which transmit jungle yellow fever, the associated diseases do not remain local problems.

Today the characteristic feature of international travel is the speed with which it can be accomplished. As a result, the rate at which potential carriers of exotic infections can be moved into nonendemic but potentially receptive zones is constantly increasing. Conversely, nonimmune citizens of well sanitated surroundings find it disturbingly simple to be transported to areas endemic for a multitude of obscure exotic infections not named in the International Sanitary Regulations. In this connection, the medical experiences of the Armed Forces in the Pacific Theater during World War II still present a sobering example.

Travel may involve single individuals or numerous individuals. Consideration must also be given to the accidental transport of infected disease vectors. Travelers may thus introduce or acquire disease. In the case of modern tourism it is usually a matter of acquisition of disease, since most tourists originate in countries where health conditions are relatively good and sanitary practices are well established.

Migrations are defined as movements of entire populations or substantial portions of populations. Their epidemiological significance lies in the fact that successful maintenance of many diseases depends upon the frequency of transmission and/or man-vector contacts. Migrations may be temporary, as is true of modern military operations and certain types of construction operations, such as dam construction. Here it is understood that manpower is recruited from distances to engage in a project with a more or less definite terminal date.

Within the category of permanent migrations it is useful to distinguish between permanently recurring movements, such as religious pilgrimages, and massive movements in a single direction, as exemplified by the migration of Jews to the newly established state of Israel.

Migratory movements may bring disease from the place of origin to a new location, or disease may be acquired in the site visited and carried back home.

Historical

The classical literature is not as instructive regarding the role of individual disease carriers as is the modern literature. Yet, some notable records exist. For example, it is recorded that smallpox was introduced to the indigenous population of the New World in May of 1519 through the agency of a single traveler. The date is that of the landing of Pánfilo de Narváez in Mexico in his attempt to succeed Cortes as supreme commander of the Spanish expeditionary forces. Among Narváez' men was a Negro infected with smallpox who was able to infect most of those with whom he came in intimate contact on his first days ashore. Many Indians were among these contacts. The ensuing epidemics, which decimated the numbers of the totally nonimmune Aztecs and probably resulted in 3,500,000 deaths, have been credited with materially assisting their subsequent downfall. [1]

The role of relatively small numbers of travelers in the spread of disease may be illustrated by the events subsequent to the hostilities of the Civil War. Malaria had always been endemic in the Eastern United States during the nineteenth century, but before the Civil War its incidence had been waning perceptibly in New England. The war, however, introduced large numbers of illy-protected susceptibles into the highly malarious areas of the South. The movements of whole civilian populations away from combat areas as well as the ensuing troop movements served to disturb the endemic balance and malaria was foremost among the diseases which afflicted all classes of citizens during the war. More significantly, individual Union troops who had recovered from attacks of the fever returned to their homes in New England, reintroducing the parasite into an area in which it had been disappearing. The resulting recrudescence of infection in New England produced many epidemics. [2]

Apart from individual humans and groups of humans, consideration of the impact of travel on the spread of disease must include the role of the disease-carrying vector. The classical example of the consequences of transporting such an agent into a new environment where spread may be unchallenged is afforded by the history of the introduction of *Anopheles gambiae* into northeastern Brazil in late 1929 or early 1930. One or more fertile females of this species were probably carried from Dakar, Senegal, to the environs of the city of Natal on a rapid French mail-carrying destroyer. Without natural enemies in its new location, this anthropophilic mosquito established itself. There was a local outbreak of malaria in 1930-1931. The presence of the new mosquito was noted but it was not attacked. Seven years later, the northeastern states of Rio Grande do Norte and Ceará were the sites of a fearful epidemic which ended in 114,500 recorded cases and 13,290 recorded deaths. It is established that the problem created by the introduction of *A. gambiae* into Brazil first focused the attention of public health workers on the hazards of disease spread caused by the fast-developing sea and air transport services. [3]

One of the best historical examples of the association of mass migration and the introduction of disease concerns the slave trade between Africa and the Americas. Slaves are believed to have brought malaria with them. There is no evidence that malaria existed in any part of America before the conquest. The malarious European was little likely to emigrate or to survive the rigors of travel. Thus the largest introduction of malaria must certainly have come with the slave ships. It is not difficult to postulate that our present transmitting anophelines existed in America before the advent of malaria.

It is also easy to visualize the importation of diseases characteristic of the Slave Coast of Africa, such as schistosomiasis, filariasis, dracontiasis, yellow fever and onchocerciasis. Such diseases require specific intermediate hosts or vectors for their transmission. Appropriate hosts or vectors, sometimes with very limited distribution, were present in the New World. The so-called American hookworm *(Necator americanus)* has been shown to have a wide distribution in tropical regions of the world and was probably brought in huge quantities to the New World on the slave ships. There is no evidence that smallpox existed in pre-Colombian America.

The principal slave origin of certain other infectious agents is suspected by some, although the evidence does not strongly support the contention. Among such diseases may be included plague, typhus, leishmaniasis, measles, syphilis and tuberculosis.[1]

The outstanding classical examples of the role of migrants in acquiring disease and transporting it to nonendemic areas are provided by the religious fairs in India and the annual pilgrimage to Mecca in Southwest Asia.

The Mecca pilgrimage has always presented many health hazards. There was an epidemic of cholera in Mecca in 1865 from which carriers fled, spreading the disease far and wide. The pilgrimage has been one of the outstanding topics at international sanitary conferences ever since. A cholera outbreak in 1902 in Egypt was traced to pollution of a well by pilgrims returning from Mecca. The well was situated close to latrines which serviced the mosque in Moucha. There were 35,000 officially reported cases in Egypt and the epidemic subsequently spread to Syria. [4] Besides cholera, the Mecca pilgrimage is historically associated with the spread of malaria, trachoma and dracontiasis in Southwest Asia.

The important role played by the pilgrims to the religious fairs held each year in India in the spread of cholera has often been reported. Epidemics of cholera at such gatherings have sometimes remained confined to the area of the fair, ceasing when the crowd dispersed (as recorded during the pilgrimage in Bengal in 1783), but more often, since the beginning of the nineteenth century, the endemic area of lower Bengal has been the source of repeated epidemics, with pilgrims the chief means of spread. Fairs are held every year and attract 20,000,000 pilgrims annually. The Hardwar Fair, held every twelfth year, can be singled out as a prime example. In 1867 cholera broke out at this fair nine days after the first pilgrims began to arrive. The religious practices of the pilgrims, including whole body immersion in the water of the river, contributed to the spread. The gathering dispersed thirteen days after it convened. There had been several cases of cholera during the convention. The infection became more apparent along the roads through which the pilgrims dispersed. The epidemic spread across the north of India and what is now Pakistan and into Afghanistan several months after the initial outbreaks at the fair. At another fair in 1891 cholera spread from the banks of the Ganges river into northern India, Afghanistan, Persia and Russia and reached as far as Germany.[4]

Relocation of Populations

In foreign countries, especially those included within the survey areas, the effect of relocating large populations on the spread of tropical diseases has occasionally been exemplified.

It rarely happens that an entire discrete community is uprooted and moved to a new location. Reports exist of at least one such situation, in which the migrating population, fleeing disease, unwittingly carried its disease with it and succeeded in establishing it stronger than ever in each new residential site adopted. In northern Uganda in 1909 as a result of an epidemic of trypanosomiasis, British authorities caused the inhabitants of a long stretch of the Albert Nile, near Lake Albert, to be moved to the banks of the river Oytino, in the vicinity of Gulu, the District Headquarters. No precautions against the disease, in the form of treatment or segregation, could be taken at this time. Since the area of resettlement was heavily infested with *Glossina palpalis*, the result was a series of severe outbreaks in the new settlement, as well as in areas of two subsequent settlements. In each case, people were being placed on banks of rivers heavily infested with the vector, thus representing localities ideal for the development of endemic trypanosomiasis.[5]

Two recent examples of the large-scale movement of populations to new sites wherein the newcomers were greeted with onslaughts of endemic infections may be cited. The first example is that of the transference of Portuguese settlers *en masse* into the Limpopo River Valley Irrigation Scheme in the Gaza District of Mozambique, an area endemic for both vesical and intestinal forms of schistosome infection. The first settlers began to arrive in 1955. In 1956, 558 individuals of all ages were selected at random and studied parasitologically. It was found that 2.86 per cent had acquired schistosomiasis haematobium.[6] There was no question but that the infections had been acquired locally, as the immigrants originated in parts of Portugal in which *S. haematobium* does not exist. Of the 558 examined, 197 were maintained under observation for periodic examinations. By 1958, two years after the first survey, it was found that 59 of the 197 had now acquired *S. haematobium* infection (29.9 per cent) and, moreover, 6 had now acquired *S. mansoni* infection (3 per cent). There has not been sufficient elapse of time to determine whether this rate of infection with a debilitating parasite will have a significant effect upon the plans for colonization and development of the irrigation scheme.

A second example in this category is that of the migration in 1954 of 400 residents of Okinawa, in the Ryukyu Islands, to a pioneering community on the edge of the Bolivian rain forest. All immigrants had received the customary immunizations against smallpox, typhoid and epidemic typhus before leaving Okinawa. They had been vaccinated against yellow fever by Bolivian health officers two months after arrival. But, within a few months of arrival, a severe febrile illness was experienced by almost half of the group, with 15 deaths resulting. In this case, inability to cope with the outbreak ultimately caused the abandonment of the colony. Subsequent investigations demonstrated that 10 to 15 per cent of cases had been caused by a virus which received the name of Uruma virus, after the colony, while the cause of the remaining cases was not determined.[7]

Fortunately all histories of migratory population movements are not so bleak. The benefits of planning for a large group of migrating laborers are well illustrated by the story of the medical program provided by the government of the Federation of Rhodesia and Nyasaland for workers during the construction of the Kariba Dam in Northern Rhodesia (1956-1960). Beginning in January 1956, the number of Europeans and their dependents employed on the clearing and construction sites was 432 and the number of non-Europeans and their dependents was 2,787. By June 1957, these figures had increased to 1,768 and 7,597, respectively. The great majority of these persons were highly susceptible newcomers whose previous exposure to the endemic risks of the area was extremely limited. The European operatives were completely nonimmune to most infections. The African workers, who had been imported at high speed fom many parts of Central Africa, were expected to have been exposed to different etiological strains of the more common infectious agents present in the nearby population.

Malaria was anticipated with considerable apprehension. However, as a result of spraying of interiors of dwellings accompanied by routine drug prophylaxis, malaria played an insignificant role in producing disability or death among the workers. Trypanosomiasis was less feared, but was known to occur in this region, and it was expected that the rapid build-up of population, accompanied by the inevitable thinning out of game animals, would result in an increase in fly-man contacts. However, as a result of intensive brush clearing and an air-spray program of insecticide application, the only cases of human trypanosomiasis at Kariba were diagnosed in natives unconnected with the labor force. Onchocerciasis was unknown in the area and filariasis bancrofti, sometimes demonstrated in thick blood films, was not a clinical problem. The preparations for the project included attention paid to adequate potable water supplies, food, living quarters and sanitary conveniences. Under these circumstances it proved possible to provide hospital services, as well as malaria and tsetse control, for a net expenditure of £117,090 (US$327,852) during the period of construction. With an annual average of 7,658 persons to account for, the per capita health expenditure for this project amounted to £8/1 (US$22.54) per annum. In terms of the total cost of the scheme, medical and preventive health services amounted to 0.3 per cent. [8]

The implications of relatively small population movements cannot easily be compared with those posed by the great cyclical migrations which are characteristic of whole races of peoples in Africa, Southwest Asia and South Central Asia. The importance of these great movements is nowhere so well established today as in the field of malaria eradication. It is approximately six years since the World Health Organization proposed the eradication of malaria on a global scale. Its feasibility was suggested by the relative ease with which anthropophilic vector mosquitoes could be attacked with imagocides. Time has now permitted some of the difficulties in achieving success in this global program to become apparent. One of the most outstanding of these problems is the question of when to discontinue an eradication program in a given locality. In this connection, the social factor posed by population migrations assumes particular importance. One author states:

> "It has happened in several instances that when spraying was discontinued in an area where malaria incidence had reached a satisfactorily low level and where there was sufficient proof of locally interrupted transmission, transmission was renewed after a short while because of large-scale migration of people between this area and neighbouring districts (in the same country or across the border) where transmission had not yet been interrupted, resulting in a large volume of import of parasites." [9]

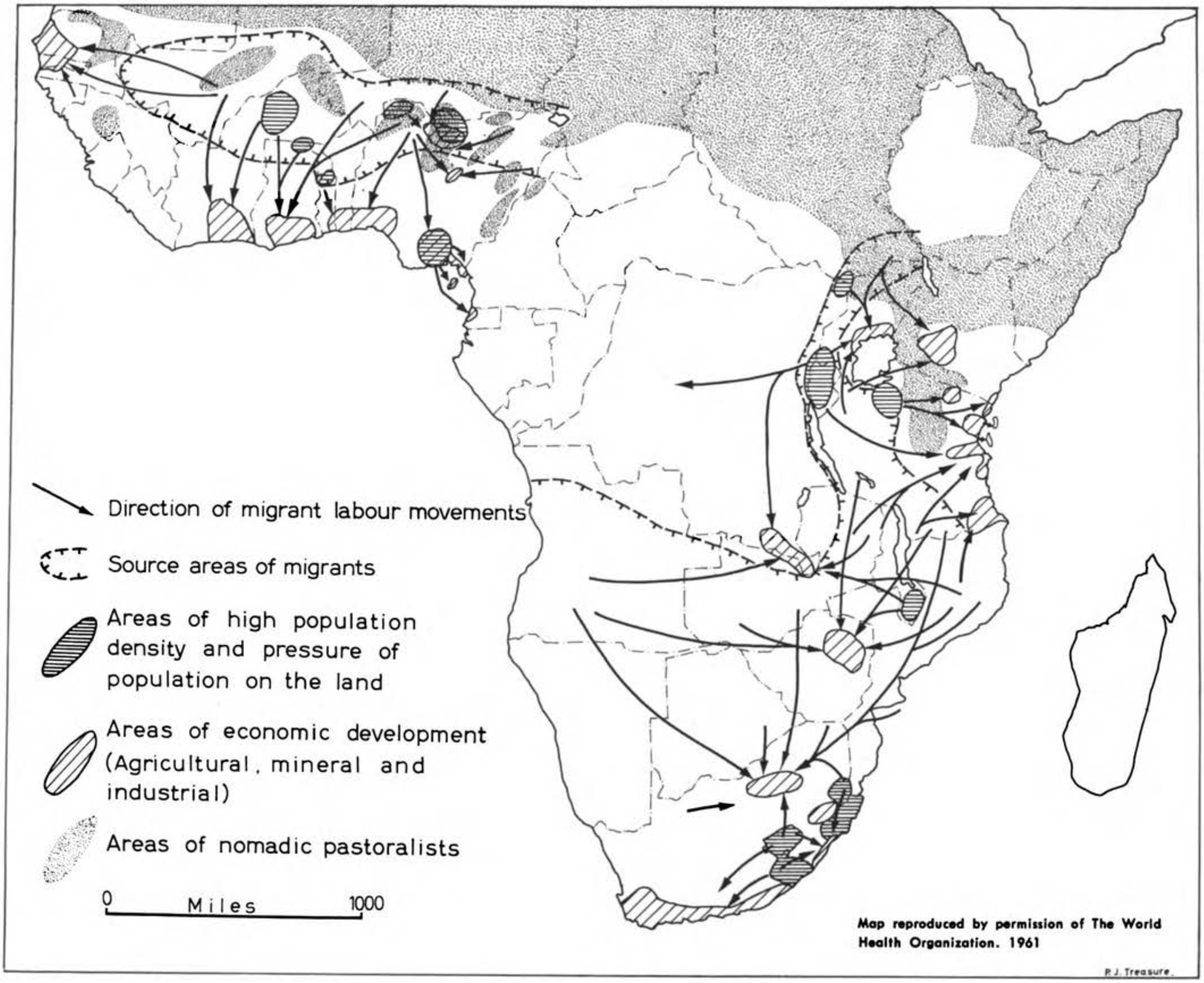
The area where greatest consideration has had to be given to the impact of population movements on malaria eradication has been Africa. Indeed, to date, only Libya, Southern Rhodesia and South Africa support malaria eradication programs on the African continent, although pre-eradication surveys are in progress in Egypt, Tunisia and Morocco, and pilot and related projects are under way in 13 countries stretching across the equatorial belt. In the lands bordering on the Sahara, nomadism poses the most serious problem in the routine application of malaria eradication methods. Nomadic movements are characteristic of many peoples in Somalia, Ethiopia, Sudan, Chad, Niger, Mali and Mauritania, as well as in parts of Guinea, Upper Volta and Nigeria (Figure 35). In such areas the success of malaria eradication will depend upon the adoption of new approaches which take note of the lack of fixed residences and of the particular need for cooperation with the tribesmen, especially during migration periods. [10]

The nomadic areas are quite limited when compared with the areas which give rise to the seasonal, large-scale migrations of agricultural labor for harvesting crops and the nonseasonal migrant labor to the mining and industrial areas of southern and eastern Africa (Figure 35). Malaria transmission in Africa south of the Sahara is perennial, but there are periods of greater and lesser intensity during the year. Much of the argricultural labor force which goes from Mali to harvest groundnuts in Senegal or from large areas of Mali, Upper Volta and Niger to pick cocoanuts in Ivory Coast, Ghana, Dahomey and Western Nigeria moves to work after the peak of the malaria season. On the other hand, migrant labor to the mining and industrial areas of Katanga Province and Northern Rhodesia, of Southern Rhodesia, and of South Africa and to the industrial and commerical areas of Uganda, Kenya and the East African coast is not seasonal but occurs all year round (Figure 35). [11]

In any case, such migratory movements as described above have traditionally occurred and will continue to occur in Africa on a continental scale. The success of eradication programs here will require adaptation to this fact. It is one of the principal reasons for the relative slowness with which programs in Africa have gotten started.

One of the most important of all migrations to occur in recent history has been the movement of Jews to settle in the newly established state of Israel. The health services of Israel are well developed and a large amount of information, satisfactorily documented, has been made

Figure 35. Migrant Labor Movements and Areas Occupied by Nomadic Pastoralists in Africa South of the Sahara



available regarding the impact of this migration on the nation's health.[12] A high percentage of the new immigrants came from regions of Southern Europe and Southwest Asia where tuberculosis mortality is high. It is estimated that of the immigrants arriving in Israel between 1948 and 1951, 4,349 were in need of hospitalization for tuberculosis and about 30,000 needed medical supervision. During the first years after the establishment of the new state, immigration was not selective and diseased persons were knowingly admitted. Schistosomiasis had existed in small foci before 1948 in Palestine, mostly among Arabs. With the establishment of the state, many of these people left the country; however, a greater potential source of infection came about with the arrival of parasite carriers from Yemen, Iraq, Egypt and Morocco. It is estimated that in 1952, 25,000 schistosome carriers entered the state as immigrants.

By sealing her borders as a result of the conflicts with her neighbors, it has been possible in recent years for Israel to avoid the annual risk of infection from pilgrims on the way to Mecca.

Infectious disease does not always take hold and spread in a way that would be expected by a knowledge of its epidemiology. For instance, the entire Jewish community of Malabar, India, was transported to Israel in 1953-54. Filariasis was prevalent among these people, infection varying from 2 to 20 per cent in the various villages involved. The travelers were treated, but by the time they reached Israel, the microfilaria carrier rate was still 12 per cent. Moreover, the part of Israel to which these people were transported supports natural populations of a mosquito which is known to transmit the disease experimentally. Yet, after the new arrivals were settled, the disease did not spread and, in fact, was unable to persist. A survey done four years later revealed only two carriers in over 1,000 persons examined, representing a drop of 98.5 per cent in prevalence. It was considered that the chain of transmission was broken by a combination of several factors, including settlement in areas of low humidity and low mosquito prevalence, decreasing of crowding, and mass chemotherapy. It is of course possible that the results would have been the same in the absence of the above precautions.[13]

Military Movements

Of all categories of temporary mass migration, military movements have historically been among the best documented, with regard to their influence on disease. With regard to tropical diseases, however, more data exist to describe the effect of the new environment upon the troops than *vice versa*. In recent warfare it has been the totally nonimmune soldier from a country where living standards are high who has been sent to a locale rife with endemic infectious disease. It is not unusual, under such circumstances, to record that disease subsequently deals more havoc than enemy troops. Malaria has always been a prime enemy, exacting severe tolls during the Civil War and the Spanish-American War. During World War I, the failure of the Macedonian Expeditionary Forces was laid to the number of hospital admissions for malaria; during the three years of the campaign, the total forces numbered 434,724, of which 162,517, or 37.4 per cent, were malaria admissions.

Not until World War II, however, when military operations were extensively conducted in the tropics, did tropical diseases extract a significant toll. In spite of the manifold excellence of medical science, familiarity with the most common endemic diseases faced by the troops in the early stages of the South Pacific operations was lacking. Here, malaria caused more than five times as many casualties as did combat. In September of 1943, the malaria case rate reached 700 per 1,000 in the South Pacific and exceeded 400 per 1,000 in the Southwest Pacific earlier in the same year. The rates fell off rapidly with the introduction of atabrine prophylaxis. The heaviest tolls in malaria morbidity were exacted in the New Guinea campaign. Figures available for Australian troops probably reflect the picture for American troops as well. Between 4 September and 26 November, 1943, the total of malaria casualties in the 7th Australian Division represented 90 per cent of all sickness casualties and 83 per cent of all casualties, including battle casualties. The figures for the 9th Australian Division were 60 and 44 per cent, respectively.

Filariasis was of military concern in the South Pacific in 1942 and 1943. Thousands of troops, including entire units, were removed from the endemic islands to the United States in order to protect them from the disabling effects of continued exposure.

In the re-occupation of Leyte in the Philippines, schistosomiasis was a serious problem, which, like filariasis, was responsible for man-day losses proportionally greater than the actual number of cases involved. It has been estimated that the disease resulted in a loss of over 300,000 man-days and immediate medical care costs of approximately $3 million, not including subsequent veterans' benefits.[14]

Current International Travel

At present, the use of rapid air transport permits symptoms to develop far from the locality where the disease was contracted. The clinician may thus be troubled and the patient often placed at considerable risk by a condition which, in the right place, could be easily identified and controlled. It is possible, for instance, for a traveler to contract a malignant tertian fever in Accra, fly home, and be felled by a fulminating cerebral attack in New York before the astonished clinician can make a correct diagnosis. The implication is particularly serious in the case of the transport of yellow fever virus, for the safety of large populations in receptive areas harboring *Aëdes aegypti* depends upon not introducing the virus into the community. Indeed, a case is recorded of a traveler in the early or infectious stage of jungle yellow fever boarding a plane in Sucre State, Venezuela, and traveling several hundred miles to Caracas. In this case, fortunately, no transfer of the disease to the city was observed.[15]

A similar instance of the transfer of disease during its unrecognizable initial stages is presented by the outbreak of smallpox in New York City in 1947. Here, a United States citizen who had lived in Mexico for a number of years boarded a bus bound for New York. He was well on entering the bus but became ill shortly thereafter. A few days after arriving at his destination he entered Bellevue Hospital. For several reasons, his condition was incorrectly diagnosed, during which time he had an opportunity to pass his infection to three other persons. These exposed others, and subsequently there occurred 12 cases of smallpox, in all, with 2 deaths. Of the 12, only 3 had been vaccinated. None of the contacts on the bus, it happened, developed the disease, but the potential carriers could have spread smallpox to 29 states had they been susceptible. This outbreak resulted in more than 6,350,000 vaccinations among the population of New York City in less than a month.[16]

In the present day, perhaps the most important category of traveler from the standpoint of transport of disease is the migratory laborer. In the United States, standards of health inspection at international border points are high. There are certain conditions, however, which permit entry of large numbers of individuals without disease surveillance. One of these, not controlled by international sanitary inspection, is the annual flow of migratory workers from Puerto Rico under contract to harvest truck crops of various sorts in the eastern United States. The incidence of worm infestation is high among these people, but the threat to the communities in which they work is small because of the generally high sanitation levels. Another source of potential disease is provided by the influx of migratory laborers from Mexico. Those crossing at controlled points are subject to health examinations, but the extent of the Rio Grande offers many opportunities for "wetback" crossings. In this connection, it has been reported that the spread of cysticercosis among cattle in Arizona is attributable to *Taenia saginata* infection in Mexican laborers who migrate into the country in search of work.[17]

The introduction of disease may be made into an area which once supported the infection but, in recent years, was free of it. Such is the case of the outbreak of *P. vivax* malaria among girl campers in Nevada County, California, in the summer of 1952. A marine who had returned to California from Korea the previous November experienced a primary malaria attack in April 1952. He subsequently passed the Fourth of July holiday at a lake resort frequented by girl campers and suffered a relapse there. At this time the numbers of *Anopheles freeborni* in the area were probably at their seasonal peak. There occurred 35 cases of malaria among the girls, 26 of whom exhibited the extremely long latent period (217 to 316 days) which had characterized the infection in the marine. Although investigators could not rule out the possibility that the girls' infections proceeded from some other source, yet the period between the acute relapse in the returned serviceman and the onsets of malarial patency in the girls supported his candidacy most strongly.[18] Such accounts emphasize the need for training in the recognition of exotic diseases. Modern quarantine procedures, when they can be applied, are not designed to unmask the prolonged latent periods or the chronic character of many parasitic infections.

Although travel today carries the risk of the introduction or reintroduction of infectious disease, it is usually the fate of today's tourist to acquire rather than to donate. The best example of this is probably the so-called diarrhea of travelers. It is, unfortunately, an unsatisfactory example in several respects, since its etiology is unknown and attempts to incriminate several of the pathogenic agents known to be identified with diarrheas under other conditions, such as amebae, flagellates, salmonellae, shigellae and other bacteria, have not been successful. Documentary evidence of the impact of this condition upon tourists is scanty, but in one study of 1,265 United States citizens returning by air from Mexico, it was found that approximately one-third of those who had spent a week or more outside the United States had developed diarrhea. The young were affected more than the old, the condition occurring in 43 per cent of persons 24 years of age and younger, whereas only 18 per cent of those 55 years of age and older became ill.[19]

Indeed, one major intercontinental airline recognizes that a substantial proportion of the illnesses of its flying and ground staff are "tropical" in nature, the dysenteries and malaria being most often cited, and requires that its senior ground medical officer be specially qualified in all aspects of tropical hygiene, including handling of food and water supplies and the administration of prophylactic drugs.[20]

The spread of disease by travelers was recognized in the nineteenth and early twentieth centuries and acknowledged in the many international sanitary conventions which met both in the Eastern and Western Hemispheres. Between 1851 and 1897 there were nine international conferences in Europe which met to discuss the international problems posed by cholera and pilgrimages. To this list should be added the 1881 conference in Washington which was concerned with the exchange of epidemiological information dealing with yellow fever.

In 1903, the International Sanitary Convention, consolidating the conventions of 1892, 1893, 1894 and

1897, was signed in Paris. In 1905, the first Pan American Sanitary Convention, modelled on the Paris convention, was signed in Washington, D. C. Amendments to the Paris convention were made in 1912 and 1926. In 1924, the Pan American Sanitary Code was signed by 18 American republics in Havana. In 1944, the United Nations Rehabilitation and Relief Agency met in Montreal to amend the 1926 and 1933 conventions, to which revisions 17 states put their signatures in 1944. The constitution of the World Health Organization, signed in New York in 1946, gave this body authority to adopt international quarantine regulations. The compilation of conventions entitled International Sanitary Regulations were first adopted by the Fourth World Health Assembly in 1951.[21] These were subsequently amended by the Eighth, Ninth, and Thirteenth World Health Assemblies in 1955, 1956 and 1960. At present the Regulations define terms, prescribe the requirements for sanitary organizations at points in international entry, prescribe sanitary measures with regard to arrivals and departures of travelers and their baggage, make special provisions for each of the quarantinable diseases (plague, cholera, yellow fever, smallpox, typhus and relapsing fever), prescribe disinsection and deratting procedures, and make various other provisions regarding international travel.[22]

The result of international cooperation regarding the quarantinable diseases has been to reduce their incidence markedly. Of the six quarantinable diseases, plague, typhus and relapsing fever are no longer sources of dismay to health officers and cholera has not spread outside of Asia (with two exceptions) since the end of World War II. Smallpox is still the most frequently reported of the quarantinable diseases, but the principal endemic reservoir of variola major with its accompanying high mortality appears to be the Indian subcontinent; elsewhere, health officers tend to be more preoccupied with mild and atypical forms of the infection (alastrim). Yellow fever is still feared, not because of the number of human cases, but because there is evidence that the sylvatic reservoir poses a continual threat to urban areas in the Americas which have allowed their programs of vector eradication to lapse into abeyance.

Until 1956, the sanitary control of pilgrim traffic, directed primarily at the pilgrimage to Mecca, formed a special section in the provisions of the International Sanitary Regulations. This section was abrogated by the Ninth World Health Assembly in 1956, being replaced by additional regulations specifying that measures applying to pilgrims should be similar to those applied to other migrants and seasonal workers as "persons taking part in periodic mass congregations."[21] During the 1961 pilgrimage, in which more than 1,000,000 persons took part, no quarantinable disease was notified by the Saudi Arabian government.[23]

In Asia, the threat of cholera spread has been markedly reduced by the introduction of programs of vaccination of pilgrims. It has not, however, disappeared. Where vaccination has been compulsory, as in the international travel to the Mecca pilgrimage, cholera has been conspicuously absent. In India, however, it is difficult to secure the cooperation of all pedestrian travelers in giving the recommended two doses of vaccine with an interval of seven days. Nevertheless, there has been a consistent decline in incidence in India, especially in areas outside of the endemic centers. There is, however, no opportunity for satisfaction yet. In East Pakistan, cholera deaths numbered 29,582 in 1948. That the hazard still is strong, although diminishing, is indicated by the fact that these deaths numbered 12,735 in 1959.[24]

It is, of course, true that pilgrimages within a country are not as easy to control from a public health

Table 66. Number of passengers departing from the United States and debarking in areas defined in this survey for years ending 30 June 1956 through 1960[1]

AREA	1956	PER CENT	1957	PER CENT	1958	PER CENT	1959	PER CENT	1960	PER CENT	FIVE-YEAR TOTAL	PER CENT
Caribbean, Central and South America	857,191	92.4	964,949	92.4	1,023,936	92.0	1,198,773	93.6	1,285,629	93.0	5,330,478	92.8
Africa	11,968	1.3	12,042	1.2	12,997	1.2	12,537	1.0	12,707	0.9	62,251	1.1
Southwest Asia	11,353	1.2	11,077	1.1	18,782	1.7	18,089	1.4	21,539	1.6	80,840	1.4
South Central and Southeast Asia	26,158	2.8	35,769	3.4	31,088	2.8	31,770	2.5	38,018	2.7	162,803	2.8
Oceania	20,792	2.2	20,419	1.9	25,532	2.3	19,803	1.5	24,315	1.8	110,861	1.9
Totals	927,462	100.0	1,044,256	100.0	1,112,335	100.0	1,280,972	100.0	1,382,208	100.0	5,747,233	100.0

[1] Does not include cruise passengers.

standpoint as those which cross international borders.

The rate of United States tourism abroad has increased markedly since the end of World War II. Of the areas included in the survey, that which is comprised of the Caribbean, Central and South America has traditionally received the bulk of American travelers. Table 66 reveals, however, that there was a small but steady increase in the number of travelers leaving the United States and debarking in the four remaining major areas of the survey during the five-year period 1956-1960. According to Table 66, the total number of such travelers rose from 927,462 in 1956 to 1,382,208 in 1960, and totaled 5,747,233 for the five-year period. Of these, an average of 92.8 per cent had primary debarkation points in the Caribbean, Central and South America, whereas only 1.1 per cent debarked in Africa, 1.4 per cent in Southwest Asia, 2.8 per cent in South Central and Southeast Asia, and 1.9 per cent in Oceania. The data include travelers by sea and air as well as Mexican travel over land borders. Aliens as well as United States citizens are included. However, the figures do not include passengers on cruises. It must be emphasized that the figures pertain only to points of primary debarkation; United States citizens traveling to Africa or Southwest Asia from Europe, for example, would not be included. Thus, it must be assumed that the true number of travelers from the United States to the areas of the survey is in excess of the figures presented.[25]

If the present foreign policy interests of the United States with regard to the underdeveloped countries of the tropics are maintained, there is little doubt that a further increase in numbers of citizens traveling to tropical areas other than those of the Americas will be observed. The need to be concerned about the health of these potential tropical travelers confronts the field of tropical medicine with a growing responsibility.

SUMMARY AND CONCLUSIONS

Travel may involve one or more persons or may include transport of vectors. Migrations are defined as movements of entire populations and may be temporary, as in the case of military operations, or permanent, as in the case of the migrations of the Jews to Israel.

Historically, the role of an individual in transporting disease is exemplified by the introduction of smallpox into Mexico in 1519 by a member of Narváez' crew. The role of numerous discrete travelers is exemplified by the epidemic of malaria in New England occasioned by the return of Union troops to their homes after the Civil War. The classical example of the transport of disease vectors is the introduction of *Anopheles gambiae* into northeastern Brazil in the early 1930s.

The best historical example of the introduction of new diseases through the agency of mass migration is that of the slave trade to the Americas. In addition, the epidemic spread of cholera through the agencies of the Mecca pilgrimages and the Indian religious fairs is mentioned.

Several examples are given of the consequences of the relocation of whole communities for varying purposes. Repeated outbreaks of trypanosomiasis accompanied the transfer of Uganda natives from one riverine settlement to another in the early part of this century. In the present decade, the transfer of large numbers of Portuguese farmers to the Limpopo Valley of Mozambique has resulted in a massive increase in schistosomiasis rates. The migration of a colony of Ryukyu Islanders to the rain forest of Bolivia was routed completely by an outbreak of "jungle fever," probably due to an arthropod-borne virus.

The benefits to be derived from planning for the influx of large populations into an area potentially rife with disease may be exemplified by the excellent medical history of the construction of the Kariba dam in Northern Rhodesia.

The implications of nomadism and the cyclical migrations of laborers in Africa south of the Sahara on malaria eradication programs are strong. Uncontrolled movements of population across borders and into areas recently cleared of malaria transmission results in the reintroduction of the parasite and renewed transmission. Future programs of malaria eradication in Africa will be directed by and must adapt to the fact of this uncontrolled movement of peoples.

Of all migrations in recent history, one of the best documented has been the movement of Jews to the newly established state of Israel. Immigrants brought tuberculosis, schistosomiasis and other diseases. Cholera has recently been excluded because the borders have been closed to the most likely carriers, i.e., Arab pilgrims to Mecca. The inability of Indian filariasis to take hold in Israel has been demonstrated.

In recent times, the greatest numbers of United States citizens exposed *en masse* to tropical diseases in the tropical environment have been military personnel. Infectious disease accounted for high casualty rates in the Spanish-American War, World War I and World War II. The occurrence of disease outbreaks stimulated research which resulted in notable advances in tropical medicine.

Today, the universal use of rapid air transport permits symptoms of disease to develop far from the site where the disease was contracted and its ready diagnosis understood. Examples include the case of yellow fever which, while in the early or infectious stage, traveled by plane from an endemic area to an urban area receptive for yellow fever. Also noteworthy is the case of the traveler from Mexico in the early stages of smallpox who went by bus from Mexico City to New York City; the resulting epidemic cost two lives and resulted in 6,350,000 vaccinations. The dangers of a prolonged latent period are exemplified by an outbreak of malaria in a girls' camp in California; the infection was traced to a serviceman returned from Korea who had not suffered his primary paroxysm until six months after his return.

It has been reported that cysticercosis of cattle in Arizona, an infection of considerable economic importance, is mainly acquired from itinerant laborers from Mexico.

At present, the most constant worry of the traveler to the tropics is the so-called diarrhea of travelers, all the more troublesome in that its etiology resists definition.

In the present report, the background, development and current description of the International Sanitary Regulations as adopted by the Fourth World Health Assembly and amended by subsequent assemblies are presented. International cooperation has succeeded in reducing significantly the international spread of most of the quarantinable diseases. However, smallpox is still frequently reported from ports, and the countries of the world defined as still yellow-fever receptive as of 1 May 1961, included 91 of the 169 countries and territories included in the survey.

The number of United States citizens debarking in the five major survey areas during the period 1956-1960 was 5,747,233. Of these, 92.8 per cent entered ports in the Caribbean, Central and South America, while only 1.1 per cent debarked in Africa, 1.4 per cent in Southwest Asia, 2.8 per cent in South Central and Southeast Asia, and 1.9 per cent in Oceania. While the commercial interests of the United States suggest that the above ratio will continue for some time to come, yet our expanded political interests, evidenced in Africa particularly by the establishment of new diplomatic missions and the activities of the Peace Corps, indicate an ever increasing number of travelers to tropical areas outside the Americas. Regardless of the port of debarkation, the health of all tropical travelers must be of concern to health officials and other interested individuals in their country of origin.

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Part V

Chapter 12

Research Programs in the United States in Medical and Hygienic Problems of the Tropics

Federal Agencies

Curt R. Schneider

This report is concerned with intramural research in tropical medicine performed in federal agencies and departments of the government. Appropriate authorities in all agencies in which intramural research in tropical medicine is conducted were approached with a request for specific information concerning the funding of such programs over the five-year period 1954-1958, the personnel involved, broken down into professional, subprofessional, and other categories, and a list of specific projects engaged in during the above-mentioned period of time and/or a list of publications which appeared during these years.

During the period 1954-1958, tropical medicine research was conducted in the following agencies:

Department of Agriculture
- Agricultural Research Service
  - Animal Disease and Parasite Research Division
    - *Plum Island Animal Disease Laboratory*

Department of Health, Education, and Welfare
- Public Health Service
  - Bureau of State Services
    - Communicable Disease Center
      - *Puerto Rico Laboratory*
  - National Institutes of Health
    - National Institute of Allergy and Infectious Diseases
      - *Laboratory of Tropical Diseases*
      - *Laboratory of Clinical Investigations*
      - *Middle America Research Unit, Canal Zone*

Department of Defense
- Department of the Army
  - Medical Research and Development Command
    - *406th Medical General Laboratory, Japan*
    - *Tropical Research Laboratory, Puerto Rico*
    - *Medical Research Unit, Malaya*
    - *Walter Reed Army Institute of Research, Washington, D.C.*
- Department of the Navy
  - Bureau of Medicine and Surgery
    - *Naval Medical Research Unit No. 2, Taiwan*
    - *Naval Medical Research Unit No. 3, Egypt*
    - *Naval Medical Research Institute, Bethesda, Maryland*

Veterans Administration
- Department of Medicine and Surgery
  - Research Division
    - *San Patricio VA Hospital, Puerto Rico*

Of all other federal departments and agencies which conducted intramural biomedical research during the period 1954-1958, inclusive, no intramural research in tropical medicine is known to have been pursued by the

Department of the Interior, Department of the Air Force, the International Cooperation Administration, or the Atomic Energy Commission.

Expenditures

Some explanations, in the form of qualifications, are needed to accompany the figures on government expenditures for tropical medicine research as presented in Table 67. No attempt was made to extract figures assignable to tropical medicine from published budgets; rather, the respective administrative chiefs or finance officers of the agencies listed were approached with requests for assistance in this regard, and the figures provided by them were utilized in preparing the table. In the case of the 406th Medical General Laboratory and the Laboratory of Tropical Diseases, the figures represent the total annual allowance of the laboratory. In all other cases, the information reflects each officer's interpretation of the meaning of "tropical medicine" and was accepted uncritically as provided.

National Institutes of Health. Information pertaining to expenditures for intramural tropical medicine research was forthcoming from only two laboratories in the National Institutes of Health; the Laboratory of Tropical Diseases (now divided into several laboratories) and the Laboratory of Clinical Investigations, both in the National Institute of Allergy and Infectious Diseases. It will be seen from Table 67 that research expenditures of the Laboratory of Tropical Diseases amounted to $695,000 in fiscal 1954 and rose to $890,000 in fiscal 1958. Total expenditures for the five-year period 1954-1958 were $3,656,000. If maintenance allocations (management funds) are added to these figures, a sum of $5,680,000 is obtained for the five-year period.

Within the Laboratory of Clinical Investigations, an estimated 20 per cent of the operating budget during the period 1954-1958, inclusive, was devoted to tropical medicine. To this must be added tropical medicine's proportion of the funds reimbursed by this laboratory to the Clinical Center of the National Institutes of Health for maintenance patient care; the proportion is conservatively estimated at 8 per cent of the total annual reimbursement. In fiscal 1954 the total expenditure for tropical medicine in this Laboratory, thus figured, amounted to $100,000 and in fiscal 1958 it amounted to

Table 67. Expenditures by federal agencies for intramural research in tropical medicine, fiscal years 1954-1958, inclusive

(thousands of dollars)

DEPARTMENT	AGENCY	1954	1955	1956	1957	1958	FIVE-YEAR TOTALS
Department of Health, Education, and Welfare	Communicable Disease Center[1]	35	45	44	45	40[2]	209
	National Institutes of Health						
	Laboratory of Tropical Diseases[3]	695	696	673	702	890	3,656
	Laboratory of Clinical Investigations	100	100	100	126	134	560
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE—SUBTOTAL		830	841	817	873	1,064	4,425
Department of Defense	Department of the Army[4]	463	466	473	510	572	2,484
	406th Medical General Laboratory[5]	60	96	95	95	88	434
	Department of the Navy[6]	551	448	700	739	605	3,043
DEPARTMENT OF DEFENSE—SUBTOTAL		1,074	1,010	1,268	1,344	1,265	5,961
Department of Agriculture	Agricultural Research Service	—	—	—	—	3,000[7]	3,000
Veterans Administration	Department of Medicine and Surgery	—	4[8]	24	25	33	86
Totals		1,904	1,855	2,109	2,242	5,362	13,472

[1] Research on schistosome vector control only.
[2] Does not include a sum of $103,000 spent for **Aëdes aegypti** surveillance.
[3] Does not include allocation for management fund.
[4] Includes tropical medicine research at Walter Reed Army Institute of Research, the Tropical Research Medical Laboratory in Puerto Rico and the Medical Research Unit in Malaya. Excludes the 406th Medical General Laboratory.
[5] Includes total operating funds.
[6] Includes tropical medicine research at the Naval Medical Research Institute in Bethesda, NAMRU-2 (Taipei) and NAMRU-3 (Cairo).
[7] First full fiscal year for the Plum Island Laboratory.
[8] Operations begun in September 1955; first full fiscal year was 1956.

$134,000. The five-year total is estimated at $560,000 (Table 67).

Figures reported for the Laboratory of Tropical Diseases unavoidably include funds for certain research programs which would not be included if the definition of tropical medicine, as utilized in this survey, could have been strictly followed. In this country, tropical medicine and parasitology are almost inextricably entwined. However, it is felt that the error introduced here will be corrected by the forced exclusion of some tropical medicine research performed in other laboratories of the National Institute of Allergy and Infectious Diseases, as well as in other Institutes, for which separate funding accounts are lacking. Specifically, some tropical medicine research has been and is being performed in the Laboratories of Infectious Diseases and of Immunology. In addition, some work has been done in this field in the National Institute of Arthritis and Metabolic Diseases.

Communicable Disease Center. The expenditures of the Communicable Disease Center for tropical medicine research amounted to $35,000 in fiscal 1954 and $40,000 in fiscal 1958. The total for five years was $209,000 and represents funds for the support of the schistosomiasis vector control program in Puerto Rico. An inspection of the Work Program of the Communicable Disease Center for the five-year period revealed no other programs assignable in their entirety to tropical medicine. Portions of some other programs seemed to represent tropical medicine research (i.e., a worldwide study of histoplasmosis epidemics, studies in Guatemala on the role of migrating birds in the spread of the encephalitides, resistance of *Aëdes aegypti* in Trinidad to DDT, an amoebiasis survey in Costa Rica), but these were fragmentary with respect to budgeted programs and cannot be reported on separately for the years in review. The sum of $102,583 was spent on *Aëdes aegypti* surveillance in the southern border states in 1958. It is problematical whether this effort should be included under the heading of research.

Table 68. Total expenditures by the National Institutes of Health and the Public Health Service for health research compared with expenditures for research in tropical medicine, for the period 1954-1958, inclusive

	TOTAL EXPENDITURE (IN U.S. DOLLARS)	EXPENDITURE FOR TROPICAL MEDICINE (IN U.S. DOLLARS)	PER CENT DEVOTED TO TROPICAL MEDICINE
NIH, Total intramural research	140,157,000	4,216,000[1]	3.0
NIH, Total intramural programs	207,497,000	6,241,000[2]	3.0
PHS, Total programs	1,643,548,000	6,450,000[3]	0.392

[1] Expenditures of the Laboratory of Tropical Diseases and 20 per cent of expenditures of Laboratory of Clinical Investigations.
[2] Includes allocation of Laboratory of Tropical Diseases for Management Fund.
[3] Expenditures of the Laboratory of Tropical Diseases, Laboratory of Clinical Investigations, and the Puerto Rico Laboratory of the CDC.

When expenditures for all research programs in tropical medicine of the National Institutes of Health are combined with those of the Communicable Disease Center, a sum of $4,425,000 for the five-year period is obtained (see Table 67).

A comparison of amounts spent for intramural research in tropical medicine with amounts spent for all intramural research at the National Institutes of Health during the period 1954-1958, inclusive, is presented in Table 68. The sum of $4,216,000 for tropical medicine represents 3 per cent of the total of $140,157,000 spent by NIH on all intramural research during the same period. The amount spent by all agencies within the Public Health Service for tropical medicine research totaled $6,450,000, or 0.392 per cent of the $1,643,548,000 spent by the Public Health Service for all operations during this period.

Department of the Army. The budget for the 406th Medical General Laboratory in Japan was $60,000 (not including military salaries) in 1954. It rose to $95,000 in 1956 and 1957 and was $88,000 in 1958. The total for the period 1954-1958 was $434,000. Much of the work of the 406th Laboratory cannot be identified as research. During the period under study, diagnostic services of all sorts for the entire eastern Pacific area were provided, and the funds reported here include expenditures for maintenance of a blood bank, serology and chemistry laboratories, library, and department of medical illustration. However, the amounts reported are in error on the conservative side, since salaries of military personnel assigned to the laboratory and many of the professional personnel are not included.

Other expenditures by the Department of the Army include civilian (but not military) salaries for work in tropical medicine research at the Walter Reed Army Institute of Research, and all work pursued at the Tropical Research Medical Laboratory, San Juan, Puerto Rico and the U.S. Army Medical Research Unit, Kuala Lumpur, Malaya. *In toto* these sums amounted to $463,000 in 1954 and $572,000 in 1958. The total for the period 1954-1958, inclusive, was $2,484,000.

Expenditures by the U.S. Army Research and Development Command in the field of tropical medicine research amounted to $4,972,000 in the period 1954-1958, inclusive, representing 9.1 per cent of the $54.4 millions expended for all medical research by the same agency during the same period (see Table 69). The expenditure for in-service (intramural) research in tropical medicine was $2,918,000, or 12.3 per cent of the total for all intramural medical research. The expenditure for contracted research amounted to $2,054,000, or 6.7 per cent of all extramural medical research.

Department of the Navy. Expenditures by the Research Division of the Bureau of Medicine and Surgery in the field of tropical medicine were $551,000 in 1954 and $605,000 in 1958, with a total for the five-year period of $3,043,000. These amounts include all work construed as falling within the definition of tropical medicine performed at the Naval Medical Research Institute, Bethesda, Maryland, as well as all the work of the Naval Medical Research Unit No. 2, Taipei, Taiwan, and the Naval Medical Research Unit No. 3, in Cairo, Egypt.

Department of Agriculture. The Plum Island Animal Disease Laboratory was established in September 1957 by the Agricultural Research Service in order to provide an area of complete isolation in the United States for the pursuit of studies on foot-and-mouth disease. The first full fiscal year of funding for this laboratory was 1958, when expenditures amounted to $3,000,000. In succeeding years, the annual expenditure has remained approximately the same.

Veterans Administration. A relatively small proportion of the research program of the Veterans Administration has been concerned with tropical medicine, and it has all been pursued, under the General Medical Research and Radioisotope Programs, at San Patricio VA Hospital, San Juan, Puerto Rico. The General Medical Research Program at this station began operations in September 1955 and the Radioisotope Program in 1958. From 1955 to 1958, a total of $86,000 was spent on tropical medicine research.

Table 67 presents a summary, year by year, of the expenditures made by all the federal agencies mentioned for intramural research in tropical medicine. In 1954, the total amounted to $1,904,000. This fell to $1,855,000 in 1955, due largely to decreased spending by the Department of the Navy. The figures rose to $2,109,000 in 1956 and $2,242,000 in 1957. In 1958, the amount spent rose abruptly to $5,362,000, largely because of the inclusion of the amount spent by the Department of Agriculture. There was no sharp increase in spending for tropical medicine research by any other agency under consideration.

Total federal support of tropical medicine research—intramural and extramural. By combining amounts spent for intramural research with those spent for extramural research (in the form of grants or contracts; see section on *Domestic grant programs* in Chapter 14, Figure 38), the total expenditure from Treasury funds for tropical medicine research may be obtained. Table 70 and Figure 36 present this summary broken

Table 69. Total expenditures by the U.S. Army Research and Development Command for medical research, compared with expenditures for tropical medicine research, for the period 1954-1958, inclusive

	EXPENDITURE (IN U.S. DOLLARS)	EXPENDITURE FOR RESEARCH IN TROPICAL MEDICINE (IN U.S. DOLLARS)	PER CENT DEVOTED TO RESEARCH IN TROPICAL MEDICINE
Total in-service research	23,700,000	2,918,000	12.3[1]
Total contract research	30,700,000	2,054,000	6.7
Totals	54,400,000	4,972,000	9.1

[1] Includes total budget of the 406th Medical General Laboratory, Japan.

Table 70. Summary of expenditures from U.S. Treasury funds for research in tropical medicine, by agency, during the period 1954-1958, inclusive

(thousands of dollars)

AGENCY	TOTAL EXPENDITURES	INTRAMURAL OR IN-SERVICE	PER CENT	EXTRAMURAL; GRANTS OR CONTRACTS	PER CENT
Public Health Service	7,328	4,425[1]	60.4	2,903	39.6
Department of the Army	4,972	2,918	58.7	2,054	41.3
Department of the Navy	3,266	3,043	93.2	223	6.8
Department of the Air Force	24	—	—	24	100.0
Veterans Administration	107	86	80.4	21	19.6
Department of Agriculture	3,000	3,000	100.0	—	—
Atomic Energy Commission	49	—	—	49	100.0
Totals	18,746	13,472	71.9	5,274	28.1

[1] Does not include amounts levied for management (administration and maintenance); when this ($2,025,000 for the five-year period) is added, the total for NIH intramural research becomes $5,967,000, or 67.3 per cent of the new total of $8,870,000.

Figure 36. Summary of Expenditures from U. S. Treasury Funds for Research in Tropical Medicine, by Agency, During the Period 1954-1958, Inclusive (thousands of dollars)

Agency	Total Expenditures	Intramural or In-service	Extramural; Grants or Contracts
Public Health Service	7,328	4,425 [1]	2,903
Department of the Army	4,972	2,918	2,054
Department of the Navy	3,266	3,043	223
Department of the Air Force	24	0	24
Veterans Administration	107	86	21
Department of Agriculture	3,000	3,000	0
Atomic Energy Commission	49	0	49
Totals	18,746	13,472	5,274

[1] Does not include amounts levied for management (administration and maintenance); when this ($2,025,000 for the five-year period) is added, the total for NIH Intramural research becomes $5,967,000, or 67.3 per cent of the new total of $8,870,000.

down by agency, with the proportion of the total spent in each case for intramural and extramural research. Total expenditures by all agencies for the five-year period 1954-1958 amounted to $18,746,000. Of this, $13,472,-000, or 71.9 per cent, was for intramural research and $5,274,000, or 28.1 per cent, was for extramural research.

Because of the discrete nature of grant programs it is possible to isolate costs for contracted research in specified fields with relative ease and accuracy. The expenditures included under the heading "Extramural" in Table 70 and Figure 36 were among those reported in Chapter 14 *(Domestic grant programs)* of the present survey and were obtained by selecting those programs which adhered closely to the definition of tropical medicine as devised for and utilized in the survey. The expenditures reported for intramural research, on the other hand, are liable to include work which cannot be strictly defined as tropical medicine (see above). Nevertheless, it is probably useful to summarize the data as in Table 70 and Figure 36 and to say that somewhat less than half of the tropical medicine research performed under the auspices of the National Institutes of Health and the U.S. Army Research and Development Command (39.6 and 41.3 per cent, respectively) has been done under contract outside of these institutions and that somewhat more than half (60.4 and 58.7 per cent, respectively) has been intramural. With regard to the Bureau of Medicine and Surgery, Department of the Navy, the greatest part of tropical medicine research was intramural (93.2 per cent) and only 6.8 per cent was extramural.

Table 71. Relation of total federal expenditures for all bio-medical research with expenditures for research in tropical medicine, 1954-1958, inclusive

(millions of dollars)

	ALL BIO-MEDICAL RESEARCH	TROPICAL MEDICINE	PER CENT
Amount	773	18.7	2.4

During the period 1954-1958, there would appear to have been an average annual federal expenditure of $3.7 million on tropical medicine research ($18,746,000 divided by five). But, it would appear more useful to consider the total expenditure for this period in relation to the total expenditure for all bio-medical research supported by Treasury funds during the same period. Table 71 shows that the $18.7 million used for the support of tropical medicine research during 1954-1958, inclusive, amounted to 2.4 per cent of the total of $773 million spent for all phases of bio-medical research.

The question arises whether this ratio is equitable in terms of international need and national interest. An answer is not readily available, but any approach to one must take into account the degree of unpreparedness in which the nation found itself with regard to tropical medicine at the beginning of World War II and the ultimate price of such unpreparedness. There must be considered also in this connection the international obligations which the United States has already assumed in the tropical world and its avowed support of the many new independent states in this underdeveloped portion of the globe. These considerations invite the suggestion that less support of tropical medicine research than this is certainly not required and more may be.

It should be added that the total for tropical medicine research does not include funds granted by Congress to assist certain privately organized institutions, such as the Gorgas Memorial Laboratory in Panama. An account of this and similar research centers will be made under the heading *Private Research.*

The total of federal expenditures for tropical medicine research also does not include the United States contribution to the World Health Organization or the Food and Agriculture Organization. The proportion of these amounts which has been utilized for medical research is not available. There are omitted from consideration also certain diagnostic laboratories organized on an international basis, such as the WHO International Serological Reference Laboratory in Chamblee, Georgia. It is not understood that they were engaged significantly in research.

Personnel

Information on the number of professional, subprofessional and other personnel employed by the Federal Government and engaged in intramural research was gathered. Employees in possession of a professional degree (i.e., M.D., Ph.D. or the equivalent) were included in the category "professional," and, where possible, a breakdown according to type of degree was obtained. Under the heading "subprofessional" were included scientific technical personnel and those professional assistants not identified as possessing a professional degree. The category "other" is understood to include administrative personnel and secretarial staff as well as laborers and maintenance staff.

Tables 72 and 73 present data pertaining to the number of persons, in several categories, employed by the Federal Government in tropical medicine research. According to the available information, 211 professional scientists were engaged in this discipline in 1958. Of these, 126 (59.7 per cent) were employed by the Department of Defense and 52 (24.7 per cent) were em-

Table 72. Personnel in federal employment engaged in tropical medicine research, 1958

AGENCY	TOTAL PERSONNEL EMPLOYED	PROFESSIONAL	SUB-PROFESSIONAL	OTHER
Puerto Rico Field Station, Communicable Disease Center	60	5	12	43
Laboratory of Tropical Diseases, National Institutes of Health	121	45	54	22
Laboratory of Clinical Investigations, National Institutes of Health	5½	2½[1]	0	3
Bureau of Medicine and Surgery, Navy Department	283	41	179	63
U.S. Army Medical Research and Development Command[2]	86[3]	43	43	[4]
406th Medical General Laboratory, Japan	205	42	97	66
Veterans Administration	10	4[5]	2	4
Department of Agriculture	117	29	28	60
Totals	887	211	415	261[3]

[1] Average number of persons devoted to tropical medicine clinical research per annum from 1956 through 1960.
[2] Excludes the 406th Medical General Laboratory.
[3] Incomplete total.
[4] Figures not available.
[5] Full-time only.

Table 73. Comparison of the percentage distribution of scientific personnel in intramural tropical medicine research in federal agencies, 1958

(figures in per cent)

CATEGORY	DEPARTMENT OF DEFENSE	DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE	OTHER
Professional	59.7	24.7	15.6
Subprofessional	76.8	15.9	7.2
Totals	71.1	18.8	10.1

ployed by the Department of Health, Education, and Welfare.

The activities of the Puerto Rico Field Station, operating as part of the Biology Section of the Technical Development Laboratories, Communicable Disease Center, extend beyond research alone to include cooperation with Puerto Rico Health Department authorities in implementation of schistosomiasis control on that island, much of which is yet in the experimental stage. About 60 persons are engaged in this work, including 5 professional workers and 12 subprofessionals. Of these, 4 professionals and 2 subprofessionals constitute the personnel of the Puerto Rico Field Station, the rest being furnished by the Commonwealth Health Department. Although not entirely under federal employment, it is felt desirable to include all of the above personnel in the figures reported in Table 72 since all were required to accomplish the research activities of the Field Station.

Table 74. Relation of Federal Government personnel engaged in intramural tropical medicine research with Federal Government personnel engaged in all intramural medical and health-related research, 1958

	TOTAL FEDERAL GOVERNMENT	TROPICAL MEDICINE	PER CENT
Professional and subprofessional	5,400	626	11.6
Other (supporting)	6,700	261[1]	3.9[1]
Totals	12,100	887[1]	7.3[1]

[1] Incomplete data.

For varied reasons, turnover in personnel at the 406th Medical General Laboratory was high. The figure for professional personnel reflects the total number of scientists who worked at this post during the year regardless of number of months spent on duty. Figures given under the "subprofessional" and "other" columns, on the other hand, reflect the average employee strength at any time during the year and were prepared by calculating, not the total number of persons in these categories who worked in the laboratories during the year, but the total number of employee-*months* of service rendered during the year; this number was divided by twelve to give a reasonable indication of the number of these employees at any one time during the year.

With the exception of the 406th Medical General Laboratory, a breakdown of the category "professional" by types of degree was not forthcoming from the Departments of the Army or Navy. The 406th Medical General Laboratory employed 11 M.D.'s and 7 Ph.D.'s, 4 of whom possessed an M.D. These figures represent only those professional degrees that could be identified.

There were 415 persons employed in a subprofessional capacity, of whom 319 (76.8 per cent) were in the Department of Defense and 66 (15.9 per cent) were in the Department of Health, Education, and Welfare.

Because figures for the Department of the Army remain incomplete, a total is not presented for the number of employees in the category "other".

It may be seen (Table 73), on the basis of the data presented, that more than half of the professional personnel engaged in intramural research in the Federal Government are employed in the Department of Defense. Less than one-quarter are employed in the Department of Health, Education, and Welfare.

The relationship of the numbers of professional, subprofessional and other Federal Government personnel engaged in intramural tropical medicine research to Federal Government personnel engaged in all intramural medical and health-related research is shown in Table 74. The total number of professional and subprofessional employees engaged in tropical medicine research was 626 in 1958, or 11.6 per cent of the total of 5,400 government employees. The figures include full-time and part-time employees. Data for supporting personnel are incomplete under tropical medicine and the figures presented ought, possibly, to be tripled to bring them into accord with reality.

SUMMARY

Data regarding the staffing and funding of Federal Government intramural research programs in tropical medicine are presented.

The following were the expenditures for intramural tropical medicine research by six government agencies for the respective years 1954-1958: 1954, $1,904,000;

1955, $1,855,000; 1956, $2,109,000; 1957, $2,242,000; 1958, $5,362,000. The five-year total for all agencies amounted to $13,472,000.

The amount expended from Treasury funds for intramural research in tropical medicine has been compared with the amount spent for extramural or contract research by all agencies engaged in any research which could be classified as tropical medicine. The total for all agencies was $18,746,000, of which $13,472,000, or 71.9 per cent, represented intramural expenditures and $5,274,000, or 28.1 per cent, represented extramural expenditures.

The sum of $18.7 million spent during the five-year period for tropical medicine research represented 2.4 per cent of the total of $773 million expended for all bio-medical research by the Federal Government during the same period.

Data pertaining to scientific personnel engaged in intramural tropical medicine research are presented. Figures are divided into professional, subprofessional and other categories. At the end of 1958 there were 211 professional and 415 subprofessional workers. Numbers of other supporting and maintenance personnel were reported in a fragmentary fashion and an accurate total could not be calculated.

Almost three-quarters of all personnel were employed by the Department of Defense. Less than one-quarter were employed by the Department of Health, Education, and Welfare.

The 626 intramural tropical medicine research workers in the professional and subprofessional categories accounted for 11.6 per cent of the 5,400 Federal Government personnel engaged in all intramural medical and health-related research in 1958.

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Medical Schools and Schools of Public Health

George A. Thurber *William W. Frye* *J. Clyde Swartzwelder* *Willard H. Wright*

The original plan of the survey called for the accumulation of data regarding tropical medicine research in medical schools in the United States over a five-year period. However, it was not found feasible to request information coverage for this period of time. Consequently, the report in this section represents research in this field which was being carried on at the selected date of 1 July 1959.

The majority of the data represented in this part of Section III of the Plan was acquired by the School of Medicine of the Louisiana State University, which undertook a survey of the teaching of tropical medicine in the United States. The results of the teaching survey are summarized by Thurber, Frye and Swartzwelder in Chapter 16.

In the preparation of the questionnaire for the teaching survey, certain questions concerning research in tropical medicine were incorporated in the document. The present report represents a summary of the replies plus a limited amount of data which was later secured from schools of public health.

The questionnaire was forwarded to 82 medical schools, of which 78, or 95.1 per cent, replied. In addition, two schools of public health are represented in the returns. The data from one of these schools referred only to research projects financed by federal funds.

Nature of the information requested. The teaching questionnaire included a request for the following research data:

a. Current research in parasitology and tropical medicine.

Title of project, director and source of funds.

b. Professional staff (without instructional duties) engaged in research in the above fields.

Name, degree.

c. Funds for research.

Estimate of expenditures (all sources) for research in above fields during the fiscal year 1958-1959.

Tropical medicine: Total funds, federal funds, non-federal funds.

Parasitology: Total funds, federal funds, non-federal funds.

d. Desire for research and experience in above fields. List members of your faculty desiring additional training in these fields.

Table 75. Type and number of research projects being conducted in 44 medical schools and 2 schools of public health in the United States as of 1 July 1959

TYPE OF RESEARCH PROJECT	NUMBER
Schistosomiasis	20
Intestinal helminths	16
Amoebiasis	14
Host-parasite relations	9
Trichomoniasis	9
Trypanosomiasis	7
Enteric diseases (other than amoebiasis)	7
Arthropod vectors	5
Trichinosis	5
Visceral larva migrans	5
Mycology	5
Malaria	4
Animal parasite immunity	4
Trematodes other than schistosomes	3
Toxoplasmosis	3
Treponemes	3
Trachoma	3
Rabies	3
Cholera	2
Chagas' disease	2
Filariasis	2
Hydatid disease	1
Creeping eruption	1
Brucellosis (in the tropics)	1
Dengue	1
Granuloma inguinale	1
Poliomyelitis (in the tropics)	1
Nutritional diseases of the tropics	1
Anaplasmosis	1
Psittacosis-lymphogranulomata viruses	1
Leptospirosis	1
Sparganosis	1
Viral encephalitides	1
Intestinal protozoa other than **Entamoeba histolytica**	1
Total	144

Adequacy of the data. Certain portions of the data in some instances were difficult to interpret. In a number of cases, research expenditures were combined for tropical medicine and parasitology. In a few instances, the support from federal funds plus that from non-federal funds did not equal the total amount indicated for the category. Some replies failed to report funds for the research; in most of these cases, however, the support was entirely from federal funds and amounts could be obtained from the records of the National Institutes of Health.

One area particularly difficult of interpretation concerned the categorizing of research projects. A great deal of variation was noted in the replies, a thing which is not surprising since it is difficult to frame a suitable definition of tropical medicine. Projects which could not with good conscience be so categorized are not included in the summary. Less difficulty was apparently experienced in defining research in the field of parasitology.

In some cases, replies included research projects by individuals not mentioned as belonging to the faculty and not indicated as full-time research investigators. In these cases, the catalogue of the school had to be consulted to obtain the information.

In the face of the inconsistencies noted above, judgment had to be exercised in attempts to arrive at some reasonable interpretation of the intent of the incomplete replies.

Number and type of research projects

Thirty-four medical schools indicated that no research was being conducted in tropical medicine or parasitology. The remaining 46 institutions reported a total of 144 research projects, of which 46 were classified as pertaining to tropical medicine and 98 as belonging to the field of parasitology. Of the 46 tropical medicine projects, 26 involved clinical studies. A few of these were carried out overseas.

Table 75 lists the type of research projects and the number in each category. The greatest number (20) dealt with schistosomiasis, followed by intestinal helminths with 16 projects and amoebiasis with 14. Nine studies concerned host-parasite relations and a similar number trichomoniasis. There were seven projects on trypanosomiasis, most of which dealt with *Trypanosoma lewisi*, and seven on enteric diseases other than amoebiasis. The remaining projects were scattered over a wide variety of subjects.

In order to provide some comparison of research projects as related to the 34 most important diseases of the tropics, Table 76 has been prepared. A total of 70 projects concerned 18 of the diseases which are regarded as those constituting most important public health problems in the tropics. No research was listed as being conducted on the 15 other such diseases. Some of the latter diseases are not commonly regarded as "tropical" diseases, although they represent imposing causes of morbidity or mortality or both in tropical countries. It is possible that some research was being conducted on some of these diseases at the time of the current survey and was not included for the above-mentioned reason.

The status of research in domestic medical schools may be compared with that of 26 medical schools in the tropics for which data are available. It will be seen from Table 89 that the 26 schools were carrying on 105 projects dealing with 29 of the most important diseases of the tropics. As might be expected, the schools in the tropics were much more concerned with the diseases within their respective areas.

The preponderance of attention to parasites and parasitic diseases in the research is notable. Of the 144 research projects, 111, or 77.1 per cent, dealt with these subjects. It is probable that a number of factors influenced the predominance of such research interest. One of these factors was no doubt associated with the large proportion of non-medical personnel engaged in the research represented. A great many of these individuals were trained in parasitology.

Personnel engaged in research

Replies to the questionnaires indicated that a total of 123 staff members were engaged in the research reported in tropical medicine and parasitology. Of these, 21 devoted their entire time to research and were not engaged in teaching. A total of 102, or 82.9 per cent, was concerned primarily with instruction and carried on research on a part-time basis.

Of the full-time research personnel, 4 held the M.D. degree, 10 the Ph.D. degree and 1 an Sc.D. degree. In addition, there were three individuals with a master's degree and three with a B.S. degree.

The degree status of the part-time research investigators was as follows: M.D. 31, Ph.D. 63, Sc.D. 8. Some of the individuals with an M.D. degree also held other degrees, such as M.P.H., Ph.D. and D.P.H.

Of the total personnel represented in the research in question, only 28.5 per cent were physicians. This is a lower figure than that in the foreign medical schools included in this survey, in which 47.9 per cent of the professional research group held the M.D. degree. However, in the foreign schools there were only 8.5 per cent of the research staff with the Ph.D. degree, while 43.6 per cent had degrees other than M.D. or Ph.D.

Table 76. Type and number of research projects being conducted in 44 medical schools and 2 schools of public health in the United States as of 1 July 1959, as related to the 34 most important diseases of the tropics

DISEASE	NUMBER OF PROJECTS
Schistosomiasis	20
Amoebiasis	14
Enteric diseases (other than amoebiasis)	7
Malaria	4
Ancylostomiasis	3
Trachoma	3
Treponematosis	3
Rabies	3
Cholera	2
Chagas' disease	2
Filariasis	2
Hydatid disease	1
Dengue	1
Poliomyelitis	1
Nutritional diseases	1
Leptospirosis	1
African trypanosomiasis	1
Arthropod-borne viral infections	1
Leprosy	0
Meningococcal infections	0
Pneumonia (all forms)	0
Tuberculosis	0
Typhoid and paratyphoid fevers	0
Whooping cough	0
Influenza	0
Measles	0
Mumps	0
Plague	0
Relapsing fever (all forms)	0
Typhus fever (all forms)	0
Smallpox	0
Yellow fever	0
Leishmaniasis	0
Onchocerciasis	0
Total	70

Expenditures for research in tropical medicine and parasitology

As previously indicated, the questionnaire called for information concerning the separate financing of research in two fields, tropical medicine and parasitology. Each category was divided into federal and non-federal support.

A total of 19 of the 46 schools represented reported financial support for tropical medicine research while 32 indicated support for research in parasitology. Of the total schools, 12 received support for research in both categories.

The total support for tropical medicine research amounted to $793,517, of which $547,459, or 69 per cent, represented federal funds. For research in parasitology, $609,560 was expended, of which $453,605, or 74.4 per cent, represented federal funds. The total amount expended for research in both fields was $1,403,077, of which $1,001,064, or 71.3 per cent, was of federal origin.

At this writing, information is not available concerning total expenditures for research in medical schools of the United States for the fiscal year ending 30 June 1959, which would correspond to the time period represented in the questionnaire returns of the current survey. However, in 1957 (presumably the calendar year), 66 per cent of the funds for medical research in the universities was supplied by the government.[1] At the same time, it was emphasized that a sharp increase had occurred in Federal Government supported medical research from a figure of 7 per cent in 1940.[1] According to the National Science Foundation,[2] 61 per cent of the separately budgeted research in medical schools of this country in the fiscal year 1957-58 represented federal funds. There is no doubt but that the proportion for fiscal year 1958-59 would be larger. However, it is questionable whether the figure would equal the 71.3 per cent contributed by the Federal Government for research in tropical medicine and parasitology.

The total expenditures for research in medical schools in the United States for the fiscal year 1957-58 equaled $105,500,000.[2] By way of comparison, it will be seen that the total amount for research in tropical medicine and parasitology as of 1 July 1959 was 1.3 per cent of the above. It is obvious that the medical schools are not paying the same amount of attention to research in these fields as is the Federal Government, which expended in the five-year period 1954-1958 an average of 2.4 per cent of all bio-medical research funds for tropical medicine investigations (*vide* page 261). This difference in research objectives is not surprising and no doubt stems from a number of factors, the chief one being that the medical schools are more concerned with the chronic diseases, which are mainly represented in their clinical material and which are now the chief causes of mortality in the United States.

Desire for tropical experience by research personnel

A summary has been presented in Chapter 16 of medical school faculty members who expressed a desire for experience or additional experience in the tropics in connection with their interest in tropical medicine. Here, effort has been made to determine the number and status of faculty members who voiced a similar desire and who were actually engaged in research on 1 July 1959.

Only nine individuals in this category felt that they were in need of tropical experience or additional work in the tropics. Seven medical schools were represented. Four of the persons possessed an M.D. degree, four a Ph.D. degree and one an M.S. degree. One individual was an instructor, four were assistant professors, one an associate professor, one a full professor and two were research associates.

Since there were 123 staff members engaged in research in tropical medicine or parasitology, the 9 investigators represent only a small proportion of total research personnel. However, the majority of the individuals concerned had already had some experience in the tropics; many other faculty members who desired additional observations in the tropics were not actually engaged on a research project at the time in question.

DISCUSSION

The response of over 95 per cent of the medical schools to the request for information was most gratifying and far more encouraging than that obtained from foreign medical schools, of which only 45.3 per cent of those contacted replied. The coverage for this particular section is indeed adequate.

The staffing of tropical medicine research projects in medical schools is essentially different from that in government institutions or private industry. A total of 123 staff members were involved in 144 research projects, or 1.17 individuals per project. Most of these investigators (82.9 per cent) conducted research on a part-time basis and only 21 devoted full time to research. There is no doubt that this factor of time influenced considerably the type of research which was carried on. With a limited amount of time available, the busy instructor must necessarily select a project that does not require constant attention but can be attended at intervals. This is even true when efficient subprofessional personnel are available.

Over half of the tropical medicine projects were concerned with clinical aspects and some of the projects were carried out, in full or in part, overseas. Since only 28.5 per cent of the research personnel represented in the replies were physicians, the emphasis on clinical tropical medicine is encouraging and somewhat beyond that which was anticipated. In Europe, most of the institutes and schools of tropical medicine are located in seaport cities where clinical material is apt to be more available. In the same way, most of the clinical research in tropical medicine in this country was carried out by medical schools in such cities. There were further geographical differences in tropical medicine interest as evidenced by the replies. Medical schools in the South and on the West Coast were conducting the bulk of the tropical medicine research. Of the 46 projects in this field, 25 were in southern schools and 6 in schools in California.

The preponderance of research in parasitic diseases as compared to that strictly related to tropical medicine has already been noted. As pointed out, this dominance of interest in parasitology on the part of medical school faculty members is probably associated with the comparatively large number of non-medical personnel represented in the replies. Many of the Ph.D.'s and Sc.D.'s majored in parasitology during their postgraduate studies and only naturally tend to retain their interest in that field. It was encouraging to note, however, that nearly all of the research projects in this field dealt with some aspect of medical parasitology and were therefore contributing in some way to public health problems associated with the parasitic diseases. This situation is somewhat contrary to the type of parasitological research which is carried on in academic institutions in this country, most of which is purely basic in nature and not related to any disease or public health problem.

It should be mentioned, however, that the amount of attention to research in parasitology in the medical schools of this country far outweighs the emphasis placed on the subject in the foreign medical schools for which data are available. In the foreign schools, research is more frequently associated with disease problems which predominate in the area regardless of the etiology and without reference to any particular branch of medicine.

Research costs in domestic medical schools were no doubt in excess of those in the foreign schools. The total funding of 144 projects represented in this report was $1,403,077, or an average of $9,743 per project. Direct comparison cannot be made with the foreign schools since the data on expenditures were not broken down on a project basis. However, salaries and wages in foreign schools are on a much lower scale than in domestic institutions and seldom does one see in the foreign schools the same amount of elaborate and costly equipment. It is evident, therefore, that the same amount of research can be purchased at a much lower figure in the foreign schools.

SUMMARY AND CONCLUSIONS

This part of the report deals with research in tropical medicine and parasitology which was being carried on in medical schools in the United States as of 1 July 1959. The questionnaire seeking the information was replied to by 78, or 95.1 per cent, of the 82 medical schools; in addition, 2 schools of public health are represented.

A total of 46 institutions reported a total of 144 research projects in the above-mentioned fields, of which 46 were classified by the schools as pertaining to tropical medicine and 98 as belonging to the field of parasitology. Of the 46 tropical medicine projects, 26 involved clinical studies.

Of the 144 projects, 70 concerned 18 of the diseases which are regarded as those constituting the most important public health problems in the tropics. A comparison is made with 26 foreign medical schools which were engaged in 105 projects concerned with 29 of these diseases.

The research interest lay predominantly in the field of parasitology, since 111, or 77.1 per cent of all projects, were related to this field.

A total of 123 staff members were engaged in the reported research, of which 21 constituted full-time research personnel. Of the total personnel, 28.5 per cent were physicians and 71.5 per cent non-medical professional faculty members. The preponderance of non-medical people no doubt accounts in part for the heavy emphasis on research in parasitology.

Nineteen of the 46 responding schools indicated expenditures for tropical medicine research, 32 expenditures for parasitological research, and 12 for research in both categories. The total support for tropical medicine research amounted to $793,517 and that for research in parasitology to $609,560. The total amount expended for research in both fields was $1,403,077, of which 71.3 per cent represented support from the Federal Government. The proportion of federal support was somewhat greater than that recorded for all budgeted research in medical schools of the United States for the fiscal year 1957-58.

The total amount expended for research in tropical medicine and parasitology in the fiscal year 1958-59 was 1.3 per cent of the total research expenditures in the medical schools for the previous fiscal year (1957-58). Data were not available for the total expenditures for 1958-59.

As indicated by the proportion of expenditure, tropical medicine and parasitological research was receiving less attention in the medical schools of the country than in departments of the Federal Government. One of the reasons for this variation is no doubt related to the changing picture of disease in this country and the ascendancy of the chronic diseases as the chief causes of mortality. The interests of physicians on medical school faculties are closely associated with the nature of the clinical material available to them and it is only natural that they should demonstrate the same propensity in their research interests.

In the light of responsibilities which the United States has assumed in the more needy areas of the world and the dependence of the country on the tropics for much of its export trade and its strategic materials, it is reasonable to believe that tropical medicine *per se* is not receiving the research attention which it should in the medical schools in this country. This lack of consideration is no doubt associated to some extent with the decline in the teaching of tropical medicine. However, it is also occasioned in part by the inordinate emphasis being placed on research in aspects of parasitology which do not seem to be closely correlated with those parasitic diseases of greatest public health importance. No doubt the continuing lack of clinical material also plays a role. It is to be hoped that the newly established federally sponsored international training and research programs in some of the medical schools will be the means of augmenting interest in tropical medicine on the part of physician faculty members and will provide an opportunity for the non-medical teachers of the basic medical sciences to engage in types of research which will be productive of material contributions to the control of the diseases of the tropics.

Acknowledgments

The authors of this section of the report wish to express their great appreciation to the deans of the schools of medicine and public health who responded to the request for information without which this material could not have been prepared.

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Expenditures for Research by American Pharmaceutical Manufacturers in Calendar Year 1958

Karl Bambach *Allan H. Wagner*

Early in 1958 the National Academy of Sciences—National Research Council requested the American Drug Manufacturers Association to conduct a survey to determine the extent of research and development in tropical medicine being conducted by its members. The American Drug Manufacturers Association was one of the parent organizations of the present Pharmaceutical Manufacturers Association. This request was later presented to the members of the latter Association with the result that the majority of the members agreed to take part in the survey and supply the necessary information. Each company with annual business greater than $1,000,000 was sent two copies of a questionnaire together with a covering letter. Replies were received from 53 firms including all of the larger ones.

Each member firm was requested to supply as much information as possible, even if data were not available on all of the questions. In the absence of precise figures, reasonable estimates were requested. It was indicated that expenditures should include research costs on biological or biochemical studies, such as those on methodology, as well as on testing, pharmacology and clinical evaluation, together with chemical and developmental costs on drugs designed for the treatment of tropical diseases and tropical veterinary diseases. Where synthesis or isolation of substances was involved, an average cost figure of $400 per compound, synthetic or isolated, was suggested.

The criteria for inclusion of research and development expenditures concerned those contracted in the United States, or any other part of the temperate zone, on drugs designed chiefly for the treatment of infectious diseases (including viral, rickettsial, parasitic, bacterial and mycotic diseases) and nutritional diseases whose occurrence predominates in the tropics. As illustrative examples of the types of diseases to be included, there were mentioned yellow fever, dengue, schistosomiasis, yaws, filariasis, malaria, African sleeping sickness, leprosy and kwashiorkor.

Information was requested also concerning total expenditures for research and development contracted in the Caribbean, Central and South America, Africa, Southwest Asia, South Central and Southeast Asia and Oceania.

Similar data were to be furnished concerning diseases of domestic animals which were predominantly tropical in their distribution. Examples furnished were African trypanosomiasis, rinderpest and East Coast fever.

Because many pharmaceutical firms sponsor educational fellowship programs, information was requested on expenditures for such programs as related to each of the categories mentioned above.

Finally each company was asked to indicate whether it conducted continuous chemical and biological programs on new drugs for tropical diseases as defined above or an intermittent evaluation program on specific substances.

Presentation of the data

Replies were received from 53 firms, including all of the larger pharmaceutical houses. Only 16 companies reported any expenditure at all for research and development in tropical medicine. A summary of the data obtained is given in Table 77 and Figure 37.

The total amount spent for research in human tropical diseases was $4,900,000, of which $3,715,000 was for intramural research and $210,000 for research by contract or grant. A total of $975,000 was spent for educational fellowships in the field of tropical medicine. Of the total expenditure of $4,900,000 for research in human diseases of the tropics, $4,700,000, or 95.9 per cent, was spent in the United States, and the remainder in the tropics.

A relatively small amount was expended for research on diseases of domestic animals occurring predominantly in the tropics. A total of $200,000 represented expenditures in the United States and $5,000 in the tropics.

A summation of the expenditure for research and development in tropical diseases by pharmaceutical firms indicates a total of $5,105,000 for the calendar year 1958, of which $4,900,000 represented research on human diseases and $205,000 research on diseases of domestic animals.

Of the responding firms, ten indicated that they maintained continuous programs in tropical disease research, while four reported intermittent activity in this field. Two of the firms failed to answer this question.

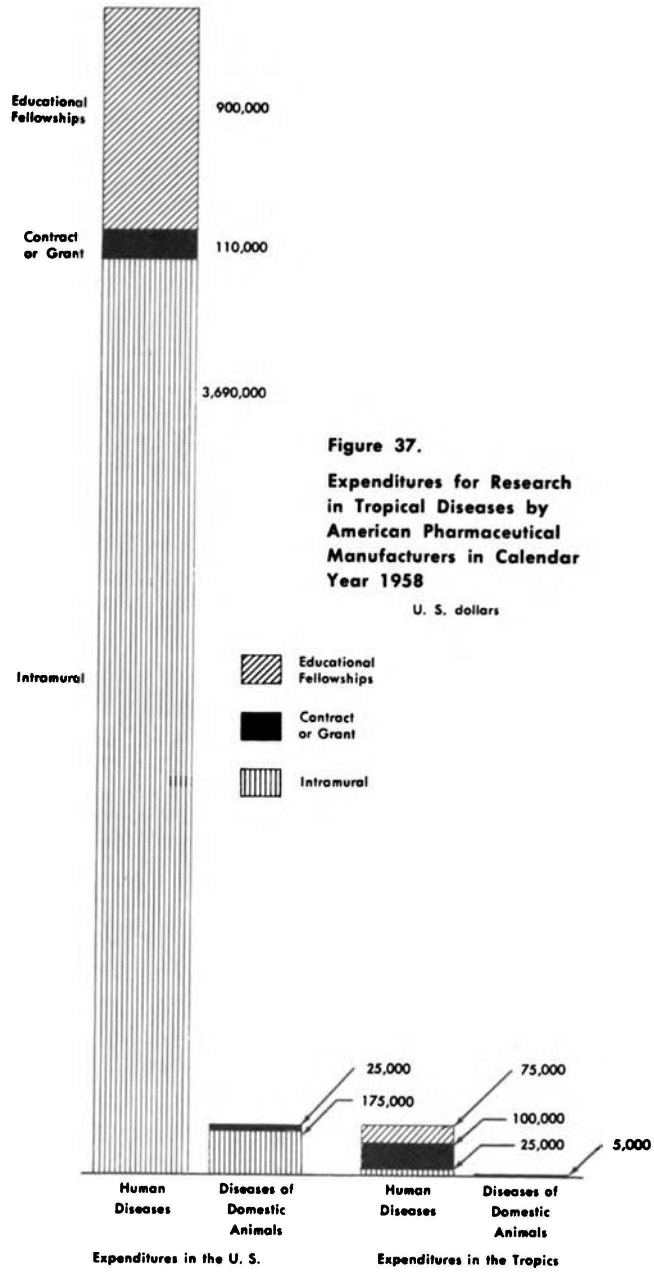


Figure 37.

Expenditures for Research in Tropical Diseases by American Pharmaceutical Manufacturers in Calendar Year 1958

U. S. dollars

Table 77. Expenditures for research in tropical diseases by American pharmaceutical manufacturers in calendar year 1958

(in U. S. dollars)

	TOTAL EXPENDITURES IN THE UNITED STATES		TOTAL EXPENDITURES IN THE TROPICS		EDUCATIONAL FELLOWSHIPS		TOTAL EXPENDITURES
	INTRAMURAL	CONTRACT OR GRANT	INTRAMURAL	CONTRACT OR GRANT	IN THE UNITED STATES	IN THE TROPICS	
Human diseases	3,690,000	110,000	25,000	100,000	900,000	75,000	4,900,000
Diseases of domestic animals	175,000	25,000	0	5,000	0	0	205,000
Totals	3,865,000	135,000	25,000	105,000	900,000	75,000	5,105,000

DISCUSSION

It is estimated that the drug industry spent for research in 1958 the considerable sum of $170,000,000. If this is a reasonable estimate, which it is believed to be, the expenditure of $5,105,000 for tropical medicine research represented only 3 per cent of the total, a relatively small proportion. The minor interest of the pharmaceutical industry in the United States in developing drugs for tropical diseases is of course understandable. Main effort is being directed toward the discovery of compounds of value in cancer, heart disease and the metabolic diseases, the chief causes of morbidity and mortality in this country. It is in the chronic diseases that the pharmaceutical industry can make the greatest contributions, and it is only natural that it is much less interested in exotic diseases which do not occur within the continental limits of the United States.

SUMMARY AND CONCLUSIONS

At the request of the National Academy of Sciences—National Research Council, the Pharmaceutical Manufacturers Association conducted a survey among its membership of research and development expenditures in tropical medicine during the calendar year 1958. A questionnaire was dispatched to each member company with an annual business greater than $1,000,000. Replies were received from 53 firms including all of the larger ones in the industry.

Only 16 companies reported any expenditure in this field. These companies spent a total of $5,105,000 for the above-mentioned purpose during the period in question. Of this amount, $4,900,000 represented costs of research in the human diseases and $205,000 expenditures for research in diseases of domestic animals. Educational fellowships in tropical medicine were supported to the extent of $975,000. The great majority of funds for intramural and contract or grant research, as well as for fellowships, was expended in the United States.

The funds in support of tropical medicine research represented only 3 per cent of the total expenditures of the drug industry for research in the calendar year 1958. It is pointed out that the main effort of this industry is directed toward the development of compounds of value in the chronic diseases which are mainly responsible for morbidity and mortality in the United States.

Acknowledgments

Appreciation is accorded those members of the Pharmaceutical Manufacturers Association who took part in this survey for their cooperation in supplying the data requested.

Research in Private Institutions

Curt R. Schneider

The number of private institutions which support research in tropical medicine in the United States is small. Included are the Gorgas Memorial Institute of Tropical and Preventive Medicine, Incorporated, Washington, D.C., which operates the Gorgas Memorial Laboratory in Panama; the American Foundation for Tropical Medicine, Incorporated, New York City, and its affiliated Liberian Institute, Harbel, Liberia; the Rockefeller Foundation; and the Leonard Wood Memorial for the Eradication of Leprosy (American Leprosy Foundation).*

* The George Williams Hooper Foundation of San Francisco has not been included in this list. Since its establishment, this foundation has acted principally as a department of the University of California Medical School and as such must be considered under the section of this chapter which deals with research in medical schools and schools of public health. However, the word "foundation" and the fact of special endowment create a category demanding special consideration. At present, the future of the Hooper Foundation has become inextricably entwined with that of the new International Center for Medical Research and Training at the University of California Medical School in San Francisco.

The Gorgas Memorial Laboratory, Panama, R. P.

This research laboratory is the sole operating agency of the Gorgas Memorial Institute of Tropical and Preventive Medicine, Inc. It was established in 1929, following legislative action by the Congress of the United States and the National Assembly of the Republic of Panama which assured, respectively, an annual contribution toward its maintenance and operation and a gift of land and a building.

At present, the professional staff of the laboratory consists of 8 persons, including 1 M.D., 5 Ph.D.'s, and 2 M.S.'s. A supporting staff of 31 includes 8 senior technicians, 4 junior technicians, 3 laboratory aides, 10 laborers, 1 field supervisor, and 5 administrative and clerical staff members. In addition to the full-time staff, there are 20 temporary employees engaged as laborers at the field stations.

Although a private institution, the Gorgas Memorial Laboratory enjoys the somewhat unusual assurance of an annual contribution of U. S. Treasury funds, the annual amount not to exceed $250,000. This contribution averaged $50,000 annually for the nineteen-year period 1930-1948. In 1949, appropriations were increased and a limit of $150,000 per annum was authorized. The authorized limit was not required until 1958. Average annual expenditures between 1949 and 1959 (eleven years) were $128,110. In 1961, Congress authorized an increase in the limit of appropriations from $150,000 to $250,000 per annum.

The annual contribution is contained in the appropriation for the National Institutes of Health, which also provides grants-in-aid for specific research programs which totaled $138,413 in FY 1960 and $152,003 in FY 1962. A small amount of money is available from the National Science Foundation, and a small additional sum accrues each year in the form of interest and dividends from endowment fund investments.

The current research interests of the Gorgas Memorial Laboratory include studies on the epidemiology of yellow fever in the Republic of Panama, the role of mammals other than primates in the transmission of the disease, the fate of yellow fever virus in the insect vector during the dry season, the epidemiology of leishmaniasis, the pathology and long-term effects of Chagas' disease, and taxonomic studies on insects of medical importance. Malaria surveillance of villages along the Chagres River is carried out. In addition, an extensive insect collection is maintained. Besides research, the Laboratory offers consulting services to governmental and industrial organizations in the fields of public health, tropical medicine, and pathology.

Salary rates for professional employees of the Gorgas Memorial Laboratory are based on the pay schedule used for classified Federal Government employees.

The Liberian Institute of the American Foundation for Tropical Medicine, Inc.

This laboratory is situated in Harbel, Liberia, and is operated by the American Foundation for Tropical Medicine, Inc., a non-profit, tax-exempt organization incorporated under the laws of New York State. The objectives of the laboratory are broad and include research on fundamental problems of disease in the tropics, including communicable diseases of man, diseases of domestic animals, and problems of adequate production of agricultural products needed to insure nutritional sufficiency. By agreement with the Liberian Government, the Institute is established free of taxes on a basis of perpetuity. Its personnel are permitted to engage in research projects and in the practice of veterinary medicine anywhere in Liberia.

In 1961, the staff of the Institute was composed of eight professional persons, including three M.D.'s and five Ph.D.'s. In addition, there were two professional administrators and an engineer. The staff of necessity undergoes frequent changes. Recruitment is always a problem and is severely hampered by a number of factors, not the least of which is the financial problem discussed below. It is most difficult to attract professional persons of sufficient competence from the United States to work at Harbel. Currently, consideration is being given to applications by professional people from Europe and Asia.

In 1960, the consolidated income of the American Foundation *cum* Liberian Institute amounted to $269,002. This figure, in 1959, was $351,646. The combined expenditures of the Foundation and Institute amounted to $256,991 in 1960 and to $354,705 in 1959. Thus in 1960 there was income in excess of expenses in the amount of $12,010, whereas in 1959 expenses exceeded income in the amount of $3,059. These figures are presented to illustrate not only the degree of absolute support but also the relative fiscal uncertainty under which the Institute must operate. In 1959 the contributions of the International Cooperation Administration and the National Institutes of Health amounted to 41.6 per cent of the total income of the Foundation and Institute. In 1960, this ratio rose to 53 per cent. It must be mentioned that support from private sources, including banking, mining, and pharmaceutical interests, has traditionally been meager and only available on an annual basis in spite of the fact that a requirement for long-term planning, with concomitant long-term financing, is inherent in sound research planning. To help obviate this difficulty, the Rockefeller Foundation, in 1959, made an outright gift of $100,000 to the Foundation to facilitate long-range planning at the Institute.

Research at the Liberian Institute is being carried out in the fields of protozoology, entomology, and helminthology. Protozoological studies are devoted to the immunity and treatment of human and primate malarias, a survey of sleeping sickness in humans, and comparative studies of the parasitic protozoa of Liberian mammals, birds, reptiles, and amphibia. Entomological research includes vector studies ancillary to the research in malaria and trypanosomiasis. In addition, extensive laboratory colonies of mosquitoes are maintained. Helminthological studies include work on the pathogenicity of onchocerciasis as well as field studies on the bionomics and ecology of the snail hosts of schistosomiasis.

The Virus Research Program of the Rockefeller Foundation

The Virus Research Program is a direct extension of the work followed by the Rockefeller Foundation in the yellow fever program of the former International Health Division. The present program has, since 1950, been actively engaged in the study of the arthropod-borne or arbor virus diseases of man and domestic animals. The central laboratory in New York is supported by the work of four field stations, three of which are in the tropics. In tropical America, a laboratory at Port-of-Spain, Trinidad, functions in collaboration with the Health Department of the Government of Trinidad and Tobago and the Colonial Research and Development Scheme, and another, at Belem, Brazil, operates in cooperation with the Special Service of Public Health of the Ministry of Health. In India, the Virus Research Centre at Poona is supported conjointly by the Rockefeller Foundation and the Indian Medical Research Council. A research unit in Berkeley, California, operates in conjunction with the State Department of Health. A fifth unit, located in Johannesburg, South Africa, was operated in collaboration with the South African Institute for Medical Research, the Council for Scientific and Industrial Research, and the Poliomyelitis Research Foundation; the Foundation withdrew from active participation in 1960, although financial support is continuing.

In 1960, the professional staff of the Virus Research Program was comprised of 19 persons, 8 of whom were in New York, 2 in Belem, 1 in Berkeley, 4 in Poona, and 4 in Port-of-Spain. Fifteen of the 19 were M.D.'s, 3 were Ph.D.'s, and 1 was a D.Sc.

The amounts appropriated by the Foundation in support of the virus research program have increased steadily over the years. In 1956, $827,750 was set aside to support the work for the year 1957. In 1960, the amount appropriated for research support in 1961 was $1,324,160. In the five-year period, 1956-1960, a total of $5,602,010 was budgeted for the virus program, averaging more than $1 million per year.

Table 78. Annual expenditures of four private institutions for tropical medicine research, 1960

INSTITUTION	EXPENDITURE	PER CENT OF TOTAL EXPENDITURE
Rockefeller Foundation Virus Program	$1,194,640	60.6
Leonard Wood Memorial	216,743	11.0
Gorgas Memorial Laboratory	303,109	15.4
Liberian Institute	256,991	13.0
Totals	$1,971,483	100.0

In the New York laboratories, the emphasis of the work has been on the basic physical, chemical, and biological properties of arbor viruses. The field stations are concerned with public health aspects of the problem, including clinical manifestations following infection, epidemiology, prevalence, and distribution of the various viruses.

The Leonard Wood Memorial for the eradication of leprosy (American Leprosy Foundation)

The Leonard Wood Memorial was organized in 1927 in order to pursue research in the treatment and prevention of leprosy. Executive offices are maintained in New York City and Washington, D. C. Field and clinical studies are pursued at the National Institutes of Health, the Armed Forces Institute of Pathology, and Johns Hopkins University. An epidemiological unit undertakes clinical studies in Cebu, Republic of the Philippines. Clinical evaluation studies of chemotherapeutic agents are pursued in Japan, the Philippines, India, and South Africa. Until 1959, pathological studies were undertaken at the Culion Reservation leper colony, Palawan, Philippines.

The Leonard Wood Memorial also supports the publication of two journals, the quarterly *International Journal of Leprosy* and the monthly *Leprosy Briefs.*

Memorial funds are obtained through voluntary annual contributions of the membership. Grants from the U. S. Public Health Service and the World Health Organization support research in specified areas of leprosy.

Salaried personnel, paid out of Memorial funds, include six professional scientists (four M.D.'s and two Ph.D.'s) and an assistant. However, approximately ten other professional people, on a full- or part-time basis, are salaried directly through specific grants. Half of these are located in the Philippines.

The annual budget of the Leonard Wood Memorial for the fiscal year 1960-61 was $216,743, of which $94,162, or 43.4 per cent, originated from federal grants or private contracts. In 1961-62, the recommended budget totaled $237,600, of which $115,000, or 48.4 per cent, represented grants for specific research programs given by the National Institutes of Health or the World Health Organization.

The staff of the Memorial published fifteen papers in 1959 and ten papers in 1960, dealing principally with the culture, immunology, and chemotherapeutic aspects of leprosy.

Funding

Table 78 presents the annual research budget for the year 1960 for each of the four private research institutions included in this section. It will be seen that $1,194,640, or 60.6 per cent of the total, represents expenditures of the Virus Research Program of the Rockefeller Foundation. Of the remainder, $216,743, or 11 per cent, represents the Leonard Wood Memorial; $303,109, or 15.4 per cent, represents the Gorgas Memorial Laboratory; and $256,991, or 13 per cent, represents the Liberian Institute.

SUMMARY AND CONCLUSIONS

An account is presented of four privately administered United States institutions engaged in research in tropical medicine. All have installations in countries defined as within the coverage of the survey. Particular attention has been paid to figures concerning staffing and funding. The institutions include the Gorgas Memorial Laboratory of Panama, the Leonard Wood Memorial for the Eradication of Leprosy, the Liberian Institute of the American Foundation for Tropical Medicine in Harbel, Liberia, and the Virus Research Program of the Rockefeller Foundation.

The most considerable of these endeavors in terms of staff, money, and extent of installations, is undoubtedly the Virus Research Program of the Rockefeller Foundation. Although somewhat retrenched in recent years, this program still counts on the contributions of four field stations, three of them in the tropics, in addition to the central laboratory located in New York City. The annual expenditure for this program now exceeds $1,000,000.

The research activities of the Liberian Institute and of the Gorgas Memorial Laboratory are centralized and located entirely outside of the boundaries of the United States, although administrative headquarters are maintained in New York and Washington, respectively. The activities of the Leonard Wood Memorial are largely concentrated in the Washington-Baltimore area; clinical studies are also pursued in the Philippines, Japan, India, and South Africa.

All of the institutions mentioned differ widely in terms of administration and continuity of support, yet their research contributions have been incontestably valuable. This is as much a testimony to the recognized need for these contributions within scientific circles in the United States as it is to the feasibility of privately supported scientific research on the international and intercultural level.

Chapter 13

Foreign Research in Medical and Hygienic Problems of the Tropics

Curt R. Schneider

The primary task in connection with a survey of foreign research in medical and hygienic problems of the tropics concerned the compilation of a list of institutions conducting such research, since no such list was available. Information was secured from many varied sources and the effort eventually occupied a disproportionate amount of time in comparison to preparation of other parts of the report. The completed compilation comprised not only institutions located within the regions covered in this report but included also those in the temperate zone which were concerned with research in this field. Included were research institutes *sensu strictu* and medical centers and hospitals with research programs. The final list included 207 institutions. In addition, 86 medical schools were surveyed.

For the reason that one section of this survey deals with diseases of domestic animals, it was believed desirable to compile information concerning research being conducted on animal diseases of importance in the tropics. Accordingly, data were requested from 65 veterinary research institutes and 63 veterinary schools, most of which were located within the boundaries embraced in the present survey.

In July 1959, a form letter was sent to each of the selected institutions requesting a copy of the last annual report. Many correspondents graciously complied with this request. However, the information in the reports was so varied that a uniform selection of essential data could not be made. Accordingly, it became necessary to forward to each institution a letter requesting specific information concerning personnel, annual budgetary expenditures and a list of publications.

Responses were received from 137 medical research institutes (66.2 per cent of the total of 207 queried), 39 medical schools (45.3 per cent), 35 veterinary research institutes (53.8 per cent), and 16 veterinary schools (25.4 per cent).

The quantity and quality of data received in the total correspondence varied greatly, from detailed and complete replies to apologies for sending no information at all. Table 79 shows the number of foreign research institutions of various types which furnished sufficient data. It will be seen that such replies were provided by 116 medical research institutes, 33 veterinary research institutes,

Table 79. Foreign research institutes and schools included in the survey—Distribution by major geographic areas

AREA	TOTAL NUMBER OF INSTITUTIONS	PER CENT	MEDICAL RESEARCH INSTITUTES	VETERINARY RESEARCH INSTITUTES	MEDICAL SCHOOLS	VETERINARY SCHOOLS
Caribbean, Central and South America	50	23.8	23	6	11	10
Africa	53	25.2	34	13	4	2
Southwest Asia	10	4.8	5	2	2	1
South Central and Southeast Asia	46	21.9	20	7	9	10
Oceania	3	1.4	3	0	0	0
Metropolitan Countries	48	22.9	31	5	12	0
Totals	210		116	33	38	23
Per Cent		100.0	55.2	15.7	18.1	11.0

38 medical schools and 23 veterinary schools. The data contained in these replies have been incorporated into the following narrative report. It occasionally happened that figures supplied in response to the specific request for data were at variance with homologous figures contained in official reports. In such cases, fortunately few, the information secured through correspondence was always preferred.

Directional Authority

Most of the institutions considered here were under governmental control or supervision. Of the 210 foreign institutes and schools, 159, or 75.7 per cent, represented branches of public authority. Only 21, or 10 per cent, were known to be privately operated and of these, 20 were medical research institutes. Five of the institutions, or 2.4 per cent, were known to enjoy the use of public and private funds, and information was lacking for 25, or 11.9 per cent (see Table 80).

For practical purposes, then, it would seem most useful to think of the data which comprise the rest of this section of the report as representing governmental efforts. It would seem that governmental support is usually necessary in order to pursue medical research in underdeveloped countries. Indeed, within the newly independent countries of French-speaking Africa the continued maintenance of pre-existing research institutes, as well as the prophylactic mobile units so essential to the public health of the rural areas, has depended upon a series of political agreements and financial understandings with metropolitan France. In essence, research is a long-range economic investment to be afforded only by the well-developed and settled economy.

Table 80. Foreign research institutes and schools included in the survey—Distribution by directional authority

	TOTAL NUMBER OF INSTITUTIONS	GOVERNMENT	PRIVATE	MIXED	NOT KNOWN
Medical research institutes	116	79	20	2	15
Veterinary research institutes	33	29	1	1	2
Medical schools	38	28	0	2	8
Veterinary schools	23	23	0	0	0
Totals	210	159	21	5	25
Per Cent	100.0	75.7	10.0	2.4	11.9

Foreign Research Institutes and Schools Engaged in Tropical Medicine Research

The institutions contacted by mail were believed to be conducting or to have conducted research which could be characterized as tropical medicine. On the basis of correspondence which provided descriptions of research programs in progress, as well as lists of recent publications, it was determined that 145, or 70 per cent, of all institutes and schools had research programs in tropical medicine. Fifty-four, or 25.2 per cent, were not engaged in any aspect of tropical medicine research as defined in Chapter 1 for the purpose of this survey. The information was not obtained from 11, or 4.8 per cent. When analyzed by type of institution, i.e., whether research institute or school, the above ratios are approximately maintained (see Table 81). However, when analyzed by geographical area (see Table 82), it becomes evident that proportionately less tropical medicine

Table 81. Foreign research institutes and schools included in the survey—Number engaged in tropical medicine research by type of institution

	TOTAL NUMBER OF INSTITUTIONS	NUMBER IN WHICH TROPICAL MEDICINE RESEARCH IS BEING PERFORMED	NUMBER NOT ENGAGED IN ANY TROPICAL MEDICINE RESEARCH	NUMBER FOR WHICH DATA WERE NOT AVAILABLE
Medical research institutes	116	80	29	7
Veterinary research institutes	33	22	7	4
Medical schools	38	27	11	0
Veterinary schools	23	16	7	0
Totals	210	145	54	11
Per Cent	100.0	70.0	25.2	4.8

Table 82. Foreign research institutes and schools included in the survey—Number engaged in tropical medicine research by area

AREA	TOTAL NUMBER OF INSTITUTIONS	NUMBER IN WHICH TROPICAL MEDICINE RESEARCH IS BEING PERFORMED	NUMBER NOT ENGAGED IN ANY TROPICAL MEDICINE RESEARCH	NUMBER FOR WHICH DATA WERE NOT AVAILABLE
Caribbean, Central and South America	50	35	12	3
Africa	53	43	5	5
Southwest Asia	10	9	1	0
South Central and Southeast Asia	46	34	11	1
Oceania	3	2	1	0
Metropolitan Countries	48	22	24	2
Totals	210	145	54	11
Per Cent	100.0	70.0	25.2	4.8

research is performed in areas of greater economic development than in the so-called underdeveloped countries. This is in accord with the concept of "priorities" in medical research; the so-called "great" tropical diseases are the most immediate causes of concern in most of the areas of the survey. In fact, a distinct impression was gained that performance of research not related to immediate problems constituted an economic luxury. However, the selection of institutions in the survey would have to be considerably augmented in order to give more substance to this impression.

Expenditures for Tropical Medicine Research by Foreign Research Institutes and Medical Schools

Table 83 presents in summary fashion the useful information pertaining to expenditures for tropical medicine research conveyed in response to the specific request.

The data were often provided in an unusable form and had to be manipulated for the purposes of this report. For instance, the request for an annual expenditure for tropical medicine research most commonly produced only a figure for the entire research budget, even though only a part of this may have been devoted to tropical medicine research. However, use was made of such data; in the event that a list of recent publica-

Table 83. Foreign research institutes and schools included in the survey—Expenditures for tropical medicine research

	TOTAL NUMBER OF INSTITUTIONS	NOT DOING TROPICAL MEDICINE RESEARCH OR NO INFORMATION	FUNDS FOR TROPICAL MEDICINE RESEARCH NOT KNOWN	NUMBER REPORTING FUNDS SPENT ON TROPICAL MEDICINE RESEARCH	TOTAL ANNUAL EXPENDITURE FOR TROPICAL MEDICINE RESEARCH (THOUSANDS US $)	AVERAGE ANNUAL EXPENDITURE PER INSTITUTION (THOUSANDS US $)
Medical research institutes	116	36	22	58	11,118	192
Veterinary research institutes	33	12	7	14	2,329	166
Subtotals	149	48	29	72	13,447	187
Per Cent	100.0	32.2	19.5	48.3		
Medical schools	38	11	15	12	275	23
Veterinary schools	23	12	2	9	76	8
Subtotals	61	23	17	21	351	17
Per Cent	100.0	37.7	27.9	34.4		
Totals	210	71	46	93	13,798	148
Per Cent	100.0	33.8	21.9	44.3		

tions accompanied the figures, it was possible to calculate the proportion of titles which could be identified with tropical medicine and apply this ratio to the reported annual expenditure. Undoubtedly, large errors were introduced in this way, but no other feasible method of making use of the available data was apparent. It may be said in advance that the totals for expenditures thus obtained are undoubtedly in error on the generous side.

With regard to the medical and veterinary schools, it is impossible to evaluate costs and estimate manpower devoted to portions of the over-all research programs which would be called tropical medicine research. In this way, schools with no program of research devoted in its entirety to tropical medicine were excluded from consideration. It is unfortunate that this step was necessary, since some of the total effort in tropical medicine research was omitted.

Of the 149 medical and veterinary research institutes included in the survey, 48, or 32.2 per cent, gave no information or indicated that no tropical medicine research was being done. Twenty-nine, or 19.5 per cent, indicated that research in tropical medicine was being pursued but did not provide specific information regarding expenditures. Less than half of the institutes (72 or 48.3 per cent) were ascertained to be engaged in tropical medicine research and also provided the amount of funds devoted to this program. A total annual expenditure of $13,447,000 for 72 institutes was reported, which is equal to $187,000 per institute per year on the average.

In like fashion, the data with regard to medical and veterinary schools are as follows: Of the 61 schools for which data were available, 23, or 37.7 per cent, gave no information or were not engaged in any tropical medicine research. Funds for research were not provided by 17, or 27.9 per cent. Twenty-one, or 34.4 per cent, reported total annual expenditures for tropical medicine research amounting to $351,000. This becomes, on the average, $17,000 per school per annum.

A considerable distortion is introduced by reducing the figures for annual expenditures to an average.

Personnel

Table 84 presents the figures pertaining to the number and type of responses to the request for information on scientific personnel engaged in tropical medicine research. Of 149 medical and veterinary research institutes, data were available on number of professional personnel from 91 (61.1 per cent) while 58 (38.9 per cent) did not give this information. In the latter category have been included those institutes in which no tropical medicine research was reported. Thirty-two, or 21.5 per cent, provided a breakdown of professional personnel by categories, i.e., M.D., Ph.D., etc. Seventy-five, or 50.3 per cent, gave numbers of subprofessional

Table 84. Foreign research institutes and schools included in the survey—Number for which data regarding personnel are available

	DATA NOT AVAILABLE[1]		NUMBER GIVING DATA ON PROFESSIONAL PERSONNEL		NUMBER GIVING PROFESSIONAL BREAKDOWN BY CATEGORIES		NUMBER GIVING DATA ON SUB-PROFESSIONAL PERSONNEL		NUMBER GIVING DATA ON OTHER PERSONNEL		NUMBER GIVING DATA ON PROFESSIONAL BUT NOT TOTAL PERSONNEL	
	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT
Medical research institutes	46		70		24		56		49		19	
Veterinary research institutes	12		21		8		19		19		2	
Subtotals	58	38.9[2]	91	61.1	32	21.5	75	50.3	68	45.6	21	14.1
Medical schools	20		18		8		12		6		11	
Veterinary schools	12		11		2		8		3		5	
Subtotals	32	52.5[3]	29	47.5	10	16.4	20	32.8	9	14.8	16	26.2
Totals	90	42.9[4]	120	57.1	42	20.0	95	45.2	77	36.7	37	17.6

[1] Includes institutions where no tropical medicine research was done.
[2] Based on total of 149 institutes.
[3] Based on total of 61 schools.
[4] Based on total of 210 institutions.

personnel, and 68, or 45.6 per cent, gave numbers of other personnel, including administrative staff and labor force.

Similarly, of the 61 medical and veterinary schools, 29 (47.5 per cent) provided data on professional personnel and 32 (52.5 per cent) did not. In addition, 10 (16.4 per cent) gave a breakdown of professional personnel by categories. Twenty (32.8 per cent) provided figures for numbers of subprofessional personnel and 9 (14.8 per cent) gave figures for other personnel.

Assuming that the completeness of the response was in greatest measure associated with availability of information at the source, the above figures are in line with contrasting data to be expected of institutes devoted almost entirely to research and schools for which research is a luxury subordinate to teaching.

Table 85 presents, in summary form, the data pertaining to personnel engaged in tropical medicine research in the foreign institutes and schools. Figures from 91 medical and veterinary research institutes indicate that a total of 1,608 professional persons were employed in tropical medicine. Seventy-five institutes reported the employment of 1,403 persons in a subprofessional capacity. Sixty-nine institutes indicated the presence of 5,283 persons working in other capacities.

With regard to the data from foreign medical and veterinary schools, 28 reported a total of 345 professional workers in tropical medicine, 19 reported a total of 240 subprofessional workers, and 9 gave figures for 113 persons engaged in ancillary capacities.

It must be pointed out, however, that the value of the data from the schools is the subject of some doubt. It is not at all certain that the data reported by the schools represented, in all or very many cases, only that segment of the staff engaged in tropical medicine research. Rather often, it appeared that the entire faculty of the school, or all those having to do with the teaching of tropical medicine, appeared in the figures which were supplied. It is, of course, true that the functions of teaching are closely united with those of research, when this is done in a teaching institution. Nevertheless, the figures for the schools are presented with some diffidence. If any revisions are indicated, the source of error suggests that they be made in a more conservative direction. It would seem that no great contrast appears in numbers of professional and subprofessional personnel between institutes and schools. The failure of the schools to supply more data regarding ancillary (administrative and labor) support of research undoubtedly reflects an administrative dilemma and not a lack of this support.

Replies with regard to the status of professional personnel according to the kind of degree were, in general, unsatisfactory. No data of this sort were received from the research institutes of Southwest Asia or Oceania, and the information was obtained from only two of the research institutes of Latin America, both of which were engaged in veterinary research.

In Africa, a breakdown on a total of 223 professional persons employed in research institutes was obtained. Of this number, 30 (13.5 per cent) held an M.D., 43 (19.3 per cent) held a Ph.D., and 150 (67.2 per cent) held professional degrees in neither of these classes. In South Central and Southeast Asia, data were obtained for 193 professionals; 52 (26.9 per cent) held an M.D., 70 (36.3 per cent) held a Ph.D., and 71 (36.8 per cent) held a degree in neither of these classes. Most of these data are derived from British colonies and members of the Commonwealth. The salient fact is the relatively small proportion of doctors of medicine in both areas. In preparing this summary, the British degree "Bachelor of Medicine" or "M.B." has been equated with M.D.

Table 85. Foreign research institutes and schools included in the survey—Number of personnel

	PROFESSIONAL		SUBPROFESSIONAL		OTHER	
	NUMBER OF INSTITUTES	NUMBER OF PERSONS	NUMBER OF INSTITUTES	NUMBER OF PERSONS	NUMBER OF INSTITUTES	NUMBER OF PERSONS
Medical research institutes	70	1,130	56	1,403	50	3,390
Veterinary research institutes	21	478	19	696	19	1,893
Total—Institutes	91	1,608	75	2,099	69	5,283
Medical schools	18	251	12	126	6	86
Veterinary schools	10	94	7	114	3	27
Total—Schools	28	345	19	240	9	113

The proportion of M.D.'s rises considerably in the data for the schools. Of 94 professional researchers in the medical schools, 45 (47.9 per cent) held an M.D., 8 (8.5 per cent) held a Ph.D. and 41 (43.6 per cent) held some other degree. Only two veterinary schools, both in Latin America, provided a breakdown on the status of their professional staff: of a total of 17 persons, 2 held an M.D. and 15 held a D.V.M.

Comparison of Data from Institutes and Schools

Table 86 compares the available data with regard to expenditures for, and personnel devoted to, tropical medicine research in the foreign institutes and schools. Seventy institutes reported a total annual research expenditure of $13,447,000 for tropical medicine. The mean sum per institute is thus $187,000 per annum, but when the institutes are grouped according to the order of magnitude of their expenditures, the median proves to fall within the group spending $76,000 to $100,000 per annum. These sums are, of course, presented in dollar equivalents of local currency.

Twenty schools reported a total annual research expenditure of $351,000 for tropical medicine. The mean is $17,000 per school, and the median occurs in the group $6,000 to $10,000.

Selecting the median values for comparison, it is seen that the institutes reported annual expenditures which tend to be approximately ten times greater than those of the schools.

With regard to personnel, 91 institutes reported a total of 1,608 professional persons working in tropical medicine research. The mean is 18 professionals per institute; the median value is 9. Twenty-eight schools reported 345 professionals in this discipline, with a mean value of 12 per school and a median value of 7. At first glance there would seem to be little contrast between the figures for personnel from institutes and schools, with an indication that there is much less money support for research in the schools. In reality, a false impression is probably conveyed by the data from the schools (see above) which cannot be documented here. Accordingly, the data for the schools are presented more in a suggestive capacity than because of any conviction that they present a true situation.

Publications in Tropical Medicine

In correspondence with foreign institutes and schools, the point was made to request information regarding the number and character of recent publications emanating from the institution. When available, a list of recent publications was requested.

Table 87 presents a summary of the information received in this connection. Seventy-four research institutes listed a total of 2,855 recently published titles of which 1,134, or 39.7 per cent, could be classified as tropical medicine. Similarly, 25 schools listed 857 titles, of which 379, or 44.2 per cent, were classed as tropical medicine.

A calculation of the mean number of publications per institution will not be attempted since the period represented by the titles in the lists varied greatly; the word "recent" was quite variously interpreted by those supplying information. The percentage ratios, however, are most useful. Less than half of the published efforts could be called tropical medicine, according to the definition employed throughout in this survey. This is by no means unusual since the criteria are strict and much of medicine as practiced in the tropics is excluded from the definition of "tropical medicine." Of more immediate importance is an examination of the relative frequency with which the so-called great diseases of the tropics, as listed for the purposes of the survey, have been the subjects of research programs in the present array of tropical research institutes and schools. Table 88 lists

Table 86. Comparison of expenditures and personnel of foreign medical and veterinary research institutes and foreign medical and veterinary schools engaged in tropical medicine research

	EXPENDITURES				PERSONNEL			
	NUMBER OF INSTITUTIONS PROVIDING DATA	TOTAL EXPENDITURE (THOUSANDS US $)	MEAN (THOUSANDS US $)	MEDIAN (THOUSANDS US $)	NUMBER OF INSTITUTIONS PROVIDING DATA	TOTAL PROFESSIONAL PERSONNEL	MEAN	MEDIAN
Institutes	70	13,447	187	76-100	91	1,608	18	9
Schools	20	351	17	6-10	28	345	12	7

Table 87. Foreign research institutes and schools included in the survey—Data pertaining to publications in tropical medicine

	NUMBER OF INSTITUTIONS PROVIDING DATA	TOTAL NUMBER OF PUBLICATIONS REPORTED	NUMBER OF PUBLICATIONS IN TROPICAL MEDICINE REPORTED	PER CENT
Medical research institutes	62	2,690	1,038	38.6
Veterinary research institutes	12	165	96	58.2
Subtotals	74	2,855	1,134	39.7
Medical schools	17	608	291	47.9
Veterinary schools	8	249	88	35.3
Subtotals	25	857	379	44.2
Totals	99	3,712	1,513	40.8

Table 88. The great diseases of the tropics, arranged in order of frequency with which they were identified with research programs in the *research institutes* included in the survey[1]

1.	Malaria	28
2.	Schistosomiasis	22
3.	Leprosy	18
4.	Kwashiorkor and other nutritional deficiencies	17
5.	Rabies	15
6.	Tuberculosis	15
7.	Filariasis	13
8.	Leptospirosis	13
9.	Bacillary dysentery	12
10.	Amoebiasis	11
11.	Chagas' disease	10
12.	Syphilis and yaws	10
13.	African trypanosomiasis	10
14.	Yellow fever	10
15.	Poliomyelitis	9
16.	Cholera	8
17.	Leishmaniasis	8
18.	Typhoid and paratyphoid fevers	8
19.	Typhus fevers	8
20.	Ancylostomiasis	7
21.	Arbor virus diseases	7
22.	Onchocerciasis	7
23.	Smallpox	7
24.	Trachoma	7
25.	Relapsing fevers	5
26.	Influenza	4
27.	Plague	4
28.	Dengue	1
29.	Measles	1
30.	Pneumonia (all forms)	1
31.	Whooping cough	1
32.	Hydatidosis	0
33.	Meningococcal infections	0
34.	Mumps	0

[1] The 78 institutes which provided data were distributed among the geographic areas of the survey in the following way: Caribbean, Central and South America, 14; Africa, 26; Southwest Asia, 4; South Central and Southeast Asia, 17; Oceania, 1; Metropolitan Countries, 16.

Table 89. The great diseases of the tropics, arranged in order of frequency with which they were identified with research programs in the *medical schools* included in the survey[1]

1.	Kwashiorkor and other nutritional deficiencies	12
2.	Chagas' disease	8
3.	Amoebiasis	7
4.	Ancylostomiasis	7
5.	Filariasis	6
6.	Malaria	6
7.	Schistosomiasis	6
8.	Leishmaniasis	5
9.	Leprosy	5
10.	Poliomyelitis	4
11.	Smallpox	4
12.	Hydatidosis	3
13.	Influenza	3
14.	Leptospirosis	3
15.	Meningococcal infections	3
16.	African trypanosomiasis	3
17.	Tuberculosis	3
18.	Bacillary dysentery	2
19.	Onchocerciasis	2
20.	Syphilis and yaws	2
21.	Trachoma	2
22.	Whooping cough	2
23.	Arbor virus diseases	1
24.	Dengue	1
25.	Plague	1
26.	Pneumonia (all forms)	1
27.	Rabies	1
28.	Relapsing fevers	1
29.	Typhus fevers	1
30.	Cholera	0
31.	Measles	0
32.	Mumps	0
33.	Typhoid and paratyphoid fevers	0
34.	Yellow fever	0

[1] The 26 medical schools which provided data were distributed among the geographic areas of the survey in the following way: Caribbean, Central and South America, 8; Africa, 3; Southwest Asia, 2; South Central and Southeast Asia, 8; Oceania, 0; Metropolitan Countries, 5.

the great diseases in the order of frequency in which the foreign medical research institutes were engaged with them. Table 89 is a similar listing for the medical schools and Table 90 presents a combination of these lists. It will be seen that six of the great diseases are common to the first ten names on each list; namely, malaria, schistosomiasis, leprosy, kwashiorkor and other nutritional deficiencies, filariasis and amoebiasis. In general, it would seem that the research of the medical schools is more concerned with those diseases which pose medical problems, as opposed to public health problems.

With regard to veterinary research, Table 91 lists the most important animal diseases of the tropics in the order of frequency with which they were identified with research programs in the 25 veterinary research institutes which provided data. A similar listing for the 18 veterinary schools providing data is contained in Table 92, and the figures from institutes and schools are combined in Table 93.

It will be noted that Table 87 lists 62 institutes as providing data pertaining to publications, whereas Table 88 indicates that 78 institutes gave information regarding specific research programs. The same disparity will be observed between Table 87 and the information presented in Tables 89, 91 and 92. This is explained when it is understood that sometimes correspondents, for various reasons, identified and described their principal research programs without providing a list of publications emanating from these programs.

Seven of the 24 animal diseases appear among the first ten names on both Tables 91 and 92; rabies, rinderpest, anthrax, tuberculosis, hemorrhagic septicemia, contagious bovine pleuropneumonia and hepatic distomatosis. It is possible, in view of the small size of the sample, that the addition of data from more institutes and schools would alter the order in which the diseases

Table 90. The great diseases of the tropics, arranged in order of frequency with which they were identified with research programs in the *research institutes and medical schools* included in the survey[1]

1.	Malaria	34
2.	Kwashiorkor and other nutritional deficiencies	29
3.	Schistosomiasis	28
4.	Leprosy	23
5.	Filariasis	19
6.	Amoebiasis	18
7.	Chagas' disease	18
8.	Tuberculosis	18
9.	Leptospirosis	16
10.	Rabies	16
11.	Ancylostomiasis	14
12.	Bacillary dysentery	14
13.	Leishmaniasis	13
14.	Poliomyelitis	13
15.	African trypanosomiasis	13
16.	Syphilis and yaws	12
17.	Smallpox	11
18.	Yellow fever	10
19.	Onchocerciasis	9
20.	Trachoma	9
21.	Typhus fevers	9
22.	Arbor virus diseases	8
23.	Cholera	8
24.	Typhoid and paratyphoid fevers	8
25.	Influenza	7
26.	Relapsing fevers	6
27.	Plague	5
28.	Hydatidosis	3
29.	Meningococcal infections	3
30.	Whooping cough	3
31.	Dengue	2
32.	Pneumonia (all forms)	2
33.	Measles	1
34.	Mumps	0

[1] The 104 institutes and schools which provided data were distributed among the geographic areas of the survey in the following way: Caribbean, Central and South America, 22; Africa, 29; Southwest Asia, 6; South Central and Southeast Asia, 25; Oceania, 1; Metropolitan Countries, 21.

Table 91. The most important animal diseases of the tropics, arranged in order of frequency with which they were identified with research programs in the *veterinary research institutes* included in the survey[1]

1.	Rabies	9
2.	Rinderpest	9
3.	Anthrax	8
4.	Foot-and-mouth disease	7
5.	Tuberculosis	7
6.	Hemorrhagic septicemia	6
7.	Trypanosomiasis	5
8.	Blackleg	4
9.	Contagious bovine pleuropneumonia	4
10.	Hepatic distomatosis	4
11.	Sheep pox	3
12.	Tick-transmitted protozoal diseases	3
13.	African horse sickness	2
14.	Nutritional deficiencies	2
15.	African swine fever	1
16.	Blue tongue	1
17.	Gastrointestinal parasitic diseases	1
18.	Hydatid disease	1
19.	Lumpy skin disease	1
20.	Sheep scab	1
21.	Sweating sickness	1
22.	Equine encephalomyelitis	0
23.	Rickettsial diseases	0
24.	Swine fever (hog cholera)	0

[1] The 25 institutes providing data were divided among the geographic areas of the survey in the following way: Caribbean, Central and South America, 5; Africa, 11; Southwest Asia, 2; South Central and Southeast Asia, 5; Oceania, 0; Metropolitan Countries, 2.

Table 92. The most important animal diseases of the tropics, arranged in order of frequency with which they were identified with research programs in the *veterinary schools* included in the survey[1]

1.	Gastrointestinal parasitic infections	3
2.	Hepatic distomatosis	3
3.	Rabies	3
4.	Hemorrhagic septicemia	2
5.	Rinderpest	2
6.	Sheep pox	2
7.	Tuberculosis	2
8.	Anthrax	1
9.	Contagious bovine pleuropneumonia	1
10.	Hydatid disease	1
11.	Nutritional deficiencies	1
12.	Rickettsial diseases	1
13.	Trypanosomiasis	1
14.	African horse sickness	0
15.	African swine fever	0
16.	Blackleg	0
17.	Blue tongue	0
18.	Equine infectious encephalomyelitis	0
19.	Foot-and-mouth disease	0
20.	Lumpy skin disease	0
21.	Sheep scab	0
22.	Sweating sickness	0
23.	Tick-transmitted protozoal diseases	0
24.	Swine fever (hog cholera)	0

[1] The 18 schools providing data were distributed among the geographic areas of the survey in the following way: Caribbean, Central and South America, 8; Africa, 2; Southwest Asia, 1; South Central and Southeast Asia, 7; Oceania, 0; Metropolitan Countries, 0.

Table 93. The most important animal diseases of the tropics, arranged in order of frequency with which they were identified with research programs in the *veterinary research institutes and veterinary schools* included in the survey[1]

1.	Rabies	12
2.	Rinderpest	11
3.	Anthrax	9
4.	Tuberculosis	9
5.	Hemorrhagic septicemia	8
6.	Foot-and-mouth disease	7
7.	Hepatic distomatosis	7
8.	Trypanosomiasis	6
9.	Contagious bovine pleuropneumonia	5
10.	Sheep pox	5
11.	Blackleg	4
12.	Gastrointestinal parasitic infections	4
13.	Nutritional deficiencies	3
14.	Tick-transmitted protozoal diseases	3
15.	African horse sickness	2
16.	Hydatid disease	2
17.	African swine fever	1
18.	Blue tongue	1
19.	Lumpy skin disease	1
20.	Rickettsial diseases	1
21.	Sheep scab	1
22.	Sweating sickness	1
23.	Equine encephalomyelitis	0
24.	Swine fever (hog cholera)	0

[1] The combination of 43 institutes and schools which provided the data were distributed among the geographic areas of the survey in the following way: Caribbean, Central and South America, 13; Africa, 13; Southwest Asia, 3; South Central and Southeast Asia, 12; Oceania, 0; Metropolitan Countries, 2.

are presented in Tables 91, 92 and 93. But it seems unlikely that additional information would affect the basic observation permitted by the data; a relative few of the most important animal diseases of the tropics (rabies, rinderpest, anthrax, tuberculosis, hemorrhagic septicemia, foot-and-month disease) are the objects of attention of researchers in the tropic.

It was not feasible to secure a breakdown of research funds by types (i.e., laboratory, clinical, or mixed), nor was it possible to discern from the titles of published papers which parts of the corresponding research programs were devoted to laboratory research and which to pure clinical research. However, the subjective impression was gained that the amount of pure laboratory research was far greater than the amount of pure clinical research.

DISCUSSION

In spite of the somewhat disappointing response to the solicitation of data, one fact seemed to disengage itself from the array of information; namely, that the foreign research institutes and schools operate research programs which utilize relatively small amounts of money in relation to the number of personnel. It has been shown that if the institutes are grouped according to the order of magnitude of their annual expenditures, the median falls in the group defined by an expenditure of $76,000-$100,000. If they are grouped according to numbers of professional, the median falls in the group employing nine professionals. Since operating costs include maintenance as well as salaries, it seems clear that, in the aggregate, the cost of research in foreign institutions is less than that in American ones; presumably, therefore, the funds invested in foreign institutions offer greater returns for the same amount of money.

No schools reported research programs which were administratively separated from teaching programs; thus the data for the schools (a median annual expenditure of $6,000-$10,000 and a median research staff of seven professional persons) probably ought not to be compared with the data for the institutes. In most cases it was evident that the data requested of the schools were not available and could not be made available. Such data as were supplied probably represented estimates for the entire research activities of the school, and it is felt that tropical medicine's share should be represented by large reductions in the amounts of the figures in both categories.

With regard to publications, no effort was made to judge relative productiveness or quality. Indeed, such a purpose would be quite beyond the intent or capacities of the staff of the survey. It was determined, however, that 1,513 (40.8 per cent) of the 3,712 titles made available as representing *medical research in the tropics*, could be identified with *tropical medicine* as defined for the purposes of the survey. Throughout this survey, the impression has been acquired that, although the vital needs of the area determine the type of clinical research to be done, the performance of basic laboratory research is directed by the personal interest of the researcher.

SUMMARY

A survey was made of the support given to tropical medicine research in the tropics. Queries were made of 207 medical research institutes, 65 veterinary research institutes, 86 medical schools and 63 veterinary schools located, for the most part, within the geographic areas included in the survey. Useful data were provided, usually by direct communication, by 116 medical research institutes, 33 veterinary research institutes, 38 medical schools and 23 veterinary schools.

Seventy-five per cent of the institutions included in the survey were operated by governments. Only 10 per cent were operated privately and this group comprised no schools.

It was determined that 145 (70 per cent) of the 210 institutes and schools had research programs in tropical medicine.

Information pertaining to annual expenditures for tropical medicine research was forthcoming from 72 medical and veterinary research institutes, which reported a dollar-equivalent total of $13,447,000. The average expenditure per institute was $187,000. The median value for all the institutes, grouped by order of magnitude of expenditure, was $76,000-$100,000. In like manner, 21 medical and veterinary schools reported a total annual expenditure which was the equivalent in dollars of $351,000. The average research expenditure per school for tropical medicine was $17,000. The median was $6,000-$10,000.

Data on number of professional personnel were obtained from 91 medical and veterinary research institutes and 28 medical and veterinary schools. The totals were, respectively, 1,608 and 345. Seventy-five medical and veterinary research institutes and 19 medical and veterinary schools reported, respectively, totals of 1,403 and 240 subprofessional employees. Sixty-nine medical and veterinary research institutes gave figures for a total of 5,283 persons employed in other capacities.

The mean number of professional personnel per institute is 18; the median is 9. The same values for both types of school are, in order, 12 and 7.

A summation of the lists of publications submitted by the institutes produced a total of 2,855 titles, of which 1,134, or 39.7 per cent, were in the field of tropical medicine. In like manner, 25 schools listed 857 titles, of which 379, or 44.2 per cent, were in tropical medicine.

Those diseases from the list of the "great diseases of the tropics" which were found to occupy most of the attention of foreign researchers working within the geographic areas included in the survey, as well as in certain of the metropolitan countries, were, in order of frequency of enumeration of programs, malaria, schistosomiasis, leprosy, kwashiorkor and other nutritional deficiencies, filariasis and amoebiasis. The most important animal diseases receiving foremost attention in the research laboratories of the tropics are rabies, rinderpest, anthrax, tuberculosis, hemorrhagic septicemia and foot-and-mouth disease.

The data conveyed the impression that foreign workers in tropical medicine and tropical veterinary medicine work with smaller expenditure allotments, and presumably less equipment, than is customary in this country. The number of resulting publications suggests that this relative deprivation does not prevent the performance of a large amount of research which constitutes almost half of the total medical research effort in these areas.

Acknowledgments

Although it is not possible to list them individually here, it is desired to accord to each of the many officials who cooperated in supplying data for the present report grateful acknowledgment for their kind assistance.

ADDENDUM

Certain research activities of the Federal Government, which can be identified with tropical health, were initiated after the essential completion of the manuscript of this report. It is believed that additional information, however brief, regarding some of these activities will be welcomed by many readers of this report.

International Centers for Medical Research and Training

Reference is made in Part VI, Chapter 17, to the international research and training program which now implements the International Health Research Act of 1960. This program was administered initially by the National Institute of Allergy and Infectious Diseases. It has now been made a part of the Office of International Research.

At the present time (1962) it is still premature to attempt a summary of the activities of the five American institutions which were initially awarded ICMRT grants. Each institution enjoys considerable autonomy in the interpretation of its mandate under the terms of the grant. In addition to this, negotiations must be undertaken with a number of foreign governments with respect to the basic agreements, and the time required for such negotiations varies greatly from one country to another. It has become clear that full development of the new programs will require a longer period than the two years which has elapsed since their inception.

The number of new staff members added by each American grantee institution has varied from six to twenty-five. In most cases, approximately equal numbers of American and foreign professionals have been involved. Information pertaining to salary scales is still fragmentary, but it would appear that, in general, foreign appointees will receive salaries similar to those which obtain for regular faculty members of similar rank.

Although the emphasis is at present on tropical medicine, it should be stressed that the programs are ultimately intended to provide opportunities for research in the various disciplines which can be identified with health in the tropics, including problems of acute and chronic disease as well as the social and economic factors which can directly influence disease.

It is likely that the number of international research centers will not be essentially increased in the near future. As an exception, however, consideration is now being given to the establishment of one new Center in Africa south of the Sahara.

SEATO Medical Research Laboratory

Certain research activities pursued under the auspices of the Federal Government will be of outstanding interest to United States parasitologists and especially to those interested in tropical medicine research. In this connection, mention may be made of the SEATO Medical Research Project currently being conducted by signatory members of the South-East Asia Treaty Organization. The United States component of this activity is represented by the SEATO Medical Research Laboratory in Bangkok, Thailand, administratively a special activity of the Walter Reed Army Institute of Research, Washington, D. C. Programs of investigation include continuing studies on cholera, typhoid fever, ancylostomiasis, dengue, malaria, filariasis and scrub typhus. The Bangkok laboratory was established in 1961.

West African Research Unit

In January 1962, the governments of Ghana and the United States signed the agreement which established the West African Research Unit (WARU), to be located in Accra. The unit will concentrate on research of interest to the United States Public Health Service and to the National Institute of Health and Medical Research of Ghana. Problems of immediate concern include malaria, tuberculosis, leprosy, malnutrition, tropical anemias, hypertension and cancer. The program will include studies in pathology, infectious disease, biochemistry, epidemiology and hematology. Administration will be provided by the National Cancer Institute as a direct extension of its intramural activities. It is anticipated that the interests of the National Institute of Allergy and Infectious Diseases will also be abundantly served.

Six sections of the laboratory have been planned and staffed as this is being written, including pathology, microbiology, biochemistry, clinical investigations, operations and epidemiology. The permanent staff will include ten professionals and about twenty technicians.

The sum of $350,000 was allocated for the project in FY 1962. It is anticipated that this amount will be increased to approximately $500,000 in FY 1963.

Far East Research Project

The Far East Research Project (FERP), formerly the Far East Research Unit, is located in Kuala Lumpur, Malaya. It is essentially a field project representing a direct extension of the intramural program of the Laboratory of Parasite Chemotherapy of the National Institute of Allergy and Infectious Diseases. As such it does not represent a permanent establishment. It was established in June 1961 and is housed, for administrative purposes, with the Institute for Medical Research in Kuala Lumpur. The professional staff of three United

States nationals is at present engaged only on malaria studies, with emphasis on strains of monkey malaria capable of parasitizing man.

In addition to the programs listed above, the Federal Government currently supports a small scattering of professional individuals on detailed assignment to various tropical posts. Some of these situations appear to be characterized by a greater degree of permanency than others, but all represent responses to urgently felt needs. Countries in which such government research workers are now stationed include Panama and British Guiana in the Americas and Uganda in Africa.

Part VI

Chapter 14

Research Grant Programs in Tropical Health

Domestic Grant Programs for Calendar Years 1954 through 1958

Janet W. Mackie

The objectives of this detailed study have been to determine the amount of support available for research in tropical medicine over the five-year period and the sources of such support. It was intended also to show any increase or decrease in the funds granted year by year and to ascertain where and how the support was utilized.

Grant programs represent only a portion of funds available for medical research. Many government departments and agencies as well as other public and private institutions conduct a large volume of continuing intramural research financed by other means. This particular segment of research is treated in another part of this report.

Before attempting to determine the amount of support provided by grants during the five years covered by the survey, it was necessary to define further the term "tropical medicine" and its various disease categories, and to set up definitive criteria for selection of grants. A discussion of factors governing such a definition is included in Chapter 1 of this report.

Categories of tropical diseases included in analysis of grant programs

The following diseases and conditions are those which have been selected as the subject matter for inclusion of grants in this survey.

Infectious diseases. 1. Those which by reason of their etiology and/or ecology (agent, vector, reservoir host, temperature requirements, etc.) have a distribution limited mainly to the geographic areas of the survey. Examples: African sleeping sickness, pinta, Carrion's disease, filariasis, schistosomiasis, yellow fever, dengue, maduromycosis, etc.

2. New infectious diseases including diseases of the temperate zone or closely related to such appearing for the first time in tropical areas; and diseases of potential importance to the tropics because of lack of knowledge concerning their etiology, epidemiology, treatment and control. Examples: Kyasanur Forest disease (India), hemorrhagic fever (Philippines).

3. Infectious diseases of world-wide distribution *only* as they present specific features related to the tropical environment.

Nutritional diseases. 1. Nutritional diseases and deficiencies which are predominantly found in the geographic areas of the survey. Example: Kwashiorkor.

2. Nutritional diseases and deficiencies of more general distribution but of public health importance in certain tropical areas. Example: Pellagra.

Tropical physiology and climatology. 1. Mechanisms of adaptability, physical and psychological, of man to a tropical climate; physiologic response to increased temperatures and/or relative humidities.

2. Impact of climate on health in the tropics.

3. Tropical hematology and diseases of racial specificity as they occur in the tropics. Examples: Tropical eosinophilia, sickle cell anemia.

Environmental hygiene. 1. Environmental sanitation and hygiene as related to public health and control and prevention of disease.

2. Development of new hygienic concepts and methods for the control of disease in the tropics.

The zoonoses and other diseases of domestic animals. 1. The zoonoses are included because of the importance of lower animals as reservoirs of certain diseases of man in the tropics.

2. Collectively, the diseases of domestic animals are of importance in public health because of their impact on the nutritional status of the human population.

Medical zoology. Certain research in this field which has a bearing on tropical health problems.

Criteria for selection of type of research within the above tropical disease categories

The criteria set up for selection of research studies are arbitrary and therefore open to criticism. There were two main problems in selection. The first is related to research on diseases of importance in both tropical countries and temperate zones, including the United States. The inclusion of basic and applied research in the United States on world-wide diseases such as the dysenteries, intestinal helminth infections, poliomyelitis, tuberculosis and other respiratory diseases, encephalitides, infectious hepatitis, leptospirosis, rabies, syphilis, brucellosis and others would grossly distort the picture although all are of importance in certain tropical areas. Long-term studies have been made on these diseases in the United States and on their etiological agents, vectors, epidemiology and control in the United States population under environmental conditions very different from those of the tropics. Some of these studies may eventually contribute to the solution of similar problems in the tropics, but they are not regarded as research in tropical medicine.

The second problem of selection concerned basic research in the United States on tropical diseases as defined earlier. The science of tropical medicine is based on fundamental research. Such research, however, is not always directed to a specific field and is not always directly applicable to improvements in the treatment and control of human disease. Selection in this group of studies was therefore based on present or future applicability to tropical disease problems.

For this reason, the following types of basic research have been omitted. Studies on antigenic structure; biochemical constitution and properties; genetic constitution; differences in strains and races of organisms; metabolic, cytotaxonomic and enzymological research on disease agents; biological and biochemical requirements of organisms; factors of susceptibility and immunity of insects to infection; studies on susceptibility to infection by parasites; gene-environment interaction in drug resistance; experimental drug testing (prior to field testing); and pharmacology of potential but unproved parasiticides.

On the basis of the above criteria, the following types of research have been included or excluded from the present compilation.

Types of research included. 1. Laboratory and field studies, basic and applied, made in the tropics on tropical diseases as defined above.

2. Basic laboratory research in the United States or other non-tropical countries immediately applicable or considered to have future applicability to the etiology, pathology, epidemiology, prevention, treatment or control of disease in the geographic areas represented in the survey.

3. Studies made in the United States which are primarily concerned with promoting health in the tropics rather than health in the United States; that is, applied research aimed to assist in developing more effective methods of treatment and prevention of tropical diseases and world-wide infections of importance in the tropics as defined above.

Types of research excluded. 1. Basic and applied research in diseases prevalent in both temperate and tropical countries where the research is carried out in the temperate zone and is not strictly applicable to the tropics.

2. Basic research which appears to have no direct application, immediate or future, to the etiology, epidemiology, prevention, treatment, or control of disease in the geographical areas represented in the survey.

3. Research grants in the United States which are directed only to disease agents and vectors found in the United States.

4. Studies on mixed temperate and tropical distributed disease agents and vectors, unless major emphasis is placed on the investigation of those of tropical importance.

Sources of information

Organizations. The great bulk of the data going into research grant compilations was secured through the courtesy of the Secretary of the Smithsonian Institution, who granted permission for the use of the facilities of the Bio-Sciences Information Exchange. The director and staff provided working space and gave maximum assistance in other ways.

In addition to the above source, data were furnished by the following organizations: Public Health Service, National Institutes of Health, Division of Research Grants; Department of the Army, Office of the Surgeon General, Medical Research and Development Command; Department of the Navy, Bureau of Medicine and Surgery; Veterans Administration; Lasdon Foundation, Information-Dissemination Service; National Academy of Sciences—National Research Council, Medical Records Section; private foundations; and pharmaceutical firms.

Publications. The following publications were reviewed:

1. Public Health Service, National Institutes of

Health Grants and Fellowships Year Books for the five years were checked for possible additional information and for the fiscal half-year 1959, as well as for grants in Study Sections other than Tropical Medicine and Parasitology (TMP). These included Metabolism and Nutrition, Microbiology, Virology and Rickettsiology, Allergy and Infectious Diseases, Bacteriology, Mycology and others.

2. Office of the Surgeon General, Armed Forces Epidemiological Board, Annual Reports for the five years of the Commissions on Viral Infections, Rickettsial Diseases, Enteric Diseases, Parasitic Diseases, Immunization, Hemorrhagic Fever, and Environmental Hygiene. Annual Research Task Summaries, fiscal years 1958 and 1959, were also consulted.

3. Veterans Administration, Medical Research Year Books.

4. Lasdon Foundation, "Research Projects in Medical Schools."

5. The annual reports of various private foundations.

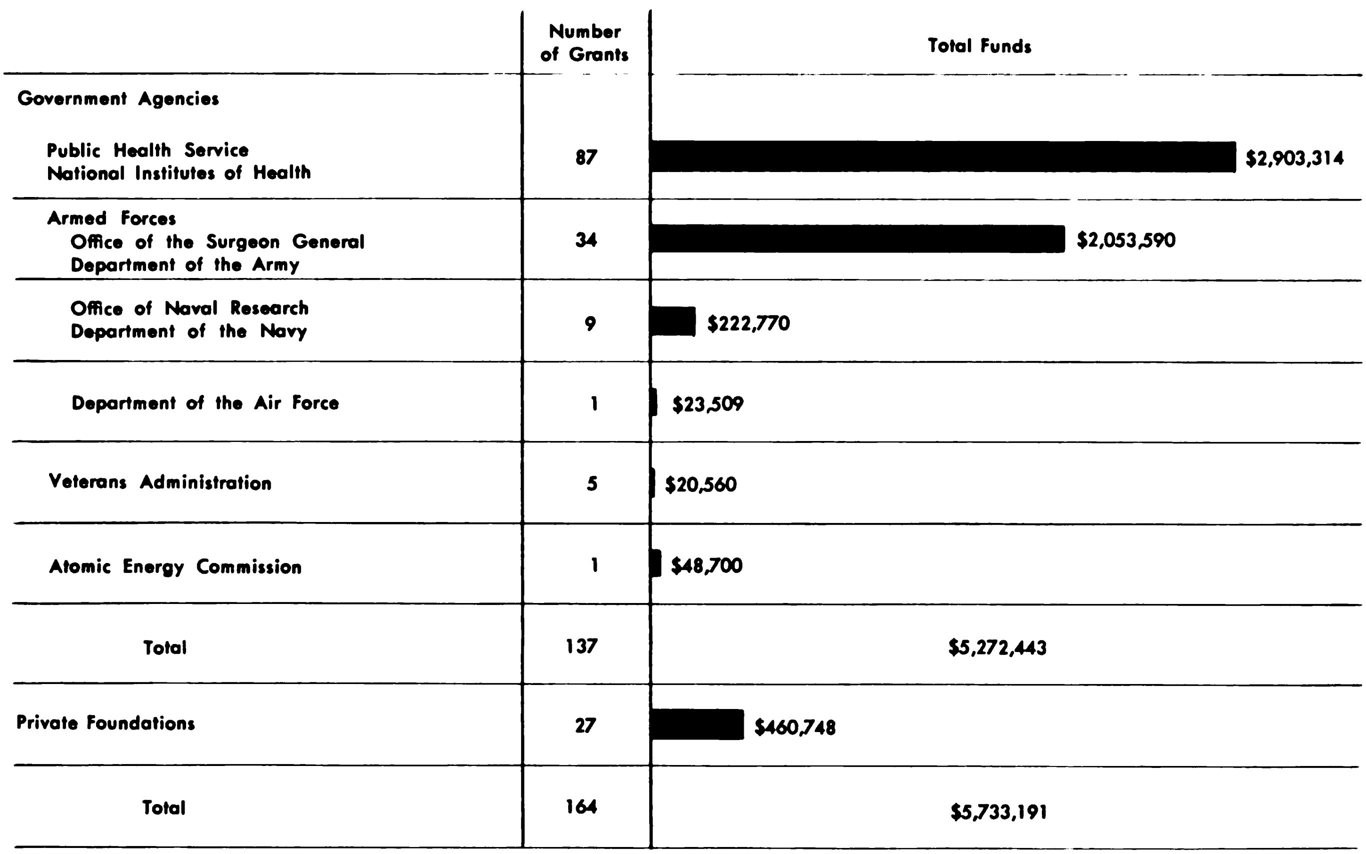
Presentation of the data

Classification of studies. It was not found possible to classify all research studies under specific disease entities. Investigations frequently dealt with broader aspects, such as the epidemiology of a group of diseases, or studies of vectors; reservoirs of diseases of potential importance in a geographic area; etc.

Studies in the survey included research on the following subjects: cholera, plague, leprosy, leptospirosis, typhus, dengue, arthropod-borne encephalitides, hemorrhagic fever, poliomyelitis, rabies, Rift Valley fever, smallpox, trachoma, yellow fever, trematodiasis, amoebiasis, schistosomiasis, ascariasis, echinococcosis, filariasis, malaria, sickle cell anemia, thalassemia, tropical eosinophilia, trypanosomiasis, histoplasmosis and mixed fungal infections, beriberi, kwashiorkor, malnutrition, sprue, mosquitoes, insects, ticks, mites, snails, poisonous fish, rodents, mixed animal reservoirs and vectors, tropical physiology and climatology, and chemotherapy.

Number of grants and source of funds. From Figure 38, it will be noted that there were made in the

Figure 38. Number of Grants in Tropical Medicine in the United States and Source of Funds for Calendar Years 1954-1958, Inclusive



United States during the five-year period 1954-1958, inclusive, a total of 164 grants in tropical medicine, as defined above. The total funds allocated for these grants were $5,733,191. A total of 137 grants were sponsored by government agencies and these grants involved a total sum of $5,272,443. Grants made by private foundations totaled 27 in an amount of $460,748.

The Public Health Service, National Institutes of Health, supported the largest number of projects (87) involving the greatest allocation of funds. The Armed Forces supplied a total of $2,299,869 in the financing of 44 grants. The considerable interest of the military in the field of tropical medicine is reflected in the proportion of funds supplied by it in relation to total funds in this field.

Geographical distribution and types of institutions. Of the total 164 grants (Table 94), 73, or 44.5 per cent, went to institutions outside of the continental United States, of which Puerto Rico and Hawaii received 34. Thirty-nine, or 23.8 per cent, of the grants were made to foreign institutions in an amount of $1,166,867, or 20.4 per cent of the total. Foreign countries receiving the remaining 39 grants included Panama, Mexico, Guatemala, Colombia, Brazil, Chile, South Africa, Liberia, Nigeria, Israel, Lebanon, India, Malaya, Japan, Korea and the Philippines.

A considerable part of this research was carried out in the tropics on problems of immediate health importance. The investment in the research programs of foreign institutions may be expected to pay prompt dividends.

International health interests are focusing increasing attention on the need for more and better equipped research institutes in tropical countries for high level research within the environment of the area health problems. Support of such developments especially where associated with clinical facilities will provide increasing opportunities for visiting research workers and senior clinical instructors and for exchange facilities. Opportunities such as these are much needed by the United States for a broad advance in the tropical medical field.

It should be pointed out that the research in tropical countries, as represented in the grants, was not carried out entirely by foreign institutions. A number of American professional schools conducted certain investigations in the tropics in connection with grant programs.

Table 94 also presents data on the types of institution receiving research grants. Professional schools received 58.5 per cent of the grants and 67.5 per cent of the total funds, followed by research institutions. Academic institutions were the recipients of the smallest number. This distribution could well have been anticipated by reason of the type and interest of the worker and the percentage of time devoted to research activities. Personnel in academic institutions usually devote the majority of their time to teaching, and research can only be undertaken on a relatively small scale. The professional schools are more numerous than are the research institutes. While here again teaching represents the primary responsibility, personnel are encouraged to conduct research and are allowed more time for such activities.

Status of principal investigator. Table 95 gives information on the status of the principal investigator. The proportion of M.D.'s (91 of 162 investigators) appears high in view of the preponderance of basic research represented in the grants. It is an encouraging sign, however, and indicates that tropical medicine does have some appeal for the physician.

Field and type of research. Of the 164 grants, 112 were for laboratory research, 12 for clinical research and 38 for mixed clinical and laboratory research. Two grants were for the support of international conferences. The grants for clinical and mixed clinical and laboratory research totaled $1,927,352. The support for the 112 grants for laboratory research amounted to $3,791,389.

Table 94. Geographical distribution and types of institutions receiving research grants for tropical medicine, 1954-1958, inclusive

GEOGRAPHICAL DISTRIBUTION	ACADEMIC INSTITUTIONS		PROFESSIONAL SCHOOLS		RESEARCH INSTITUTES		TOTALS	
	NUMBER OF GRANTS	TOTAL AMOUNT	NUMBER OF GRANTS	TOTAL AMOUNT	NUMBER OF GRANTS	TOTAL AMOUNT	NUMBER OF GRANTS	TOTAL AMOUNT
United States	19	$383,702	54	$3,196,397	18	$ 439,626	91	$4,019,725
Puerto Rico	0	—	25	423,453	2	4,526	27	427,979
Hawaii	4	35,640	0	—	3	82,980	7	118,620
Foreign	0	—	17	251,676	22	915,191	39	1,166,867
Totals	23	$419,342	96	$3,871,526	45	$1,442,323	164	$5,733,191

Table 95. Status of principal investigator in 164 grants for tropical medicine, 1954-1958, inclusive

Bachelor of Science	1
Master of Science	3
Doctor of Medicine	91
Doctor of Philosophy	61
Doctor of Science	4
Doctor of Veterinary Medicine	2
	162
Conferences[1]	2
	164

[1] "Nutritional Deficiencies in the Americas." Colombia, S. A.
"To establish a technical advisory group on diseases transmitted between animals and man in the Americas."

Table 96. Amount of funds and number of tropical medicine grants active by calendar year, 1954-1958, inclusive

YEAR	FUNDS	GRANTS ACTIVE
1954	$ 625,826	57
1955	838,796	77
1956	1,107,543	86
1957	1,440,123	109
1958	1,720,903	116
	$5,733,191	

The relatively small amount devoted to clinical studies can be attributed in part to the position of the United States in world health activities in the past. The United States has not had the clinical opportunities of some Western European countries which have, or have had until recently, responsibility for medical services, hospitals and public health programs in large areas of the tropics. This comparative lack of field opportunities in the past has been reflected in the minor emphasis on tropical medicine in general medical education and consequent lack of incentive for applied research.

Ninety-four of the 164 grants call for basic research. This basic research had little follow-up in applied grants during the five years, as indicated by the paucity of applied clinical research. Basic research is wasted as a contribution to the field of tropical medicine if not applied to the improvement of medical care and prevention. Hence the need for broader planning of basic research together with some provision for the application of the results to applied research.

Grants by calendar year. Table 96 indicates the funds allocated each year for grants in tropical medicine and the number of grants active in each calendar year 1954-1958, inclusive.

An increase in number of grants and in amount of funds was shown each year. Increases were small, however, and were no doubt limited to a considerable extent by the size of appropriations to government institutions concerned.

An analysis of research grants approved by the Tropical Medicine and Parasitology Study Section, National Institutes of Health, Public Health Service. Since over half the grants and half the funds furnished for research in tropical medicine during the period 1954-1958 emanated from the National Institutes of Health, a special study was made of these grants. The grants were reviewed by the Tropical Medicine and Parasitology Study Section. This is one of the smaller study sections as regards the number of applications assigned to it and in the total funds chargeable to its selections from year to year. Changes of personnel in the Study Section took place during the period in question. However, it was one of the original study sections formed in 1947 at the organization of the research grants program and has been functioning continuously since that time, although not always under this designation.

During the period 1954-1958 this Study Section approved 836 grants in the sum of $7,094,596. Of these grants 87 for a total of $2,903,314 met the specifications of a tropical medicine grant as set up in this study. Thus only about one-third of the selections of this Study Section could be considered as coming within this field.

In order to analyze further the selections, those grants approved by the Study Section and paid during the fiscal year 1958 were reviewed in detail. These grants numbered 210 for a total amount of $2,084,468. Of these, 32 in the sum of $489,098 were considered to be in the field of tropical medicine. The remaining 178 grants totaling $1,595,370 were mainly in the fields of general parasitology, general zoology or entomology.

A list of the grants not coming within the present definitions of tropical medicine will be found in Appendix 13. As liberal interpretation as possible was made in the classification of grants for the reason that the relationship of parasitology and entomology to tropical medicine is a close one. Even with such an interpretation, the analysis of these grant projects shows an extraordinarily high proportion of support given for those unrelated to tropical medicine and public health. This lack of relationship to these fields can hardly constitute a criticism of policies of the Study Section for the reason that the Study Section does not generate grant applications but is charged only with the review of applications assigned to it. Rather the situation emphasizes further the general lack of interest in tropical medicine and the failure of a sufficient number of individuals to undertake research in this field.

DISCUSSION

The new demands for international research and the increasing emphasis on broad scale attack on well-known diseases indicate growing interest in the health needs of the geographic areas covered by the survey. This in turn will increase demands for well-qualified workers in clinical and research work.

The following indicate some ways of enlarging the scope of tropical medicine in the United States to meet the demand:

a. A review of present systems of allocating research grants with more emphasis and publicity on what research is needed rather than leaving the making of suggestions solely to the applicant.

b. Planning at a national level for coordinated research according to areas in need, and circulation of these research needs so that universities and research institutes may participate according to their interests.

c. Individual research studies to be considered in the light of their contribution to national and international projects.

d. Priority to be given to research projects planned and coordinated from basic research through field studies and application to medical care, disease control and prevention. The success of basic research and its immediate follow-up and application to the problems of a geographic area have been demonstrated in many areas of the tropics. For example: (1) In Tahiti, research in filariasis included field bionomics of mosquitoes, intensive mosquito survey methods, use of microfilaricides, an organized educational campaign, a mosquito control program, and studies of harmful effects of insecticides on agricultural pursuits; (2) At the Institute for Medical Research, Kuala Lumpur, Malaya, a research grant program includes research beds for patients with unknown febrile diseases, isolation of etiological agents, epidemiological investigation, studies on Malayan mosquitoes, isolation of viruses from pediatric cases and central nervous system disease cases, serological surveys of population groups, etc.; and (3) An onchocerciasis research program in Guatemala included research on the clinical aspects as well as studies on epidemiology and entomology. After primary screening of compounds for *Simulium* control, field trials with promising chemicals were undertaken. The field research was closely correlated with basic studies at the National Institutes of Health.

e. Consideration of incentives and ways of arousing interest in tropical disease in the tropics.

The expanding field of tropical medicine is not arousing the interest of students and medical workers at present because of ignorance rather than indifference. Students are not exposed to tropical medicine at an early stage in their training, as they are to the other specialties; thus interest is not aroused and potential workers are lost. In addition, there is little opportunity for them to learn of the growing demand for specialists in both clinical and research development in this field. Clinical tropical medicine particularly has been relatively neglected; yet applied research cannot be completely successful without clinical knowledge of disease as it appears in its tropical environment.

As pointed out by a medical officer in Nigeria,[1] "Such conditions for example, as pulmonary tuberculosis, toxaemia of pregnancy, intussusception, measles and peptic ulcer are simply not the diseases that we know by those names." A knowledge of the economic, social and cultural factors which influence the incidence and course of disease is needed whether for the practice of medicine or research, in addition to the ability to get along with disparate peoples. The author adds that "the basic problems of health are still largely social, to be solved at community rather than at mass levels, and to be solved by doctors whose training is not only sufficiently catholic for the task, but is also designed to develop the highest levels of adaptability."

f. Increased support for research institutes and associated clinical facilities overseas to strengthen research within the tropical environment and to provide laboratory, clinical and field research opportunities for visiting and exchange workers.

SUMMARY AND CONCLUSIONS

Results of a survey of research grants in the field of tropical medicine in the United States during the period 1954-1958, inclusive, are presented.

Criteria were established for an evaluation of the subject matter of grants and its relationship to tropical medicine. These criteria were followed in classifying grants. Grants in tropical medicine for the period in question totaled 164, a relatively small number compared to total grants in medicine and the medical sciences.

One hundred and thirty-seven of the grants were made by United States government agencies and 27 by private foundations. Of the government agencies, 87 grants were made by the National Institutes of Health and 44 by the Armed Forces. The funds involved in the 164 grants amounted to $5,733,191. Over the five-year period, there was a gradual increase both in the number of grants and the amount of funds.

With regard to the type of institution receiving grants, 96 were awarded to personnel in professional schools, 45 to research institutes and 23 to academic institutions. Beneficiaries by country were as follows: United States 91, Puerto Rico 27, Hawaii 7 and foreign countries 39.

The majority of the grants (91 of 164) went to investigators holding the M.D. degree; 61 recipients had Ph.D. degrees; 4 Sc.D. degrees; and 2 the degree of D.V.M. Two grants went to the support of international conferences. It is an encouraging note that the great bulk of awards went to established professional investigators. Individuals with an M.D. degree were in preponderance, a noteworthy fact considering that the majority of the research represented by the grants fell within the basic laboratory classification. In only 12 cases was the investigation concerned with clinical research, although 38 additional grants fell within the classification of mixed laboratory and clinical research.

The relatively small number of grants would seem to indicate that American institutions have not utilized to the fullest extent opportunities for research in tropical medicine, although funds have been available. Efforts have been concentrated in allied fields such as general parasitology, general zoology and entomology. Minimal exposure to tropical medicine in undergraduate medical education is no doubt a factor in lack of interest in research in this field in the United States. This factor is discussed in more detail in Chapter 16.

There were some notable studies of a well-integrated and progressive nature. However, the impression remains of a series of isolated pieces of research as shown by the list of diseases involved. This suggests the need for broader planning of certain types of basic research together with follow-up through developmental stages so that basic results may be more quickly and advantageously applied to the solution of public health problems in the tropics.

Addendum

This section of the survey report was the first to be written and was completed before the untimely death of Dr. Janet W. Mackie in November 1959. Since the writing, encouraging developments have taken place in connection with some of the needs which were specified by the author. On the other hand, certain of the expressed views with regard to deficiencies for research support and its utilization are still timely. For the reason that many of the observations currently have validity, no revision of this part of the report has been attempted.

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Reference

1. Wright, J.—1958. Education for the tropics. Lancet, 30 Aug., pp. 453-456.

Foreign Grant Programs for Calendar Years 1954 Through 1958

Willard H. Wright *Cecil M. Wootton*

This portion of the survey concerned the gathering and evaluation of data with regard to foreign grant support for research in tropical medicine during the above-mentioned period.

A questionnaire was formulated to include the various items concerning which information was desired. In general, the objectives were the same as those in the survey of domestic research grants for the same period of time. A preliminary draft of the questionnaire was submitted to science attachés of several embassies in Washington and certain changes in content and format were made at the suggestion of these individuals.

Information concerning national research councils was not available in any one place and it was necessary to compile the data from many different sources. A list of 28 such agencies was finally prepared; it is not known whether this list is complete. The following are the national research councils or equivalent organizations to which inquiries were addressed.

Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina
National Health and Medical Research Council, Australia
Österreichische Akademie der Wissenschaften, Austria
Fonds National de la Recherche Scientifique, Belgium
Conselho Nacional de Pesquisas, Brazil
National Research Council of Canada
Chinese Association for the Advancement of Science, Republic of China
Det teknisk-videnskabelige Forskningsråd, Akademiet for de tekniske Videnskaber, Denmark
Centre National de la Recherche Scientifique, France
Medical Research Council, Great Britain
Indian Council of Medical Research
Madjelis Ilmu Pengetahuan Indonesia (Council for Sciences of Indonesia)
Hamoetsa Hamada'ith Le'Israel (Research Council of Israel)
Nihon Gakujutsu Kaigi (Science Council of Japan)
Instituto Nacional de la Investigación Científica (Mexican National Institute of Scientific Investigations)
Gezondheidsorganisatie, T.N.O. (Organization for Health Research T.N.O.), The Netherlands
The New Zealand Medical Research Council
Norges Almenvitenskapelige Forskningsråd (Norweigian Research Council for Science and the Humanities)
Pakistan Council for Scientific and Industrial Research
National Research Council of the Philippines
Consejo Superior de Investigaciones Científicas (Higher Council for Scientific Research), Spain
Statens Medicinska Forskningsråd (Swedish Medical Research Council)
Fonds National Suisse de la Recherche Scientifique, Switzerland
The Royal Institute, Thailand
South Africa Council for Scientific and Industrial Research
Al-Maahad Al-Kawmy Lelbohouth (National Research Council of Egypt), United Arab Republic
Consejo Nacional de Higiene (National Health Council), Uruguay
Deutsche Forschungsgemeinschaft (German Research Association), West Germany

The finished questionnaire (Appendix 14) was dispatched with a suitable letter to embassy officials of the various countries having national research councils asking that the form be sent to the responsible official of the research council. In addition personal contacts were made in certain instances.

It was essential to include with the questionnaire a list of criteria for the selection of grants considered to come within the field of tropical medicine. These criteria followed closely those formulated as a standard for the selection of domestic grants. The individual supplying data for the questionnaire was requested to follow the definitions. These definitions varied somewhat in keeping with the geographical location of the country in which the research was conducted. There were two concepts governing these definitions. It was considered that research carried out in tropical countries would for the most part concern the diseases of those countries and that grants for such investigations should be included in the survey summary. On the other hand, definitions for research in countries other than those within the geographical coverage of the present survey were somewhat more restrictive. These criteria were formulated in an attempt to exclude projects which could not justifiably be considered as contributing to tropical medicine. In no case was research on the so-called chronic diseases included.

The following were the specifications accompanying questionnaires forwarded to research councils in tropical countries.

I. *Types of grants to be included*:

Grants for laboratory and field studies, both basic and applied, in the following fields of tropical medicine:

(a) Infectious diseases, including bacterial, spirochaetal, rickettsial, viral, parasitic and fungous diseases.

(b) Nutritional diseases and deficiencies.

(c) Tropical hematology.

(d) Environmental sanitation and hygiene.

(e) The zoonoses and other diseases of domestic animals.

II. *Types of grants to be excluded*:

(a) Laboratory and field research which has no direct application, immediate or future, to the etiology, epidemiology, treatment, prevention and control of tropical diseases as listed above.

(b) Grants for research in the so-called chronic diseases, such as the malignancies, cardiovascular disease, metabolic diseases, etc.

The following directions were to serve as a guide in replying to questionnaires sent to research councils outside of the geographical coverage of this project.

I. *Types of grants to be included*:

(a) Laboratory and field studies, basic and applied, made in the geographical areas listed on the accompanying form on tropical diseases as defined below.

(b) Basic laboratory research in countries not included in the geographical areas listed but which is immediately applicable or considered to have future applicability to the control of disease in the tropics.

(c) Applied research in non-tropical countries which is primarily concerned with promoting health in the tropics.

II. *Types of grants to be excluded*:

(a) Grants in support of basic and applied research in diseases prevalent in both temperate and tropical countries *where the research is carried out in the temperate zone and is not strictly applicable to the tropics.*

(b) Grants for research in the so-called chronic diseases, such as the malignancies, cardiovascular disease, metabolic diseases, etc.

III. *Fields of tropical medicine to be considered*:

(a) *Infectious diseases* (including bacterial, spirochaetal, rickettsial, viral, parasitic and fungous diseases) which are predominantly confined to the geographical areas listed on the form. Infectious diseases of world-wide distribution *only* as the research deals with some specific feature related to the tropical environment.

(b) *Nutritional diseases and deficiencies* which are found predominantly in the tropics and those of more general distribution which are of public health importance in certain tropical areas.

Table 97. Foreign research councils—Number of grants for tropical medicine research by source of funds for calendar years 1954-1958

COUNTRY	NUMBER OF GRANTS BY SOURCE OF FUNDS					NUMBER OF GRANTS ACTIVE PER YEAR				
	GOVERNMENT	PRIVATE INDUSTRY	PRIVATE FOUNDATIONS	OTHER SOURCES	TOTAL GRANTS	1954	1955	1956	1957	1958
Belgium	33	5	5		43	8	8	7	8	12
Canada	43		2		45	8	9	8	10	10
China (Taiwan)	11	4	2	12	29	4	4	7	7	7
Great Britain	42		11		53	8	10	12	16	7
India	592				592	72	71	126	167	156
Indonesia	29		13	7	49	7	6	8	13	15
Netherlands	10				10	1	1	4	1	3
New Zealand	5				5	1	1	1	1	1
Philippines	38	2		5	45	8	6	7	9	15
South Africa	26		13	12	51	5	5	12	13	16
Spain	5				5	1	1	1	1	1
Thailand	3		3		6	1	1	1	1	2
West Germany	17	6	13		36	6	4	7	9	10
Totals	854	17	62	36	969	130	127	201	256	255

Table 98. Foreign research councils—Total funds for grants for tropical medicine research and funds spent per year by source, 1954-1958 (Figures in U. S. dollars)

COUNTRY	FUNDS SPENT PER YEAR BY SOURCE											
	GOVERNMENT						PRIVATE INDUSTRY					
	1954	1955	1956	1957	1958	TOTALS	1954	1955	1956	1957	1958	TOTALS
Belgium	75,500	75,940	77,500	80,980	83,520	393,440	8,500	10,060	10,740	10,940	13,040	53,280
Canada	35,279	40,820	45,416	57,380	56,609	235,504						
China (Taiwan)	132,422	241,295	162,090	218,154	197,676	951,637		287	1,257	1,268	96	2,908
Great Britain	277,544	397,964	476,803	569,993	336,142	2,058,446						
India	320,082	216,923	293,497	759,365	680,825	2,270,692						
Indonesia	31,140	50,219	69,404	69,333	62,018	282,114						
Netherlands	2,504	8,128	8,285	1,973	4,527	25,417						
New Zealand	7,000	7,000	7,000	7,000	7,000	35,000						
Philippines	135,624	126,087	133,718	144,204	177,164	716,797				1,250	100	1,350
South Africa	12,978	21,439	34,988	61,504	72,410	203,319						
Spain[1]	803	803	803	803	803	4,015						
Thailand	145	240			965	1,350						
West Germany	2,464	6,633	15,571	17,238	39,871	81,777	1,849	2,315	1,141	2,069	119	7,493
Totals	1,033,485	1,193,491	1,325,075	1,987,927	1,719,530	7,259,508	10,349	12,662	13,138	15,527	13,355	65,031

[1] Total figure only furnished; divided by five.

(c) *Tropical physiology and climatology* including mechanisms of adaptability of man to a tropical climate, physiological response to increased temperatures and/or relative humidities and impact of climate on health in the tropics. Tropical hematology and diseases of racial specificity in the tropics.

(d) *Environmental sanitation and hygiene* including development of new hygienic concepts and methods for control of disease in the tropics.

(e) *Diseases of domestic animals* because of their impact on the nutritional status of the human population and the zoonoses because of the importance of animal reservoirs of certain diseases of man in the tropics.

(f) *Medical zoology.* Any research which has a bearing on health problems in the tropics.

Presentation of the data

Replies were not received from all of the 28 countries represented in this part of the survey. No response was forthcoming from Argentina, Australia, Brazil, France, Israel, Pakistan, United Arab Republic (Egyptian Province) and Uruguay. Mexico was unable to furnish the information requested.

Replies were received from the following countries but the organizations represented had given no grants over the five-year period for research in tropical medicine: Austria, Denmark, Japan, Norway, Sweden and Switzerland.

Partial or complete information was supplied by the national research councils of the following countries: Belgium, Canada, China, Great Britain, India, Indonesia, The Netherlands, New Zealand, The Philippines, Spain, Thailand, South Africa and West Germany.

The sections under presentation of the data will correspond to the parts of the questionnaire from which the information is taken.

Source and number of grants. Table 97 presents data concerning the number of grants by source of funds and the distribution of the grants over the five-year period 1954-1958. Of the 13 countries from which data are available a total of 969 grants were made during the

PRIVATE FOUNDATIONS						OTHER SOURCES						
1954	1955	1956	1957	1958	TOTALS	1954	1955	1956	1957	1958	TOTALS	TOTAL FUNDS SPENT
1,200	2,000		23,000	25,600	51,800							498,520
17,204	16,896				34,100							269,604
			192	822	1,014	413,605	576,426	123,264	173,211	120,489	1,406,995	2,362,554
	14,000	27,984	415,784	96,024	553,792							2,612,238
												2,270,692
877	438	438	1,701	560	4,014	1,000	1,000	15,000	5,000	7,000	29,000	315,128
												25,417
												35,000
						43,094	34,644	43,722	34,404	46,273	202,137	920,284
29,400	30,800	46,200	50,960	53,970	211,330	50,400	51,800	61,600	77,560	89,320	330,680	745,329
												4,015
		1,954	1,207	1,690	4,851							6,201
3,409	357	3,626	3,232	1,359	11,983							101,253
52,090	64,491	80,202	496,076	180,025	872,884	508,099	663,870	243,586	290,175	263,082	1,968,812	10,166,235

five-year period, of which the great majority (854) were from government funds. Seventeen grants were financed by private industry, 62 by private foundations and 36 by other organizations, mainly international health agencies. During 1954 and 1955, the number of grants remained about the same but there was a decided increase from 127 to 201 between 1955 and 1956. A further increase was noted in 1957, in which 256 grants were active, with approximately the same number (255) in 1958. Expanded research characterized programs in India, Indonesia, the Philippines and South Africa.

Over the period in question, India operated the largest program in terms of numbers of grants. Here, the Medical Research Council has been very active with support entirely from government sources. The marked progress being made in medical education and research in this country has coincided with the creation of new medical facilities and new research institutes which have had government grant support.

Nearly all of the research grant support represented in Table 97 was utilized in the reporting countries. The main exceptions were Great Britain, The Netherlands and New Zealand. In the case of Great Britain the funds were expended to a certain extent for projects in tropical countries. The government funds were largely allocated to the Medical Research Council but included also certain allotments from the Colonial Development and Welfare fund for medical research. The Netherlands grants were utilized partly in home institutions and partly for field projects in overseas possessions. New Zealand funds were devoted to tropical medicine research in the Island territories including Western Samoa, the Tokelau Islands, Cook Islands and Niue.

The number of grants for tropical medicine research by foreign research councils during the period 1954-1958 greatly exceeded the number in the United States during the same period (969 vs. 164). However, difficulty has been encountered in interpreting the information furnished on many of the questionnaires. It is not clear in many cases whether the grants were made on a yearly basis or whether a single grant was designed to furnish support for more than a single year. In the case of most grant programs in the United States, support is initially pledged for more than one year; in this event the grant was counted only once in compiling the data for Category IV.A. of the Plan. Perhaps a more accurate comparison between United States grants and foreign grants could be made on the basis of grant years. For the United States the number of grant years for the five-year period 1954-1958, as given in Table 96, was 445. This figure is therefore a little less than half of the total number of foreign grants.

During the period in question, of 164 grants in the United States, 137 or 83.5 per cent were made by government agencies and the remainder by private foundations. Of the 969 grants made by foreign research councils, 854 or 88.1 per cent represented government funds; the remaining grants were financed by private industry, private foundations or other sources, mainly international organizations.

Source of funds. Table 98 provides information concerning the funds spent per year by source by foreign research councils reporting on tropical medicine research grants. The amounts are given in terms of U.S. dollars. Conversion from local currencies was made in accordance with the yearly exchange rates published in the Statistical Yearbook of the United Nations for 1958. For the year 1958, rates for the year 1957 were utilized.

The total grant monies reported as having been spent during the five-year period 1954-1958 were $10,166,235, of which $7,259,508, or 71.4 per cent, represented funds allocated by the various governments. Of other sources of funds, $65,031 was supplied by private industry, $872,884 by private foundations and $1,968,812 by other organizations, mainly international in character.

The total of $10,166,235 may be compared with a total of $5,733,191, the amount of funds involved in the 164 grants for tropical medicine research in the United States for the period 1954-1958. The average sum represented by the foreign grants was $10,535 while the average for grants in the United States for the same period was over three times more, or $34,958. The larger amount represented by the average grant in the United States probably reflects in part the higher costs of research in this country.

Of the countries represented in Table 98, China (Taiwan), Great Britain and India invested the largest amounts of grant funds in tropical medicine research over the period 1954-1958. Belgium, Indonesia and South Africa spent sizeable amounts. Of these countries, Belgium and Great Britain have always been leaders in the field of tropical medicine, because of their colonial interests in the tropics. South Africa for many years has evinced a considerable interest in the field. The relatively great attention paid to tropical medicine research as indicated by reports from China (Taiwan), India and Indonesia is an encouraging symbol of the great progress which these countries are making in the solution of their major public health problems. The fact that the total grant funds for tropical medicine research for the period in question were nearly twice as great as similar funds allocated by agencies in the United States is in itself an encouraging sign, especially when it is considered that this sum represents only a minimum figure and that other countries not reporting must also have made substantial contributions to research in this field.

Beneficiaries. From Table 99 it will be noted that a total of 150 institutions benefited from grants for tropical medicine administered by the research councils in the countries named. Seven academic institutions, 69 professional schools and 74 other institutions were represented. The latter were mainly institutes devoted almost entirely to research and having little or no activities in the educational field.

The data in the above-mentioned table may be compared with the types of institutions receiving research grants in tropical medicine from sources within the United States. Of the grants dispensed by foreign research councils, only 7 academic institutions were represented out of a total of 150. For the United States, of the

Table 99. Foreign research councils—Institutional beneficiaries of grants for tropical medicine research, 1954-1958

COUNTRY	BENEFICIARIES			TOTAL NUMBER OF BENEFICIARIES
	ACADEMIC INSTITUTIONS	PROFESSIONAL SCHOOLS	OTHER	
Belgium	0	1	1	2
Canada	1	0	0	1
China (Taiwan)	0	0	3	3
Great Britain	2	2	13	17
India	0	53	41	94
Indonesia	0	5	3	8
Netherlands	0	3	4	7
New Zealand	0	1	0	1
Philippines	0	1	1	2
South Africa	4	0	5	9
Spain	0	0	1	1
Thailand	0	1	0	1
West Germany	0	2	2	4
Totals	7	69	74	150

total of 82 institutions represented in the 164 grants, 18 were in the academic category, indicating possibly that a larger proportion of grant funds in tropical medicine in this country are devoted to basic research. Of the other types of institutions represented in the United States grants over the period 1954-1958, there were 36 professional schools and 28 other types of institutions. There are no significant differences when these figures are compared with corresponding ones in the grants made by foreign research councils.

Status of principal investigator. The questionnaire called for information concerning degrees held by the principal investigator of each grant. Apparently the question was misinterpreted by many of the respondents, since it was obvious that the information furnished represented in many cases the status of the entire professional staffing of the grant projects. However, other data in the replies furnished clues to the item in question. Based on an analysis of these data, Table 100 has been prepared and it is believed that the information is fairly accurate.

Table 100. Foreign research councils—Status of principal investigator of grants for tropical medicine research, 1954-1958

COUNTRY	STATUS OF PRINCIPAL INVESTIGATOR					TOTAL NUMBER OF INVESTIGATORS
	B.S.	M.A. OR M.S.	M.D.	PH.D. OR D.SC.	D.V.M.	
Belgium			2			2
Canada			1			1
China (Taiwan)		1	2			3
Great Britain			14	3		17
India[1]		53	27	14		94
Indonesia			7	1		8
Netherlands			3	3	1	7
New Zealand			1			1
Philippines		5	14	3		22
South Africa[2]			7	2		9
Spain			1			1
Thailand			1			1
West Germany			4			4
Totals		59	84	26	1	170

[1] Estimate; separation of M.D. and Ph.D. categories not furnished.
[2] Estimate; specific data not furnished.

From the table in question, it will be noted that a total of 170 principal investigators were represented in the 969 grants bestowed by the foreign national research councils supplying data for the period 1954-1958. In many of the countries, the number of research institutions is limited and for this reason a single individual in some instances received a number of grants during the period. Of the 170 investigators represented, 111 or 65.3 per cent held doctorates in various disciplines. This percentage figure may be compared with that relating to the status of principal investigators of grants made in the United States during the same period. Of 162 such individuals, 97.5 per cent held doctoral degrees. This difference does not present a discouraging picture when it is taken into consideration that some of the countries represented in Table 100 have not been able in the past to provide the same postgraduate educational facilities as has this country.

Evaluation of past and current needs. This question was answered by only 6 of the 13 countries represented. Of these 6 countries, 2 replied that past and present resources were sufficient; 4 countries indicated that the support available for tropical medicine research was entirely inadequate in relation to the disease problems of their countries. One country reported that the low salaries paid to research investigators constituted a considerable handicap and influenced materially the amount and quality of the research which could be carried out.

Estimate of future needs. Replies to this question were very unsatisfactory and the relatively meager data (Table 101) do not permit general conclusions. No information is available from four countries, viz., Great Britain, New Zealand, the Philippines and Spain. India indicated that it could not supply estimates for years beyond 1959. Belgium furnished data for 1960-1963 but not for 1959.

Comments can only be made on the relative significance of the figures from various countries in comparison with the amount of grant funds actually spent for tropical medicine research for the previous five-year period 1954-1958. The data from Belgium indicate an increased need for funds if consideration is given the absence of any figure for 1959. Substantial increases were indicated to fulfill research needs in Canada, Thailand, South Africa and West Germany. Some question might be raised concerning the interest of Canada and West Germany in tropical medicine research. The research in Canada has been carried on for many years by a single institution. In West Germany, the Bernhard-Nocht-

Table 101. Foreign research councils—Estimate of future needs for grant funds for tropical medicine[1]

COUNTRY	1959	1960	1961	1962	1963	TOTALS
Belgium		108,480	118,300	128,700	130,000	485,480
Canada	85,279	85,279	85,279	85,279	85,279	426,395
China (Taiwan)	238,060	278,224	242,042	221,380	244,625	1,224,331
Great Britain	—	—	—	—	—	—
India	773,420	—	—	—	—	773,420
Indonesia	75,913	84,036	27,413	27,413	27,807	242,582
Netherlands	5,263	5,263	5,263	5,263	5,263	26,315
New Zealand	—	—	—	—	—	—
Philippines	—	—	—	—	—	—
South Africa	186,939	292,102	288,680	317,800	329,840	1,415,361
Spain	—	—	—	—	—	—
Thailand	9,657	19,314	24,143	28,972	38,629	120,715
West Germany	46,429	47,619	48,810	50,000	51,190	244,048
Totals	1,420,960	920,317	839,930	864,807	912,633	4,958,647

[1] In terms of U.S. dollars at 1957 exchange rates in the United Nations Statistical Yearbook for 1958.

Institut für Schiffs-und Tropenkrankheiten at Hamburg has long been one of the world's leaders in tropical medicine research and still retains an eminent position. Certain German universities have maintained a lively interest in this field.

The amount indicated as needed for Indonesia for the five-year period 1959-1963 is less than that spent between 1954 and 1958 inclusive. The difference is accounted for by the fact that the data supplied for certain years in the former period are not complete.

In China (Taiwan), a considerable portion of research grant funds during the period 1954-1958 were funneled into the Taiwan Provincial Malaria Research Institute at a time when laboratory and field research was greatly needed for the promulgation and operation of the country-wide malaria eradication program. This campaign has been marked by such gratifying progress that it seems probable that the smaller amounts required for the period 1959-1963 are related to the decreased demands in this particular line of research. The fluctuation in rates of exchange influences any comparison of figures for the two periods.

The response to this portion of the questionnaire was actually not too disappointing when it is considered that few organizations project budget needs for five years in advance. Most of the individuals furnishing information on this part of the request evidently gave careful consideration to this item. Those who did not respond apparently were unable for various reasons to supply estimates of future needs.

SUMMARY AND CONCLUSIONS

In an attempt to secure an idea concerning the extent of grant support for research in tropical medicine in foreign countries during the five-year period 1954-1958, a questionnaire (Appendix 14) was sent through the respective Washington embassies to 28 countries known to have national research councils or equivalent organizations. Eight countries failed to respond; one was unable to supply the requested data; and six reported that no grants had been made for tropical medicine research during the period in question. Thirteen countries furnished partial or complete information.

In these 13 countries, 969 grants were made during the five-year period, of which 854 were from government funds, 17 from funds supplied by private industry, 62 from private foundation sources and 36 from other sources. There was an increase in the number of grants from 127 to 201 between 1955 and 1956 and a further increase from 201 to 256 from 1956 to 1957.

The number of grants for tropical medicine research by research councils in the 13 countries during the period in question greatly exceeded the number in the United States (969 vs. 164). However, U. S. grants are usually given for a longer period of time. On the basis of grant years, the number bestowed in the 13 countries was 969 as compared with 445 in the United States. During the period in question, 83.5 per cent of grants in the United States were made by government agencies as compared to 88.1 per cent from government funds in the countries named.

The total funds involved in the foreign grant programs under consideration for the period 1954-1958 were $10,166,235. This may be compared with a total of $5,733,191 allocated for tropical medicine grants in the United States for the same period. The amount of the average foreign grant was $10,535, as compared with $34,958 for United States grants for the same period. The higher figure in this country probably reflects in part the higher research costs prevailing here.

A total of 150 institutions benefited from the grant programs in the 13 foreign countries. Seven were academic institutions, 69 professional schools and 74 other institutions. In the United States, a slightly higher proportion of grant funds went to academic institutions, possibly indicating the greater attention to basic research in this country.

Of the 170 principal investigators represented in the 969 foreign grants, 65.29 per cent held doctor's degrees; this may be compared to 97.53 per cent in the same category in the United States grants for the same period.

Unsatisfactory replies were received to a question designed to evaluate past and current research needs in relation to grant resources. Similarly, insufficient data were secured in a request for information on future needs.

In general, the results of the survey indicate a considerable interest and activity in supporting tropical medicine research in many foreign countries having national research councils or equivalent organizations. Information from the 13 countries furnishing adequate data indicated that the funds advanced during the period 1954-1958 exceeded those which were allocated by United States agencies. Several of the countries expressed a considerably increased need for additional funds over the succeeding five-year period 1959-1963.

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China (Taiwan)—Dr. Geo. T. W. Fong, Secretary General, Chinese Association for the Advancement of Science

Denmark—Mr. B. Wittrup Christensen, Attaché, Danish Embassy

Great Britain—Sir Harold Himsworth, K.C.B., M.D., F.R.C.P., F.R.S., Secretary, Medical Research Council

Dr. R. Lewthwaite, C.M.G., O.B.E., D.M., F.R.C.P., Director, Colonial Medical Research Committee, Colonial Office

Dr. F. H. K. Green, C.B.E., M.D., F.R.C.P., Scientific Secretary, The Wellcome Trust

India—Dr. C. G. Pandit, Director, Indian Council of Medical Research

Mr. L. R. Sethi, Educational and Cultural Counsellor, Embassy of India

Indonesia—Dr. Soediman Kartohadiprodjo, Executive Director, Madjelis Ilmu Pengetahuan Indonesia

Japan—Dr. Seiichi Ishizaka, Scientific Attaché, Embassy of Japan

Mexico—Ing. Ricardo Monges Lopez, President, Instituto Nacional de la Investigación Científica

Netherlands—Dr. J. W. Tesch, President, Gezondheidsorganisatie, T.N.O.

New Zealand—Sir Charles Hercus, Chairman, Tropical Research Committee of the New Zealand Medical Research Council

Mr. R. M. Miller, First Secretary, New Zealand Embassy

Norway—Dr. E. Fjellbirkeland, Administrative Director, Norges Almenvitenskapelige Forskningsråd

Philippines—Dr. A. G. Sison, Chairman, National Research Council of The Philippines

Spain—Señor José Mª Albareda, Secretary, Consejo Superior de Investigaciones Científicas

Señor Enrique Suarez de Puga. Cultural Counselor, Embassy of Spain

Sweden—Professor Bror Rexed, Secretary, Statens Medicinska Forskningsråd

Switzerland—Dr. J. R. Geigy, Director, Schweizerisches Tropeninstitut in Basel

Professor Dr. Urs W. Hochstrasser, Scientific Attaché, Embassy of Switzerland

Thailand—Dr. Phya Anuman Rajadhon, Acting President, The Royal Institute

Union of South Africa—Mr. M. F. Baxter, Administrative Officer-in-Charge, Medical Research/Research Grants Division, South African Council for Scientific and Industrial Research

Mr. D. R. Masson, Scientific Attaché, South African Scientific Liaison Office

West Germany—Mr. Erwin Gentz, Secretary General, Deutsche Forschungsgemeinschaft

Grants to Foreign Institutions by American Foundations for Calendar Years 1954 through 1958

Willard H. Wright *Cecil M. Wootton*

In reviewing sources of research grant funds for tropical medicine, it became apparent that a considerable amount of support was being given by American foundations through institutional grants to foreign research institutes and schools of medicine and public health. This support was not reflected in the preceding sections of this Chapter on domestic grant programs or foreign grant programs, the latter of which included only funds furnished through the national research councils of countries having such organizations. In the present case, grants were made directly to the institution by the American foundation. This class of grants included funds for rehabilitation of teaching and research facilities, equipment for research, teaching aides, expansion of medical school departments, etc., as well as funds directly labeled for specific research projects.

The situation necessitated an additional classification under Category IV of the Plan. The purpose of this section of the report is to summarize the data which are available concerning institutional grants by American foundations for research in tropical medicine. The information contained herein was abstracted from reports of various American foundations for the fiscal or calendar years 1954 through 1958. These foundations included The Rockefeller Foundation, the W. K. Kellogg Foundation, the China Medical Board of New York, Inc., the Ford Foundation, the National Vitamin Foundation and the New York Iran Foundation.

Criteria for selection of type of institutional grant

A review of the purposes for which these grants were made disclosed that they fell into three categories insofar as constituting support of research in tropical medicine.

The first category included those grants which could be construed as contributing to research in the infectious, nutritional or animal diseases and other fields of tropical medicine as defined in the introduction to this report. This category has been designated as Category R.

The second category dealt with those grants which may promote public health and medicine in the tropics but which are not specifically related to research in the areas mentioned above. This category has been designated as Category MPH.

The third category included grants which obviously contributed nothing to research, public health or medicine in the tropics or those which were concerned with the chronic diseases. Grants in this category have been disregarded and are not included in this report.

Presentation of the data

For the purposes of summarizing the information, institutional grants by various foundations are being reported for major geographical areas represented in the total geographical coverage of the survey. The grants are further broken down into amounts allocated in each year of the five-year period under consideration. Data are also presented on the basis of Category R and Category MPH.

R grants. Table 102 summarizes the data relative to the number and amount of grants distributed by American foundations to foreign institutions during the calendar years 1954-1958. For the period in question, a total of 281 grants were made in the sum of $11,814,-624. Of the geographical divisions represented in the present survey, institutions in the Caribbean, Central and South America have by far been the favored beneficiaries of grants in this category. A total of 175 grants amounting to $7,774,121 were made in this area during the five-year period. The geographical area receiving the next highest number of grants was South Central and Southeast Asia, with 79 grants amounting to $2,070,708. Southwest Asia was represented by 13 grants totaling $949,500. Africa received the least benefits from programs represented in this summary with only 3 grants for the five-year period for a total amount of $240,895.

During the period in question, there was no material increase in the number of grants; in fact, the numbers varied somewhat widely from year to year. However, there was a marked increase in the amount of funds allocated between 1954 and 1955, and between 1955 and 1956. In 1957, the total amount was considerably re-

Table 102. Grants to foreign institutions by American foundations for calendar years 1954-1958 (R grants)[1, 2]

AREA	NUMBER AND AMOUNT OF GRANTS BY YEAR											
	1954		1955		1956		1957		1958		TOTAL GRANTS	
	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT
Caribbean, Central and South America	42	$1,098,577	27	$2,042,729	37	$1,403,510	30	$1,674,948	39	$1,554,357	175	$ 7,774,121
Africa	1	895	0	—	1	10,000	0	—	1	230,000	3	240,895
Southwest Asia	1	10,000	1	100,000	5	368,715	4	220,815	2	249,970	13	949,500
South Central and Southeast Asia	19	96,296	9	158,505	22	1,051,188	10	192,363	19	572,356	79	2,070,708
Other areas in which grants are specifically concerned with research in tropical medicine	3	86,600	2	45,500	3	328,300	1	10,000	2	309,000	11	779,400
Totals	66	$1,292,368	39	$2,346,734	68	$3,161,713	45	$2,098,126	63	$2,915,683	281	$11,814,624

[1] R grants are those defined as contributing to research in tropical medicine.
[2] The figures for the grants were compiled on the basis of payments on the grants during each year with the exception of one foundation from which it was not possible to obtain actual payment figures. In this instance, the amount given for the year of allocation represents the total amount of the grant.

duced, followed by an increase in 1958 to the approximate level of 1956, the peak year of fund allocation.

The grants to institutions in areas other than those represented in the geographical coverage of this survey were few in number and totaled $779,400. These funds were mainly bestowed upon institutions which had strong programs in tropical medicine, and were designed for the most part to strengthen teaching and research programs, from which many students from the tropics benefited. Thus while the institutions represented are not physically located within the geographical coverage of this survey, the funds allocated to them redounded to a considerable extent to the benefit of medical research in the tropics; the funds must therefore be considered as coming within the purview of this survey. No R grants were made to institutions in Oceania.

MPH grants. These grants were 61 in number and represented a total of $3,027,511 over the five-year period. (Table 103.) The yearly number of grants was consistent over the period with the exception of 1955, when a smaller number was made. As in the case of the R grants, the largest number of grants (37) and the greatest amount of funds ($1,531,085) went to institutions in the Caribbean, Central and South America, although South Central and Southeast Asia followed closely with a total of 17 grants in the sum of $1,388,838. Again as with the R grants, Africa received only meager assistance, represented by a single grant of $75,000. Institutions in Oceania received aid to the extent of $13,388. Institutions in countries outside of the geographical scope of this survey were given 2 grants totaling $9,200. Southwest Asia was represented by one grant of $10,000.

DISCUSSION

The extent to which funds, represented in Category IV.C of the Plan, promoted tropical medicine research in the institutions receiving them is difficult, if not impossible, to ascertain. However, it is certain that they did aid research to the extent that they cannot be ignored in a study of this sort. The R grants represent a greater contribution to research than the MPH grants but even with the latter some of the funds were probably channeled into research activities either directly or indirectly.

Over the period in question, the distribution of both the R and MPH grants has followed a well-defined pattern without significant deviation. The two areas most favored have been the Caribbean, Central and South America and South Central and Southeast Asia. Of the total of $14,842,135 represented by both categories, $12,764,752, or 86 per cent, has gone to institutions in these two geographical areas. Three hundred and eight of 342 grants were made in these areas.

Table 103. Grants to foreign institutions by American foundations for calendar years 1954-1958 (MPH grants)[1, 2]

AREA	1954		1955		1956		1957		1958		TOTAL GRANTS	
	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT
Caribbean, Central and South America	9	$71,815	4	$ 89,254	9	$652,554	7	$ 644,150	8	$ 73,312	37	$1,531,085
Africa	0	—	0	—	0	—	0	—	1	75,000	1	75,000
Southwest Asia	0	—	0	—	0	—	0	—	1	10,000	1	10,000
South Central and Southeast Asia	2	12,492	2	52,048	3	307,408	6	783,246	4	233,644	17	1,388,838
Oceania	2	7,605	1	5,783	0	—	0	—	0	—	3	13,388
Other areas in which grants are specifically concerned with research in tropical medicine	1	7,200	0	—	1	2,000	0	—	0	—	2	9,200
Totals	14	$99,112	7	$147,085	13	$961,962	13	$1,427,396	14	$391,956	61	$3,027,511

[1] MPH grants are defined as those which may promote public health and medicine but are not specifically related to research in tropical medicine.

[2] The figures for the grants were compiled on the basis of payments on the grants during each year with the exception of one foundation from which it was not possible to obtain actual payment figures. In this instance, the amount given for the year of allocation represents the total amount of the grant.

The Caribbean, Central and South American region has been especially favored. Two hundred and twelve grants, or 62 per cent, of a total of 342 over the five-year period have been made to medical schools and other institutions in this area. Of the total funds of $14,842,135, $9.305.206, or 62.7 per cent, has been allocated to the area.

Of the 342 grants in both categories, 96 or 28.1 per cent went to institutions in South Central and Southeast Asia. The funds represented were $3,459,546, or 23.3 per cent of the total of $14,842,135.

The reasons for the relatively unequal geographical distribution of grants are linked with the policies of the foundations represented. In certain cases, an organization has traditional interests in one part of the world and maintains a fixed policy in favoring institutions in that area. In other instances, distribution of funds may be made in accordance with the wishes of the original sponsor. Since these foundations are dispensing private funds, they are able to formulate their own policies and select their own goals. Perhaps in some instances it is felt that greater benefits can be derived and greater returns anticipated from funds allocated to certain areas to the exclusion of others. From the standpoint of medical research this policy, however, could scarcely apply to Africa, since research in tropical medicine in that continent has been of the highest quality. Thus the lack of support accorded African institutions could hardly have been due to any lack of confidence in their research ability.

It is obvious that the distribution of funds designed for the promotion of medicine and public health in the tropics over the five-year period represented in this study has not been in keeping with the proportionate needs in these fields in different parts of the world. For instance, it has been shown in Chapter 2 of this report that the area of the Caribbean, Central and South America has the lowest infant mortality rate and the lowest proportionate mortality rate of any tropical area. It has more physicians in relation to population than other parts of the tropics. In proportion to the population, Latin America has more nurses and more hospital beds than any tropical area other than Oceania. Of all geographical areas of the tropics, the Federal Government per capita expenditure for health is highest in tropical America with the single exception of Oceania.

During the five-year period 1954-1958, Africa received little aid from American foundations. Only four grants totaling $315,895, or 2.1 per cent of the total, were made. Yet the medical and public health needs in Africa exceed those in many other parts of the tropics and certainly overshadow to a considerable extent those in tropical America, when measured by all existing standards. In some respects, the needs of Africa are more pressing than are those of South Central and Southeast Asia. It seems logical to assume that if health needs are great, research needs are also great.

If Africa has been neglected in this segment of private philanthropy, it is gratifying to know that considerable aid has gone during the period in question to the needy countries of South Central and Southeast Asia. Material advances have been made in recent years in raising medical and public health standards in this part of the free world and the contributions made by American foundations have no doubt played a role in this gratifying result.

SUMMARY AND CONCLUSIONS

A survey has been conducted of grants in medicine and public health by American foundations to foreign institutions during the five-year period 1954-1958. Most of these grants were not designed specifically for research but were made for a variety of purposes. An examination of the objectives indicated that the grants could be divided into two categories, viz: Those which could be construed as contributing to research in the subject areas represented in this study and those which may promote public health and medicine in the tropics but which are not related to research. The grants in the first category have been designated as R grants and those in the second category as MPH grants.

During the five-year period in question, a total of 281 R grants were made for the total sum of $11,814,624. There was no progressive increase in the number of grants over this period of time, and the number from year to year sometimes varied widely. There was, however, an over-all although not a constant increase in the amount of funds allocated.

Between 1954 and 1958, 61 MPH grants were made for a total of $3,027,511. The number of yearly grants was uniformly consistent with the exception of 1955, when the number was smaller.

A well-defined pattern of distribution was exhibited by both R and MPH grants. The majority went to institutions in the Caribbean, Central and South America and in South Central and Southeast Asia. Of 342 grants over the five-year period, 212, or 62 per cent, were bestowed on institutions in Latin America. Of the total funds of $14,842,135, $9,305,206, or 62.7 per cent, were allocated to that area. Ninety-six, or 28.1 per cent, of the 342 grants went to institutions in South Central and Southeast Asia; these grants totaled $3,459,546, or 23.3 per cent of the total of $14,842,135. Africa, with its greater needs in many areas of medicine and public health, received only 4 grants representing $315,895, or 2.1 per cent of the total amount allocated.

A comparison has been made between the distribution of the grants with medical and public health needs as revealed in Part I of this report. There is little relationship geographically between health needs and the grant coverage. The single exception concerns South Central and Southeast Asia. It is evident, however, that American foundations have contributed materially to the promotion of medicine and public health in needy areas by grants to medical institutions and have thus supplemented generously public aid to these areas.

Chapter 15

Fellowship Programs in Tropical Medicine

Willard H. Wright
Jane Rust

The purpose of this portion of the survey was to ascertain the amount of support available for fellowships in tropical medicine and to determine whether such support was adequate and in keeping with demands for training in this field. Fellowship programs of various government agencies and private foundations were reviewed. Data were collected on the number of fellowships in tropical medicine granted during the five-year period 1954-1958, as well as the financing involved. The survey included both national and international programs.

Unfortunately the information desired was not available from any central agency as was the case with research grants in medicine and the medical sciences in the United States. It was necessary, therefore, to gather information concerning the various agencies, both public and private, which supported fellowships in these fields. Following such a survey, annual reports of agencies were collected and much of the data extracted from these documents. However, in many cases annual reports were limited in scope, in which case it was necessary to secure the information through personal contact or through correspondence.

The geographical coverage of fellowship programs corresponded to that of the survey as a whole, i.e., the Caribbean, Central and South America, Africa, Southwest, South Central and Southeast Asia, and Oceania. In most cases, fellowships to citizens of the United States were for work in countries within the above-mentioned regions; in a few cases, they were granted for studies outside of these regions, but in every case the studies concerned problems in tropical medicine. All of the foreign fellowships included were granted to individuals within the confines of the geographical regions of the survey. Foreign fellows usually took their fellowship in countries other than the one in which they resided.

In this category, it was essential to formulate arbitrary decisions as to what constituted a fellowship in tropical medicine. For domestic fellows, the general rules laid down for the selection of research grants were employed as a guide. However, it soon became apparent that these definitions could not be utilized in the case of fellowship programs for non-United States citizens. It was not feasible in the case of most foreign programs for the granting organization to undertake the task of securing data from old records which were often in dead storage. Furthermore, the magnitude of the task in some cases was so great that any request for detailed compilation of material would have imposed an unwarranted burden on the agency involved.

Under these circumstances, it was necessary to modify the criteria governing the selections of grants to foreigners. The final basis on which selections had to be made in many cases rested on whether the fellowship was related to medicine in the tropics. If so, it was considered as contributing to tropical medicine. Accordingly, there were included under fellowships for non-United States citizens the general fields of the basic medical sciences, sanitary engineering, public health nursing, health education, medical library science, environmental hygiene, food and drug control, public health dentistry, nutrition, tropical physiology, and the clinical specialties of internal medicine and pediatrics. Excluded were fellowships in the other clinical specialties and in the chronic diseases, the latter in keeping with the general exclusion of these diseases from the survey.

Data concerning fellowship programs were collected in Washington, New York, Lisbon, Paris, Geneva and London.

At the beginning of the survey, many organizations were canvassed for information concerning fellowship activities. In addition to the organizations mentioned in Tables 104 and 108, programs of the following foundations were reviewed: National Vitamin Foundation, Commonwealth Fund, Lee Foundation for Nutritional Research, National Foundation, Sarah Mellon Scaife Foundation, Ciba Foundation, Smith Kline and French Foundation, Ford Foundation and Doris Duke Foundation. None of these foundations granted fellowships in the field of tropical medicine during the period covered by the survey.

Effort was made to survey fellowships granted by the National Science Foundation. During the time period of the present study, this organization had fellowship programs in the predoctoral, postdoctoral, senior postdoctoral and science faculty categories. None of these programs covered the field of medicine, but they did include medical sciences. During the five-year period 1954-1958, there were 19,774 fellowship applications, of which 4,583 were activated. It was not possible to examine all of these applications. For the purposes of sampling, applications for predoctoral and postdoctoral fellowships approved for the fiscal year 1958 were selected and those in the disciplines of microbiology, zoology and the medical sciences were reviewed in detail. The total number thus examined was 171. None of these was found to lie within the field of tropical medicine. On the basis of this sampling, it was thought that it would be unrewarding to conduct similar samplings of applications for other years.

The fellowships for non-United States citizens listed in Table 108 undoubtedly do not represent a complete list of those granted during the period 1954-1958. Considerable difficulty was encountered in efforts to secure data on tropical medicine fellowship programs in foreign countries; in fact the obstacles were so great as to force abandonment of such attempts. Sufficient information, however, was available to indicate that such programs were small in comparison with those enumerated in Table 108.

Fellowship programs for United States citizens

Table 104 summarizes information on fellowship programs available to United States citizens during the period 1954-1958 inclusive. The total number of tropical medicine fellowships was 172 representing financial support in the amount of $600,193. The total fellowships granted for all categories by the agencies represented was 30,282 amounting over-all to $113,064,248. The largest program was that of the Department of State with fellowships under the Fulbright and Smith-Mundt Acts. During the period in question there were given under this program a total of 29,444 fellowships amounting to $100,357,849. These fellowships included many in disciplines other than medicine and the medical sciences. Fellowships in the latter disciplines totaled 1,767; it was impracticable to furnish data on the amount represented by the medical fellowships alone. The inclusion in the table of the total fellowships under the Fulbright and Smith-Mundt Acts tends to distort any comparisons to be derived from the data; however, the

Table 104. Tropical medicine fellowship programs for United States citizens, 1954-1958, inclusive

ORGANIZATION	TITLE OF PROGRAM	TROPICAL MEDICINE FELLOWSHIPS		TOTAL FELLOWSHIPS	
		NUMBER	AMOUNT	NUMBER	AMOUNT
National Institutes of Health—National Microbiological Institute—National Institute of Allergy and Infectious Diseases	Pre- and Post-doctoral Fellowships	9	$ 47,947	164	$ 568,310
National Institutes of Health	Senior Research Fellowships[1]	4	81,362	173	3,502,213
National Institutes of Health—Division of Research Grants	Research Fellowship Program	3	19,439	168	643,337
National Academy of Sciences—National Research Council	Medical Fellowship Board	1	3,900	90	388,000
Louisiana State University	Inter-American Program of Fellowships in Tropical Medicine and Parasitology	104	167,482	104	167,482
Department of State	Fellowships under Fulbright & Smith-Mundt Acts	25	148,663	29,444[2]	100,357,849[2]
John and Mary R. Markle Foundation	Scholars in Medical Science	3	84,000	115	7,389,167
World Health Organization	Regular and Technical Assistance Fellowships	23	47,400	24	47,890
Totals		172	$600,193	30,282	$113,064,248

[1] Representing support for five years.
[2] Includes all fellowship programs.

program offered opportunities in the field of tropical medicine to a far greater extent than were sought.

Of the total of 172 fellowships in tropical medicine during the period, 104 were in the Louisiana State Medical School program for travel and study at San Juan, Puerto Rico, or San José, Costa Rica. These fellowships were for three months whereas others represented in the table for the most part were for a longer term. The summary includes fellowships taken during the calendar year 1959, in order to complete a five-year period.

Table 105. Distribution of fellowships in tropical medicine for United States citizens, 1954-1958, inclusive

	1954	1955	1956	1957	1958	TOTALS
National Institutes of Health—National Microbiological Institute—National Institute of Allergy and Infectious Diseases	0	4	1	1	3	9
National Institutes of Health	0	0	1	1	2	4
National Institutes of Health—Division of Research Grants	1	0	0	1	1	3
National Academy of Sciences—National Research Council	1	0	0	0	0	1
Louisiana State University		23	30	24	27[1]	104
Department of State	0	6	5	4	10	25
John and Mary R. Markle Foundation	3	0	0	0	0	3
World Health Organization	7	5	3	5	3	23
Totals	12	38	40	36	46	172

[1] Includes 1959 fellows.

Table 105 lists data on the distribution of tropical medicine fellowships by years. With the exception of the increase in numbers from 1954 to 1955, there has been no marked fluctuation in numbers in other years. Certainly, the data do not indicate any greater demand for fellowships in this field during the period of time represented.

Table 106 indicates the geographical areas in which tropical medicine fellowships were taken. The majority (126) represented work in the Caribbean, Central and South America. Eighteen were for studies in the United States, 7 in Europe, 11 in Africa and 10 in Asia. These figures indicate a fairly uniform distribution of selections by area, allowing for the skewness of the Caribbean, Central and South American region by reason of the 104 fellows studying in this area under the Louisiana State University School of Medicine program.

The fellowships involved studies on a wide range of problems. In all, these problems comprised 18 different fields. The fellows in the Louisiana State Medical School activity were involved in a training program. The

Table 106. Fellowships in tropical medicine for United States citizens—Areas in which fellowships were taken, 1954-1958, inclusive

ORGANIZATION	TITLE OF PROGRAM	UNITED STATES	EUROPE	CARIBBEAN, CENTRAL AND SOUTH AMERICA	AFRICA	ASIA	TOTALS
National Institutes of Health—National Microbiological Institute—National Institute of Allergy and Infectious Diseases	Pre- and Post-doctoral Fellowships	8	1				9
National Institutes of Health	Senior Research Fellowships	4					4
National Institutes of Health—Division of Research Grants	Research Fellowship Program	2	1				3
National Academy of Sciences—National Research Council	Medical Fellowship Board	1					1
Louisiana State University	Inter-American Program of Fellowships in Tropical Medicine and Parasitology			104			104
Department of State	Fellowships under Fulbright and Smith-Mundt Acts		4	5	11	5	25
John and Mary R. Markle Foundation	Scholars in Medical Science	3					3
World Health Organization	Regular and Technical Assistance Fellowships		1	17		5	23
Totals		18	7	126	11	10	172

Table 107. Fellowships in tropical medicine for United States citizens—Degrees of fellows, 1954-1958, inclusive

DEGREE	NIH NMI NIAID	NIH SENIOR	NIH DRG	NAS-NRC	STATE DEPART-MENT	MARKLE FUND	WHO PAHO	LOUISIANA STATE UNIVERSITY	TOTALS
A.B. B.S.					3		1	0	4
M.S. M.P.H.					1		4	2	7
M.D.			1		11	3	15	33	63
Ph.D.	6	3	1	1	6		2	62	81
D.V.M.					3				3
Sc.D. D.Sc.	3	1	1		1		1	7	14
Totals	9	4	3	1	25	3	23	104	172

Table 108. Fellowship programs in tropical medicine for non-United States citizens, 1954-1958, inclusive

ORGANIZATION	TITLE OF PROGRAM	TROPICAL MEDICINE FELLOWSHIPS		TOTAL FELLOWSHIPS	
		NUMBER	AMOUNT	NUMBER	AMOUNT
Food and Agriculture Organization	Fellowships in animal health and veterinary medicine	76	$ 175,000	1,252	$ 2,726,000[1]
World Health Organization	Regular and Technical Assistance Fellowships	3,233	5,110,104[1]	5,388	8,535,750
International Cooperation Administration	Long-Term Foreign Fellowship Program	1,284	4,679,600[2]	1,538	5,579,020
National Institutes of Health	Post-doctoral Research Fellowships for Foreign Scientists[3]	7	56,755	66	442,000
Department of State	Fellowships for Foreign Scholars under Fulbright and Smith-Mundt Acts[4]	8	20,757	428	[5]
Colonial Office, Great Britain	Fellowships and Studentships	11	17,360[6]	12	19,740[6]
Medical Research Council, Great Britain	Scholarships and Fellowships	2	1,960	[5]	[5]
China Medical Board	Fellowship Program	120	371,787	[5]	854,309
John Simon Guggenheim Memorial Foundation	Inter-American and Philippines Exchange Fellowships	6	31,850	154	589,800
W. K. Kellogg Foundation	International Fellowships in Medicine (Latin America)	327	945,414	327	945,414
Nutrition Foundation	Graduate Fellowship Fund	18	31,116	[5]	90,500
Rockefeller Foundation	Various Fellowship Programs in Medicine and the Medical Sciences	248	1,622,500	1,045	2,994,534
Totals		5,340	$13,064,203	10,210	$22,777,067

[1] Estimated.
[2] Fiscal years 1955-1959, inclusive.
[3] Fiscal years 1958 and 1959, only.
[4] Fellowships only in medicine and microbiology.
[5] Not available.
[6] Approximate cost.

following is a summary of problems which engaged the attention of the remaining 68 fellows.

Tropical public health	—24	Medical parasitology	— 3
Nutrition	— 7	Hematology	— 2
Veterinary medicine in the tropics	— 5	African trypanosomiasis	— 2
Virus diseases	— 4	Fungous diseases	— 2
Clinical tropical medicine	— 4	Plague	— 1
		Relapsing fever	— 1
Medical entomology	— 3	Fish poisoning	— 1
Chemotherapy of tropical diseases	— 3	Medical malacology	— 1
		Chagas' disease	— 1
Leprosy	— 3	Medical bacteriology	— 1

Information concerning the educational levels of the 172 United States fellows in tropical medicine is contained in Table 107. The majority of the fellowships were at the postdoctoral level. The degrees represented were as follows: M.D. 63, Ph.D. 81, Sc.D. or D.Sc. 14, D.V.M. 3, M.S. or M.P.H. 7, and A.B. or B.S. 4.

Fellowship programs for non-United States citizens

Table 108 presents data on medical and public health fellowship programs for non-United States citizens for the years 1954-1958 inclusive. As indicated previously difficulty was encountered in securing information concerning tropical medicine fellowships available in certain foreign countries. No effort was made to obtain information on programs which did not concern the field of tropical medicine.

Over 9,000 fellowships were reviewed in the various programs represented in the table. During this five-year period there were 5,340 fellowships in tropical medicine involving a total subsidy of $13,064,203. Thus the fellowships for non-United States citizens greatly exceeded in number and amount of funds those available to United States citizens. The shortage of trained personnel in the medically underdeveloped countries dictated the need for large fellowship programs on the part of the World Health Organization and in the technical assistance operations of the International Cooperation Administration. A number of the private foundations contributed substantially in the support of fellowships.

Table 109 indicates the distribution of tropical medicine fellowships for non-United States citizens by years between 1954 and 1958. As happened with those for United States citizens, there was a substantial increase in the number from 1954 to 1955; there were fewer available in 1956, but the number again increased in 1957, to be followed by a smaller increase in 1958.

The fellowships represented in Table 109 concern nearly every aspect of medicine and public health in the tropics. Nearly every country in the geographical coverage of this survey was represented. Data are not available concerning the educational qualifications and degrees held by those fellows represented in the table. A large number had medical degrees; there were many sanitary engineers, public health nurses, public health administrators and laboratory workers. Many of the WHO and ICA fellows went to schools of public health for advanced studies.

Table 109. Distribution of fellowships in tropical medicine for non-United States citizens, 1954-1958, inclusive

	1954	1955	1956	1957	1958	TOTALS
Food and Agriculture Organization	18	20	7	17	14	76
World Health Organization	458	644	546	805	780	3,233
International Cooperation Administration	211	313	236	232	292	1,284
National Institutes of Health					7	7
Department of State		2	0	2	4	8
Colonial Office, Great Britain[1]						11
Medical Research Council, Great Britain				1	1	2
China Medical Board	9	22	26	32	31	120
John Simon Guggenheim Memorial Foundation	2	0	3	0	1	6
W. K. Kellogg Foundation	58	41	53	93	82	327
Nutrition Foundation		2	3	8	5	18
Rockefeller Foundation	38	48	44	53	65	248
Totals	794	1,092	918	1,243	1,282	5,340

[1] Data not available.

SUMMARY AND CONCLUSIONS

Surveys were made of fellowship programs in tropical medicine for the five-year period 1954-1958. Information was gathered on fellowships available for United States citizens and for those in countries within the purview of this survey. Difficulties were encountered in securing information from some quarters; it is probable therefore that the summaries presented here do not include total fellowships available during the period in question.

The total number of fellowships in tropical medicine for United States citizens during the period was 172; these were divided among eight different programs. The number of fellowships in all disciplines represented in these programs was 30,282 of which 2,521 were in medicine and the medical sciences. The tropical medicine fellowships represented an expenditure of $600,193. With the exception of a small increase in these fellowships between 1954 and 1955, there was no marked fluctuation. The majority of the fellowships in tropical medicine were for studies in the Caribbean, Central and South America. A wide variety of problems engaged the attention of the fellows.

Fellowships in tropical medicine for non-United States citizens greatly exceeded those for United States citizens. Over 9,000 fellowships for foreign workers were reviewed in eleven different programs. Of these programs, six represented national and international organizations and five comprised private foundations. During the five-year period, tropical medicine fellowships in these programs totaled 5,340 involving a total subsidy of $13,064,203. Nearly every country within the geographical coverage of this survey was represented among these fellowships. There was a substantial increase in tropical medicine fellowships between 1954 and 1955 and smaller increases in 1957 and 1958.

The relatively small number of tropical medicine fellowships granted to citizens of this country in the five-year period would seem to reflect lack of interest in the field. There were many more fellowship opportunities available than were taken. It is especially regrettable that younger workers did not take greater advantage of these opportunities.

There has been an almost uninterrupted increase in the number of foreign fellowships available during recent years. With the demand for training of nationals in the underdeveloped countries, it is likely that this trend will continue. At least for the time being, there is no evidence that fellowship needs in the field of tropical medicine and international health have been satisfied.

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Chapter 16

Teaching of Tropical Medicine and Hygiene

Domestic Teaching Programs in United States Medical Schools for 1959

George A. Thurber *William W. Frye*
J. Clyde Swartzwelder

Existing medical school curricula are being subjected to a wide range of analytical studies. Committees in most schools, various accrediting agencies and study groups at the national level are engaged in evaluation procedures. From these evaluations it is envisioned that recommendations may be formulated which will enable the medical schools to produce a greater quantity of physicians without sacrificing, or even by increasing, the quality of the end product, medical care. The National Academy of Sciences—National Research Council requested the Louisiana State University School of Medicine to conduct a survey of the present status of teaching and research in tropical medicine and parasitology in the United States medical schools.

Previous studies of this type [1, 2, 3] conducted in 1941, 1945 and 1954 respectively, indicated a significant increase in the teaching of tropical medicine and parasitology during the years of World War II followed by (a) an almost complete disappearance of tropical medicine as a specific course and (b) a slight decline in emphasis on parasitology. The present study is an attempt to determine the trends from 1954 through 1959.

A questionnaire was formulated and approved by both the Academy-Research Council's Committee and the Association of American Medical Colleges. The questionnaire treated tropical medicine and parasitology as separate disciplines and attempted to discover the following facts about each:

- (a) The scholastic year in which it is presented
- (b) Its identity as a discipline
- (c) The department responsible for its instruction
- (d) The personnel engaged in the instructional program as to
  - (1) Numbers, degree and academic status
  - (2) Experience in the tropics
  - (3) Research experience
- (e) The amount of research being conducted

The questionnaire was mailed to the deans of all United States medical schools. Seventy-six of the 82 had responded at the time the data were tabulated. Wherever possible, information from the current survey is compared with that from the previous surveys of reference.

Scholastic year of presentation

Tropical medicine is presented in 67 schools at various stages of the curriculum. Approximately 50 per cent is accomplished during the second year and 25 per cent in each of the third and fourth years. Only two schools present any aspect of tropical medicine to first-year students.

As will become clear later, little of this subject matter is presented as tropical medicine. It is developed as corollary material, the tropical aspect of some disease entity or public health problem.

Parasitology is presented in the second year by all the 75 schools in which it is taught. Seventy-four reported the major parasitology course in that year. The remaining school presents some aspects of parasitology in the second year as a part of clinical pathology but gives a comprehensive course to the seniors. Compared to the 74 per cent reported as presenting parasitology to the second-year class in 1954, there seems an obvious trend to consider the sophomore year as the most convenient spot for parasitology in the medical curriculum.

Identity of the disciplines

Table 110 is indicative of a loss of identity by both disciplines and a marked tendency toward teaching both tropical medicine and parasitology as parts of other courses. In order to get a more distinct idea of the pattern being followed in this re-alignment, the data were further analyzed as to departments.

Department responsible for instruction

From the tabulation in Table 111, it is evident that tropical medicine is no longer taught as a separate course or even as a distinct and separate segment of any other single course or department. A similar trend seems to be developing in the teaching of parasitology.

It is of interest to note that exclusive of those medical schools which have an associated School of Public Health, there is only one school with a separate Department of Tropical Medicine and only two accord departmental status to parasitology.

Personnel engaged in instruction in tropical medicine and parasitology

As shown in Table 112, the questionnaires list 151 teachers of tropical medicine and 246 teachers of parasitology. One hundred of these have dual assignments, teaching in both subject areas, and four have appointments to the staffs of two different medical schools. The net total of teachers of the two disciplines becomes 293.

Comparisons of these with 1954 data are difficult as the 1954 data covered only a part of the teachers. However, Meleney and Frye (1954) reported 193 teachers of parasitology and 63 teachers of tropical medicine, a total of 256.

A study of the background of those with teaching assignments in these disciplines showed 84 of the 293 to have had practical experience in the tropics. The average length of such experience was about four months. Twenty-four schools had no staff members with tropical experience assigned to the teaching of tropical medicine and parasitology, and 8 of these 24 schools listed no personnel desiring such training.

One hundred and eight research projects dealing with tropical medicine and parasitology were listed by 32 of the responding schools. Some discrepancy in reporting (an inherent weakness of questionnaire type surveys) was discovered by a comparison with records of the National Institutes of Health. The NIH was supporting (May 1959) 78 research studies in 46 medical schools which, by rigid categorization, would be classified in the fields of tropical medicine or parasitology. Inclusion of investigations supported by other funds would undoubtedly bring the total considerably above the 108 listed on the questionnaires. Major research emphasis is on the intestinal helminths, amoebiasis and schistosomiasis.

It is of interest that NIH listed 35 non-medical schools as conducting 71 projects pursuing the problems of tropical medicine, with support of funds from the United States Public Health Service.

Table 110. Identity of tropical medicine and parasitology as discrete disciplines

	TROPICAL MEDICINE		PARASITOLOGY	
	1954[1]	1959	1954[1]	1959
Taught separately	10	6	40	25
Integrated into other courses	49	61	33	50
Not taught	15	9	1	1
Total schools reporting	74	76	74	76

[1] Meleney, H.E. and Frye, W.W., 1955. Teaching and research in parasitology and tropical medicine in medical schools of the United States: A survey and a fellowship program. Amer. J. Trop. Med. and Hyg., 4:769-775.

Table 111. Departments administering the teaching programs

DEPARTMENT	TROPICAL MEDICINE		PARASITOLOGY	
	1954[1]	1959	1954[1]	1959
Tropical medicine		1	[2]	1
Parasitology	7	1	[2]	2
Medicine	20	38	[2]	7
Microbiology		32	20	58
Clinical pathology		12	10	12
Others	11	27	10	11

[1] Meleney, H.E. and Frye, W.W., 1955. Teaching and research in parasitology and tropical medicine in medical schools of the United States: A survey and a fellowship program. Amer. J. Trop. Med. and Hyg., 4:769-775.

[2] Data not published.

Table 112. Degrees and academic rank of instructional personnel

		TROPICAL MEDICINE (67 SCHOOLS)	PARASITOLOGY (75 SCHOOLS)
Academic rank	Professor	62	78
	Associate Professor	37	56
	Assistant Professor or below	52	112
Totals		151	246
Degree status	M.D.[1]	94	96
	Ph.D.	44	119
	D.Sc.	5	10
	M.S. or below	8	21
Totals		151	246

[1] Fourteen M.D.'s also have Ph.D. degrees.

SUMMARY

Tropical medicine and parasitology have lost much of their identity as discrete disciplines during the past five years. Much of this has been due to a trend to absorb these subjects into other courses. Tropical medicine seems to be included most often in the course-work of the Department of Medicine. Parasitology is gradually being moved into the framework of microbiology. Curriculum planners seem to favor the second year for presentations of tropical medicine and parasitology.

The number of teaching personnel in these subjects has decreased slightly during the past five years. The degree and academic status of these professional persons correspond well with those of teachers in other disciplines. Despite the favorable degree and academic status of their staffs, approximately one-third of the schools are teaching tropical medicine and parasitology without staff members who claim actual tropical experience. Only one-half of the medical schools are engaged in research devoted to these disciplines and only one-third of the total teaching personnel is actively conducting research.

DISCUSSION

If we discount the potential recurrence of the training weaknesses so strongly brought into focus by World War II, we must face (1) the increasing proximity of every physician to the medical problems of a more integrated world population, (2) the several unconquered diseases of many segments of that population, and (3) the great increase in the numbers of United States citizens travelling to and returning from all parts of the globe. It should be unnecessary to remind ourselves that, with modern travel facilities, disease can be transported to the very heart of the United States from almost any point in the world in a matter of 24 hours. These facts seem of sufficient urgency to demand increasing emphasis on tropical medicine in our medical schools. The survey seems to indicate the conclusion that an opposite trend is in operation. Perhaps our intense preoccupation with local problems has caused us to neglect a highly significant area of study.

Table 113. Society affiliations of the 293 teachers of tropical medicine and parasitology

	NUMBER	PER CENT OF TOTAL
American Society of Tropical Medicine and Hygiene	111	38
American Society of Parasitologists	77	26
Both Societies	66	23
Neither Society	167	56

The fractioning of tropical medicine and parasitology into smaller units and teaching them as portions of other disciplines suggests the probability of a corollary dilution of teaching effort. Data concerned with teaching hours were inadequate and another criterion was sought to evaluate this possibility.

Membership in professional societies is generally considered as a fair indicator of the major interests of educators. Table 113 summarizes the affiliations of the 293 teachers in the societies devoted to these disciplines.

Although such a survey is obviously not fully adequate for strictly quantitative conclusions, there is probably a high degree of significance in the fact that 56 per cent of the teachers belong to neither professional organization. This is indicative of major interests in other areas and does not appear compatible with a high level of teaching interest in the disciplines under consideration.

The survey points to the desirability of curriculum study groups re-evaluating the importance of tropical medicine and medical parasitology.

ADDENDUM

At the time of this survey the Louisiana State University School of Medicine had been conducting an Inter-American Program in Tropical Medicine for over four years. Through this program teachers and research workers have been provided training in geographical areas of the tropics, experiencing field, hospital and laboratory work with the problems of tropical medicine. Over one hundred have received such experience and training.

A comparison of the Inter-American Program's records with the returned questionnaires gave the following information:

(1) Fifty of the 52 medical schools which reported staff members with tropical experience had at least one who had received some training in the tropics under the auspices of the Louisiana State University Inter-American program.

(2) Fifty-eight former participants were on medical school staffs. This is 19 per cent of the total staff

members in tropical medicine and parasitology and is 69 per cent of the total who reported tropical experience.

(3) There were also 28 former participants who were teaching the disciplines allied to tropical medicine in non-medical schools.

(4) Sixty-one of the 86 (see 2 and 3 above) were conducting research, 43 with National Institutes of Health funds, 18 funded from other sources.

It is probable that this program, which is currently being expanded, has been of some influence in minimizing the trend toward the de-emphasis of tropical medicine and medical parasitology in the United States schools of medicine.

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Teaching of Tropical Medicine and Hygiene in Foreign Institutions

Curt R. Schneider

It is the purpose of this portion of the survey to describe some of the major centers of tropical medicine teaching in the world. Distinction must be made between academic instruction in the practice of medicine in the tropics and the teaching of tropical medicine as defined in Chapter 1 for the purposes of this survey. With regard to the former, most of the medical schools located within the areas of the survey are under some constriction to orient their instruction toward the management of local medical problems. Insofar as many of these problems fall within the definition of tropical medicine as used in this survey, students in these schools usually are made adequately aware of them even though tropical medicine does not appear in their curriculum as a separate rubric.

In contrast, medical schools in the metropolitan countries of Europe, as well as Canada, Australia and Japan seldom devote more than a few hours of instruction to tropical medicine, and this is usually limited to parasitology. In order to augment his knowledge, the student must apply to one of the postgraduate schools of tropical medicine which will be described below. These schools offer a course of instruction to medical graduates (and often nurses and sanitary engineers) which lasts from three to nine months. A Diploma in Tropical Medicine (D.T.M.&H.) is customarily offered upon completion of the studies. In certain countries, some postgraduate instruction in tropical medicine is required by statute in order to practice medicine in the colonies.

In this context, it is not feasible to survey all of the medical schools of the survey areas in order to determine the character of the instruction in tropical medicine offered in each. In India alone there are 43 medical schools in which courses of instruction, protracted over five to six years, include much tropical medicine scattered among courses in bacteriology, parasitology, hygiene and public health, medicine, pathology, etc. In the Caribbean, Central and South America there are a total of 94 accredited medical schools, 21 of which are in Mexico and 28 of which are in Brazil. It is clearly impossible to give attention to all of the institutions in which instruction of some sort in tropical medicine is given. Therefore, space has been reserved in the following account only for those postgraduate institutions which merit special consideration in this regard.

Insofar as possible, a distinction will be made in this part of the survey report between *centers of teaching* and *training centers* (which will be the object of a subsequent section).

Tropical medicine as a specialty. In countries which recognize tropical medicine as a legal specialty, facilities for acquiring specialty training are well developed. This is true in Italy, Portugal, Switzerland and France. In Italy and Portugal, three postgraduate years must be devoted to the discipline. In Switzerland, the number of years to be devoted is determined in each case. In Turkey, parasitology is recognized legally as a medical specialty. It is interesting that two countries which, historically and at present, have had large tropical commitments, namely Spain and South Africa, do not recognize tropical medicine as a specialty.

Tropical medicine and colonial practice. The tropical colonies of England, France, Belgium, Italy, Portugal and the Netherlands were, until quite recently, extensive. In large measure, the tropical schools in these metropolitan countries were created to meet needs proposed by colonial medical problems. With the advent of independence for many of these colonies, a nationalistic pride in the prospect of autonomy in all things, including medical practice and research, has combined with an uncertain view of the economic future to create an environment different from that which had previously attracted the European scientist to the tropics. However, no diminution in interest in the problems of the tropics has been observed. None is anticipated, if the example of Germany may be cited. Following World War I, this country was deprived of all of its tropical holdings and it has none today. Yet its activities with regard to tropical medicine have hardly lessened, and its students are currently able to make liberal use of recently established liaisons with the schools of Brazil and other South American countries.

Teaching of tropical medicine in the Western Hemisphere exclusive of the United States

The number of institutions devoted to the teaching of tropical medicine is considerably smaller than it was ten years ago. Then, it was possible to include the Institute of Tropical Medicine of the University of Habana, in Cuba, on such a list. No mention of this institute is found in current publications. The School of Tropical Medicine in San Juan, Puerto Rico, was absorbed into the structure of the School of Medicine when the latter was organized in 1949; subsequently, the teaching of tropical medicine in this school has assumed the more modest proportions which typify the presentation of the discipline in most medical schools of this hemisphere. The Oswaldo Cruz Institute in Rio de Janeiro, Brazil, is understood to have retrenched the extent of its teaching activities in recent years.

However, certain centers continue to provide first-rate instruction in tropical medicine in this hemisphere. The Institute of Tropical Medicine of São Paulo, Brazil, (see Appendix 15) was formed early in 1959 out of the former Pavilion of Viruses and Rickettsiae of the Faculty of Medicine, University of São Paulo. At the present time, the Institute consists of the Chairs of Microbiology and Immunology, Parasitology, and Clinical Infectious and Tropical Diseases. In its postgraduate teaching of tropical medicine, it enjoys the collaboration of the entire medical faculty as well as the assistance of many governmental agencies. Two programs of regular courses of three months' duration are offered annually to graduate physicians from Brazil or other countries. Twenty-five students are accepted in each term. A diploma is offered upon completion of studies which provides the recipient with the title "Medico Tropicalista" (Tropical Physician). The regular course is divided into these topics: Bacterial diseases, diseases produced by viruses, rickettsiae and bartonellae, fungous diseases, protozoan diseases, helminthic diseases, medical entomology, noxious animals, general problems of tropical medicine, deficiency states and biostatistics. In all cases, emphasis is placed on such diseases and conditions as are characteristic of the country.

The School and Institute of Health and Tropical Diseases in Mexico City (see Appendix 15) was created in 1952 by the expedient of uniting the administrations of the old Institute of Health and Tropical Diseases and the old School of Health and Hygiene. The resulting institution functions as a part of the Federal Department of Health and Public Assistance. A basic course of one year's duration is offered to graduate physicians, veterinarians and sanitary engineers. The degree of Master of Public Health is offered on completion of studies, and 25 students may be accepted each year. The criteria for admission are somewhat strict, with emphasis on securing students who will prove dedicated to their work. Besides the Master of Public Health course, other training programs are provided for the preparation of health nurses, laboratory technicians, statisticians and sanitarians. The services of the following laboratories are available: Bacteriology, Mycology, Protozoology, Helminthology, Entomology, Intestinal Bacteriology, Epidemiology and Statistics, Chemistry, Physiology and Pharmacology, and Pathological Anatomy. There is a clinical section and an outpatient clinic; in addition, clinical experience is provided by the Hygiene Center and Tropical Diseases Training Station in Boca del Río, Veracruz, which is at present an administrative dependent of the School and Institute of Health and Tropical Diseases.

A third center of teaching must be mentioned (although this contradicts the intent not to mention undergraduate faculties in detail). The Department of Parasitology of the Faculty of Medicine, University of Chile, Santiago, (see Appendix 15) is joined with the National Health Service's Technical Advisory Office on Parasitology in the implementation of teaching, research and public service. Although the medical problems of Chile are not to be considered truly tropical, yet many of the parasitic infections endemic in this country are of considerable interest in the over-all context of tropical medicine. Most of the activity is identified with the Department of Parasitology; some is performed in the Departments of Epidemiology and of Infectious Diseases of the School of Public Health. Teaching of parasitology is included as part of the undergraduate instruction in the School of Medicine. An unusual teaching service is provided by the Outpatient Clinic in Parasitic Diseases, which serves as a demonstration center for students who are thus enabled to observe epidemiological, clinical and prophylactic aspects of parasitic disease. In addition, each student must follow up his observations with field trips, accompanied by a Public Health Nurse, to the homes of his patients, where he may take note of the conditions under which the diseases were contracted and form some notion of the likelihood of relapse. By the end of his third year of medicine, the student is in a position to deal adequately with any local parasitic infection.

The three institutions mentioned above accept international students in addition to their own nationals. At present it is thought that local needs with regard to preventive medicine and public health are largely being met by these schools, supplemented by those in the United States and Canada. However, it seems clear that the needs in tropical medicine in Latin America are not defined by the geographic locations of schools devoted principally to this discipline.

One of the most outstanding centers of teaching of tropical medicine outside of the United States is the Faculty of Medicine of McGill University, Montreal, Canada, (see Appendix 15) which offers a Diploma in Tropical Medicine and Hygiene (D.T.M.&H.) upon completion of a full academic year's course work. The establishment of this program dates back to the events of World War II, when the critical military needs of the Pacific Theater dictated the development of intensive training courses in tropical medicine. At present, the first term of study is concerned with principles of public health, including bacteriology and immunology, epidemiology, environmental hygiene, industrial hygiene, public health administration, statistics, etc., amounting to some 400 hours of classroom instruction. Second-term classes are held at the Institute of Parasitology of Macdonald College and comprise about 300 hours of theoretical and practical work in parasitology and entomology, clinical aspects of tropical medicine, tropical hygiene and sanitation. Throughout the course the clinical aspects of tropical medicine are stressed, and arrangements are made to send the students to the Caribbean region during the final part of the course, to complete their training in tropical medicine and tropical preventive medicine and hygiene. All students admitted to the course must be graduates in medicine, although those who possess a Diploma in Public Health (D.P.H.) are permitted to omit the courses of the first term.

European teaching centers

The schools of tropical medicine of metropolitan Europe remain paramount as sources of instruction in this discipline throughout the world.

In the United Kingdom, postgraduate teaching of tropical medicine is carried out by the schools of tropical medicine of London and Liverpool. In addition, the medical school of the University of Edinburgh offers work leading to the D.T.M.&H. to its own graduates. (See Appendix 15.)

The London School of Hygiene and Tropical Medicine offers postgraduate courses of instruction to qualify for the Diploma in Tropical Medicine and Hygiene (D.T.M.&H.). Diplomas are also offered in Public Health, Applied Parasitology and Entomology, and Bacteriology. Courses other than those leading to diplomas are given in many subjects, including tropical nutrition, environmental control, and the Ross Institute lay course in tropical hygiene. Upwards of 500 students are in attendance at the school, the majority being enrolled in the courses leading to the Conjoint Board Diploma in Tropical Medicine and Hygiene (D.T.M.&H.-England). The main emphasis in teaching for the D.T.M.&H. remains on the control of communicable diseases. In recent years, there has been an increase in stress given to certain problems (e.g., tuberculosis) which are not confined to the tropics. The school is comprised of eleven departments: Applied Physiology, Bacteriology and Immunology, Medical Mycology, Clinical Tropical Medicine, Entomology, Human Nutrition, Medical Statistics and Epidemiology, Occupational Health, Parasitology, Public Health, and the Ross Institute. (The Ross Institute of Tropical Hygiene, founded in 1926 as a memorial to the late Sir Ronald Ross, has been associated with the London School of Tropical Medicine and Hygiene since 1934. Its objects are the teaching of tropical hygiene, the promotion of public health schemes in the tropics, particularly in relation to industry, and research both in Great Britain and in the field overseas.)

The Liverpool School of Tropical Medicine has as its objectives "to train medical men proceeding to the tropics in tropical medicine and hygiene, to conduct original research into tropical diseases and their control, and to organize and conduct clinical and prophylactic measures against tropical diseases." Thus, the emphasis is upon the preparation of students for the practice of medicine and hygiene in the tropics. The school is governed by a council representative of the University of Liverpool and the merchants and shipowners of that city. Two courses of instruction for medical graduates are held annually. Each is of three months' duration. The Diploma in Tropical Medicine and Hygiene is granted. In addition, four courses of instruction are held each year for nurses studying tropical nursing. Also, lectures on parasitology and entomology are offered to postgraduate students who are taking the Diploma in Public Health given by the

University of Liverpool, and in veterinary parasitology and entomology to undergraduates of the University studying for the B.V.Sc. degree.

The University of Edinburgh offers the D.T.M.&H. The Departments of Public Health, Bacteriology, and Zoology deal with theoretical matters, while the Tropical Diseases Unit of the Eastern General Hospital provides clinical experience. The curriculum is in two parts, given from October to March to graduates in medicine and surgery of the University of Edinburgh and others with degrees which are recognized as corresponding. Classes are held in the following subjects: Entomology and Parasitology, Bacteriology, Diseases of Tropical Climates, Virology, Tropical Hygiene, Applied Physiology, Venereal Diseases, Tuberculosis and Statistics.

Undergraduate instruction in tropical medicine is lacking in Great Britain. But recent medical graduates who enter the armed services receive a short and intensive training in tropical medicine, which is supplemented by further local training for those who are actually sent to tropical posts.

In France, the teaching of tropical medicine is not integrated with the customary training given to medical undergraduates. It is not required as a subject, and most students who are not interested succeed in by-passing it. It is taught as a set of separate elective courses in the Universities of Paris, Bordeaux, Marseilles, Lyons, Montpelier and Algiers. In Paris, the core of the body of instruction given in the School of Public Health is tropical medicine. Also, there is a special course within the medical school which is offered to graduate physicians only and provides them with a Diploma in Malariology. However, the main body of instruction is provided by the Institute of Tropical Medicine in the School of Medicine (see Appendix 15). It was created to offer French physicians theoretical and practical instruction in tropical diseases. Besides graduates of the national schools of medicine, students are admitted to the courses who have a diploma from the local schools of Dakar, Tananarive (Malagasy Republic) or Pondicherry (India), as well as foreign physicians who have been passed for matriculation by the Faculty of Medicine. The staff is comprised of 14 persons, representing Chairs of Tropical Pathology, Parasitology, Bacteriology, Ophthalmology, Tropical Hygiene and Epidemiology, Dermatology, Infectious Diseases, Surgery, and Sanitation. Sixty students are accepted each session, which runs annually from the beginning of October to the end of December.

The Institute of Tropical Hygiene and Social Medicine of the University of Aix-Marseille (see Appendix 15) has a staff of six full-time professional instructors, and three assistants, as well as a staff devoted entirely to research. The Institute is divided into the following sections: Virology and Epidemiology, Industrial Medicine and Social Hygiene, Nutrition, and Tropical Hygiene. Upon completion of the appropriate studies, certificates are awarded in Hygiene and Social and Sanitary Action. Nursing courses are given, and the Institute has charge of the courses in hygiene in the School of Medicine in Casablanca, Morocco.

The Tropical Institute in Basel, Switzerland, offers annually a ten-week course in tropical medicine, leading to a Diploma in Tropical Medicine. The course was not given in 1960 because of construction work, but in 1959 there were 21 enrolled students and 69 auditors. Four physicians stood for the qualifying examination and received the diploma. The regular teaching staff of the Institute is formed by 11 persons whose services are regularly augmented by numerous guest lecturers.

In Portugal there is one postgraduate institute, the Institute of Tropical Medicine in Lisbon (see Appendix 15), which offers training in tropical medicine. No tropical medicine is taught in any of the three schools of medicine in Lisbon, Coimbra or Porto. The Institute of Tropical Medicine functions in close association with the Commission on Hygiene and Health of the Overseas Ministry, and the director and two professors of the Institute occupy seats on this Commission. The Institute confers no degree. However, under present law, the course in tropical medicine is required postgraduate work for physicians who desire to practice medicine in the colonies. The eight-month course runs from the beginning of November until the end of the following June, with approximately 30 class hours of instruction per week. Subjects are presented under six general headings: Hygiene and Climatology, Tropical Clinical Pathology, Entomology and Helminthology, Hematology and Protozoology, Dermatology and Mycology, and Bacteriology and Virology. In 1958 the full-time teaching staff of the Institute was composed of 10 full professors, 1 assistant or auxiliary professor, 4 investigators, and 19 assistants. Although some of the personnel engaged in full-time research in the Institute possess the Ph.D., all of the teaching staff have an M.D. degree.

In Italy, tropical and subtropical diseases comprise one of the required subjects during the fifth and sixth years of undergraduate medical training, and courses are taught primarily from the clinical standpoint. In Italy, tropical medicine is recognized legally as a medical specialty for which three years of specialist training are required. Clinical instruction is provided in the Clinical Institute for Tropical and Subtropical Diseases, of the Faculty of Medicine and Surgery, University of Rome (see Appendix 15).

The Institute of Malariology of Rome (see Appendix 15) presents a class in malariology each year from June to August. Although the students who attend often have varied backgrounds, in 1959 there were 26 medical graduates and 2 naturalists in attendance. Upon satisfactory completion of the course, a diploma is given.

There are two large centers of instruction in tropical medicine in the Federal Republic of Germany. The Institute for Infectious Diseases and Tropical Medicine of the University of Munich (see Appendix 15), associated with the Bavarian Vaccination Clinic, serves primarily as a source of undergraduate and postgraduate instruction. It was founded in 1951. The professional staff is composed of 3 physicians and 2 veterinary surgeons, with assistance provided by 6 medical technicians and about 15 others.

The Bernhard Nocht Institute for Ships Medicine and Tropical Diseases of Hamburg (see Appendix 15) is primarily a research institute. However, a program of courses is offered each year in which the entire research staff of the Institute may serve in a teaching capacity. In addition, many guest lecturers from Germany and abroad are present by invitation. In 1956 the number of students in attendance was 32. This number rose to 40 in 1957 and 49 in 1959.

In Belgium, statute decrees that physicians who intend to practice in the Congo must undertake a certain period of in-service training in tropical medicine. Otherwise, this discipline is offered on an optional basis to medical students in the fourth year of study. Satisfaction of the legal requirement is accomplished primarily at the Prince Leopold Institute of Tropical Medicine in Antwerp (see Appendix 15). Two twenty-week courses are taught each year. Besides the advanced course for physicians and veterinarians, there are less advanced courses for nurses, sanitary inspectors and veterinary inspectors. In 1957-58, 286 students enrolled in the fall term and 164 in the spring term. Instruction is provided in both French and Flemish. Subjects taught include bacteriology, virology, medical zoology, protozoology, tropical pathology, hematology, helminthology, entomology, tropical hygiene, and tropical veterinary pathology and medicine. In 1958 instruction was given in French by six professors, in Flemish by seven, and in both languages by two.

Another important source of instruction in this discipline is centered in the Laboratory of Tropical Parasitology of the Free University of Brussels (see Appendix 15). This laboratory is specially devoted to the teaching of an introductory course in tropical parasitology which is optional for medical students in the fourth year of their studies but obligatory for all hygienists and laboratory technicians.

In the Netherlands, the two tropical institutes in Amsterdam and in Leiden provide instruction, as part of their functions, to undergraduate and graduate medical students. The Department of Tropical Hygiene and Geographical Pathology (see Appendix 15) of the Royal Tropical Institute of Amsterdam organizes courses for physicians but also provides individual instruction for physicans, entomologists and laboratory assistants who intend to work in the tropics. There are Chairs of Hygiene, Parasitology, Medical Entomology, Tropical Nutrition, and Tropical Health. The staff is composed of 10 persons of professorial rank, and there are about 25 subprofessional and other employees.

The Tropical Medicine Institute of Leiden (see Appendix 15), with a research and teaching staff of 13 professional persons, presents postgraduate courses in tropical hygiene to medical graduates as well as missionaries and nurses who are bound for the tropics. In addition, lectures in parasitology, entomology and helminthology are provided for medical undergraduates. Clinical instruction is provided by liaison with the Seamen's Hospital in Rotterdam. Close cooperation is maintained between the Institutes of Amsterdam and Leiden with regard to physician-training in tropical medicine.

Teaching of tropical medicine in the U.S.S.R.

In the Soviet Union, postgraduate training of practicing physicians is carried out in 11 Institutes for the Advanced Training of Physicians, 4 of which have teaching chairs in tropical medicine. The Central Institute for the Advanced Training of Physicians in Moscow has a Chair of Malaria and Medical Parasitology. In Tbilisi (Georgian S.S.R.) the State Institute for the Advanced Training of Physicians has a Chair in Medical Parasitology and Tropical Medicine. The Azerbaidzhan Institute for the Advanced Training of Physicians in Baku (Azerbaidzhan S.S.R.) possesses a Chair in Malaria and Medical Parasitology. Lastly, the State Institute for the Advanced Training of Physicians in Tashkent (Uzbek S.S.R.) supports a teaching Chair in Malaria, Parasitology, and Tropical Diseases. These institutes offer courses of two and one-half to three months' duration to specialists and are designed to keep the physician away from practice for as short a period as possible. It is noteworthy that, except for the Central Institute in Moscow, the schools mentioned above are located in the capital cities of three of the southernmost political divisions of the Soviet Union, in close proximity to several of the countries included in the survey's definition of Southwest Asia.

There seems to be little tropical medicine as such taught in the undergraduate medical curriculum in the Soviet Union. Only one medical school, the Tbilisi Medical Institute (Georgian S.S.R.), is known to possess a teaching chair which can be identified with this discipline; the chair is called Epidemiology in Connection with Medical Parasitology.

Teaching of tropical medicine in Africa

There are no schools of tropical medicine acting as postgraduate centers of instruction in Africa.

There are five medical schools in the Republic of South Africa, which offer some instruction in tropical medicine as part of the undergraduate curriculum. The Medical School of the University of Witwatersrand offers a diploma course to its graduates.

The three medical schools of Egypt offer clinical training in tropical medicine as a part of the fifth and sixth undergraduate years.

The undergraduate medical schools of Dakar, Ibadan and Kampala, of relatively recent installation, inevitably lay stress on local aspects of medical practice (i.e., practice in the tropics) and the curricula include much tropical medicine.

Teaching of tropical medicine in Southwest Asia

There are no schools in Southwest Asia which are devoted exclusively to postgraduate instruction in tropical medicine. Some form of instruction in parasitology or tropical medicine is included in the excellent undergraduate curricula provided by the medical faculties of the American University of Beirut, Lebanon, the Hebrew University, Jerusalem, Israel, the University of Teheran, Iran, the Syrian University, Damascus, Syria, and the Universities of Ankara and Istanbul, and Aegean University in Turkey. The geographical position of these schools assures that clinical studies in pediatrics, ophthalmology, dermatology and venereology, phthisiology, and pathology will provide the student with much experience in the field of tropical medicine as it is defined for the purposes of this survey.

Teaching centers in South Central and Southeast Asia

It has been stated above that some instruction in tropical medicine is offered in most medical schools located within the geographical area included in the survey. This is to be anticipated, since the schools are under constraint to prepare their students to cope with local medical problems. However, such instruction, mixed with the large number of other ingredients included in the basic science preparation of the medical student, must be considered scanty, and indeed few medical schools in South Central or Southeast Asia seem to present an outstanding program of instruction in tropical medicine.

Only two specialized schools may be mentioned here, both located in India. The Calcutta School of Tropical Medicine (see Appendix 15) offers a postgraduate teaching program which lasts nine months and leads to the D.T.M.&H. Every year about 50 students are accepted. In addition to the D.T.M.&H., there is a one-year course leading to the Diploma in Clinical Pathology (D.C.P.) and a short (three-month) course which offers a Licence in Tropical Medicine (L.T.M.). In addition, a short training course in leprosy is offered each year.

The All-India Institute of Medical Sciences in Calcutta (see Appendix 15) is concerned with all matters pertaining to the health of the nation, and at present is organizing a program of inter-departmental cooperation in the teaching of tropical medicine. This training is given to postgraduate medical students who have obtained the M.B.B.S., and is undertaken in the Departments of Bacteriology, Pathology, Medicine, and Preventive and Social Medicine of the Institute. In 1960 the Institute had 250 undergraduates and 75 postgraduate students working in various medical disciplines. Many of the staff members of the Calcutta School of Tropical Medicine participate on a reciprocal basis in the training program of the All-India Institute of Hygiene and Public Health.

Apart from India, there are no other tropical schools organized as postgraduate centers in Southeast Asia. The Institute of Hygiene of the University of the Philippines offers courses in parasitology and infectious diseases which attract not only regular students but also cross-registrants from the College of Medicine. The Institute offers courses leading to the degrees of Bachelor of Science in Hygiene, Certificate in Public Health, and Master of Public Health, and accepts students from South Korea and Taiwan in addition to Philippine nationals.

In Thailand, a new School of Tropical Medicine is in process of organization in the University of Medical Sciences in Bangkok.

Teaching of tropical medicine in Australia

The School of Public Health and Tropical Medicine of Sydney (see Appendix 15) is operated as a part of the Commonwealth Department of Health and incorporates (since 1930) the Australian Institute of Tropical Medicine of Townsville, Queensland. Postgraduate medical students may enroll in courses leading to the D.T.M.&H. In 1954 there were 8 candidates for this diploma, with 5 in 1955 and 13 in 1956. Diplomas are also offered in Public Health, Nursing and Nursing Administration. A three-month course in tropical medicine is presented during June-August for missionaries and others proceeding to the tropics. In addition, special instruction is available in tropical hygiene for Northern Territory school teachers and governmental officers as well as Army personnel. The principal undergraduate teaching consists of lectures in public health and preventive medicine which are presented to fifth-year medical students.

DISCUSSION

With the exception of certain outstanding centers in Latin America, most of the teaching of tropical medicine is performed in Europe. Instruction is usually organized in a form which is suitable to the postgraduate training of physicians. Schools may be large and offer a number of degrees in various subjects ancillary to tropical medicine, such as tropical nursing, hygiene and sanitation, statistics, etc., or they may be small, limited to the presentation of a single set of courses, leading to a certificate of attendance. The thread which unites them all is the history of European colonization of the tropics with its concomitant responsibility for colonial health. With few exceptions, the European institutions described here were created in response to this political and economical need.

An understanding of this perspective explains the relative great extent and organization of tropical medicine teaching in Europe as compared to the United States. This country has never had the political and social responsibility for vast areas of the tropics that the metropolitan countries of Europe have had.

The schools of South Asia have been patterned after those of Europe, but in response to needs which were felt locally. The patterns of teaching in the tropical schools and institutes of Latin America are also organized largely in terms of regional requisites.

The background of colonial medicine has had implications with regard to the practical experience of faculty members in many of the European schools. This is usually acquired in civilian status, but in France, until recently, tropical (or colonial) medicine has been traditionally approached principally by the military. Throughout its colonial history, overseas medical posts in French colonies have been staffed by military personnel. The military schools of France follow the custom of permitting their officers to profit from the theoretical instruction in tropical medicine offered in the institutes associated with the universities. But with regard to clinical experience, military authorities maintain their own "schools of application" (e.g., hospitals such as the Val-de-Grace in Paris) which permit the military physician, destined to be detailed to a tropical post, to acquire clinical experience which is not available to civilian students.

The virtues of linking military service with colonial medicine have become more apparent with the acquisition of political independence for large numbers of colonies; it has proved progressively difficult for the new governments to secure the practical services of civilian physicians to staff the reorganized curative and prophylactic health services.

Teachers of tropical medicine in foreign countries are not known to enjoy elevated salary levels. The strong impression has been conveyed that these teachers are as illy compensated as is generally true elsewhere in the teaching profession, an impression accentuated by the fact that professors in the schools of tropical medicine often devote only a part of their daily routine to teaching, reserving a large part for private practice or other work. The larger schools offer many exceptions, of course. In one European school, the salary level at the professorial level was in the neighborhood of the equivalent of $3,300 per year in 1960, and associate professors received $2,700, while assistants received only $1,700 annually. It must be considered, however, that this level of underpayment for valuable services undoubtedly reflects attitudes regarding the role of the teacher rather than the role of tropical medicine.

SUMMARY

Some of the major centers of tropical medicine teaching in the world are described. In general, medical schools located within the geographical areas of the survey were excluded from lengthy consideration. The tropical schools mentioned here include: Institute of Tropical Medicine, São Paulo, Brazil; the School and Institute of Health and Tropical Diseases, Mexico, D.F., Mexico; the Department of Parasitology of the Faculty of Medicine, University of Chile, Santiago; Institute of Parasitology, McGill University, Montreal, Canada; the London School of Hygiene and Tropical Medicine; the Liverpool School of Tropical Medicine; the Tropical Diseases Unit of the University of Edinburgh; the Institute of Tropical Medicine in Paris; the Institute of Tropical Hygiene and Social Medicine in Marseilles; the Swiss Tropical Institute in Basel; the Institute of Tropical Medicine, Lisbon, Portugal; the Clinical Institute for Tropical and Subtropical Diseases, University of Rome, Italy; the Institute of Malariology in Rome; the Institute for Infectious Diseases and Tropical Medicine in Munich, Germany; the Bernhard Nocht Institute in Hamburg, Germany; the Prince Leopold Institute in Antwerp, Belgium; the Royal Tropical Institute of Amsterdam, Netherlands; the Tropical Medicine Institute of Leiden,

Netherlands; the Calcutta School of Tropical Medicine and the All-India Institute of Medical Sciences, Calcutta, India; and the School of Public Health and Tropical Hygiene, Sydney, Australia.

It is seen that most of the above-named schools are located in the countries of metropolitan Europe. Here, tropical medicine is recognized as a legal medical specialty in Italy, Portugal, Switzerland and France. Parasitology is a legal medical specialty in Turkey.

The schools were developed primarily in response to the health needs of the tropical colonies. At the present time, European responsibility for these needs has diminished in direct measure as political independence has been acquired in the former colonies. However, teaching of tropical medicine, especially in Europe, continues strong because interest has not disappeared along with responsibility.

The practical experience of the tropics has been acquired by most of the teachers in the European schools in a civilian capacity, although many were assuredly brought into tropical contact during World War II, and some, especially the French, have a tradition of associating colonial medical services with military service.

Teachers of tropical medicine are not known to enjoy a special social position. Salaries are, for the most part, routinely low, and many teachers supplement their teaching with private practice or other endeavors. When this is true of a whole staff, the entire institution may be reduced to part-time operations with regard to teaching.

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Chapter 17

Training Facilities in the Field of Tropical Medicine and Hygiene

Curt R. Schneider

A distinction will be maintained between academic training facilities and field training facilities. Concerning the former, many teaching programs, of necessity, include practical training as a necessary adjunct to the theoretical aspects of the discipline. In addition, training programs, as distinct from teaching programs, are provided in a number of United States research laboratories. For the purposes of this survey, however, attention will be given only to those training opportunities involving field experience within the underdeveloped areas defined elsewhere in this report.

Academic Training Opportunities

The United States possesses a number of excellent centers for teaching the technical and theoretical aspects of tropical medicine, especially where this is equated with parasitology or with hygiene and public health. Foremost among such institutions are the Johns Hopkins School of Hygiene and Public Health, Columbia University School of Public Health and Administrative Medicine, Harvard University School of Public Health, Tulane University School of Medicine and Louisiana State University School of Medicine. On the western seaboard there may be included the University of California Schools of Medicine in San Francisco and in Los Angeles, and the School of Tropical and Preventive Medicine of the College of Medical Evangelists, Loma Linda, California. In the Caribbean area, there is the School of Medicine of the University of Puerto Rico, San Juan. The list is far from complete.

The situation with regard to the teaching of clinical tropical medicine is much more restricted. A lack of local clinical material in the United States, combined with a ubiquitous indifference of instructors toward utilizing such imported cases as may be available, usually succeed in withholding such few opportunities as do exist for viewing tropical patients from the students' eyes. Exceptions are fortunately to be found in certain hospitals associated with the medical schools of the more cosmopolitan port cities, such as Boston, New York, New Orleans and San Francisco. But, even here, the seeking out and presenting of such cases to medical students remains a labor initiated by a handful of informed and devoted teachers.

It may be stated that educational institutions in the United States which accord recognition to tropical medicine identify it, almost without exception, with parasitology. The number of schools which recognize tropical bacteriology and virology are few; even rarer is the consideration of tropical mycology. The tropical aspects of nutritional deficiencies, of human genetics as evidenced medically by the hemoglobinopathies, and the physiological and psychological sectors of tropical medicine are subjects of curricular refinements usually left to the schools of Europe. The corollary of this has been, evidently, the establishment of an orientation in the United States away from clinical tropical medicine and towards comparative parasitology. This trend may be partly documented by an inspection of the titles of research projects awarded grants by the Tropical Medicine and Parasitology Study Section of the Research Grants Division, National Institutes of Health (see Chapter 14).

Under these circumstances the opportunities for securing advanced training in tropical diseases in United States academic institutions are seen to be small.

In the geographic sense, the School of Medicine of the University of Puerto Rico, San Juan, is in a unique position, among American medical schools, to offer clinical and field training in tropical medicine. It is our only medical school in the tropics. It offers its students excellent basic training in certain of the local tropical diseases, and this is reinforced by the availability of much local clinical material. The language of instruction is English; however, the language of the patients seen in clinic is invariably Spanish.

The School of Tropical and Preventive Medicine of the College of Medical Evangelists, Loma Linda, California, began in 1950 a program of summer clinical institutes for medical and nursing students, to be held in Mexico or Guatemala. However, in more recent years, this program has been severely curtailed for budgetary reasons.

The National Leprosarium at Carville, Louisiana, is available to students in the two medical schools of that state. Visits to the institution form part of the schools' regular curricula.

At Columbia University, students enrolled under the Faculty of Medicine have for more than ten years been offered elective field work, during the junior or senior year, in association with the hospital facilities of certain private industrial firms in Surinam, Panama, Liberia and Nigeria. Expenses are borne partly by the student (travel) and partly by the host institution (per diem and maintenance). In recent years, Public Health Service funds have been available, in the form of grants, to help defray these expenses.

The Department of Tropical Public Health of the Harvard School of Public Health has for many years sponsored and promoted on an unofficial basis the training of competent individuals in clinical and research aspects of tropical medicine under tropical field conditions. Recently, the availability of training grant funds in medical parasitology and tropical medicine has permitted this program to be placed on a formal basis. Currently, senior and postgraduate medical students as well as faculty members have been enabled to spend varying periods of time working in Liberia, Ghana and Puerto Rico.

A unique opportunity to acquire clinical experience in certain underdeveloped countries is provided by the Foreign Fellowship Program which is sponsored by the Smith Kline & French Laboratories, Philadelphia, and administered by the Association of American Medical Colleges. The program provides for the nomination, by prominent medical educators, of junior and senior medical students to work overseas in mission hospitals and outpost facilities, largely in tropical countries. The countries include Pakistan, Burma, Haiti, New Hebrides, India, Thailand, Cambodia, Ghana, Congo Republic (Leopoldville), Tanganyika and other African countries. Under the terms of these fellowships, traveling students spend an average of three months practicing daily clinical medicine under the supervision of a responsible professional sponsor. Originally set up for a three-year term and due to expire in 1962, the program is to be extended through 1963. During the years 1960 and 1961, grants totaling approximately $100,000 were made to 59 students under the program.

Certain United States medical schools have, in recent years, established academic contacts with some of the foreign medical schools located within the so-called underdeveloped areas of the world. The purpose has usually been to assist in the academic development of the foreign school by giving advice on the curricular status and by the loan of teaching personnel. Such an event, for example, has occurred between the University of California Medical School in San Francisco and the Medical School of the University of Indonesia in Djakarta. With regard to training, such programs are not known to involve an exchange of students, in either direction.

A program of training grants, awarded to non-federal institutions, forms part of the total effort of the National Institutes of Health to develop extramural programs. Those grants which are administered by the National Institute of Allergy and Infectious Diseases are classified as being primarily concerned with (a) tropical medicine and parasitology, (b) infectious diseases, and (c) allergy and immunology.

Traineeships, in the form of grants made directly to individuals, are also provided. However, none has been granted to individuals working in the field of tropical medicine, and no further account will be made of them here.

The program of training grants was inaugurated in FY 1958, the first four grants in tropical medicine and parasitology being awarded 1 September 1957. The total amount awarded was $128,941, distributed among three institutions. As of 1 January 1959, the number of grants in tropical medicine and parasitology had increased to 18, distributed among 16 institutions, and totaling $439,670. The figures have increased with regularity over the last few years, the limiting factor being only the amount of funds available. On 1 January 1960, there were 22 grants active in 20 institutions, totaling $783,804, and on 1 January 1961, the number of grants was 25, distributed among 20 institutions and totaling $1,024,782.

For the purposes of this report it will be assumed that all of the training grants listed above represent tropical medicine. In practice this was probably not entirely true. Many grants were undoubtedly used for training in the fields of parasitology unrelated to tropical medicine as defined for the purposes of this survey. Moreover, it must be remembered that the fields of medical discipline overlap greatly and many grant applications include activities of interest in more than one area.

Field Training Facilities

As is well known, the small size of United States administrative interests in the tropics offers limited research and training facilities. With regard to established research laboratories, the Liberian Institute of the American Foundation for Tropical Medicine in Harbel, Liberia, and the Gorgas Memorial Laboratory in Panama may be named. However, these institutions, which operate with rather limited budgets, do not offer facilities for the routine training of numbers of students, even though an occasional young investigator is able to take advantage of them.

The most significant of these programs is undoubtedly the Inter-American Program of Fellowships in Tropical Medicine and Parasitology which is administered by the Louisiana State University School of Medicine. Originally intended to offer some practical experience in the tropics to teachers of tropical medicine and parasitology in United States medical schools, the program was eventually expanded to include research workers, teachers and advanced graduate students in all disciplines relating to tropical medicine. The program, at present, provides group fellowships for teachers and advanced graduate students to make prearranged tours of two months' duration of the Caribbean (Puerto Rico, Dominican Republic and Haiti) or of Central America (Costa Rica, Guatemala, El Salvador and Panama). In addition, funds are allocated on an individual basis for travel and subsistence to permit research workers to conduct projects in tropical sites. A third type of training has been added, to offer tropical fellowships to promising medical students in an effort to assess their aptitudes for research and teaching in tropical medicine.

In 1960, Congress passed the International Health Research Act (PL 86-610) and expressed hope that, in partial fulfillment of its objectives, there would be established "a program through the U. S. universities for the early development of research and research training centers with adequate field opportunities for international studies." As a form of implementation of this expressed desire, the program of International Centers for Medical Research and Training (ICMRT) was established, under the administration of the National Institute of Allergy and Infectious Diseases. Each participant in the program is characterized by a staff and facilities in the U. S. grantee institution as well as affiliation with a foreign institution which possesses the scientific and technical competence to support overseas investigations. At present, five universities have been awarded ICMRT grants. They are the University of California (Schools of Medicine, Public Health, and Veterinary Medicine) affiliated with the Institute for Medical Research in Kuala Lumpur, Malaya, and the University of Malaya in Singapore; Tulane University (School of Medicine) affiliated with the Universidad del Valle, Cali, Colombia; Johns Hopkins University (Schools of Public Health and Hygiene, and Medicine, and the Hospital) affiliated with the All-India Institute of Public Health and the School of Tropical Medicine in Calcutta, India; University of Maryland (School of Medicine and other departments of the University) affiliated with medical colleges at Lahore, Multan and Rawalpindi, West Pakistan, and Dacca, East Pakistan; and, finally, the Louisiana State University (School of Medicine) affiliated with the Universidad de Costa Rica (School of Medicine).

Foreign Training Facilities

Europe

Until recently, the metropolitan countries of Europe occupied a pre-eminent position with regard to access to tropical areas under their administrative jurisdiction. Under this aegis, many research facilities were developed to investigate tropical diseases. The official attitudes of the newly independent governments which have replaced or are about to replace the colonial governments vary considerably with regard to the fate of these medical research establishments. Medical research represents a considerable investment the rewards of which are often delayed; in general, it can be assumed that those new governments which plan to maintain the established research facilities within their boundaries will reach cooperative agreements regarding financing and staffing with their former colonial governors.

The colonial retrenchment of the British Empire has not carried with it a concomitant diminution in interest in tropical medicine. Under the colonial system, territories were eligible for aid from the Colonial Development and Welfare (C.D.&W.) funds. The West African Council for Medical Research, the East African Council for Medical Research and the Committee for Medical Research in the British Caribbean derived much of their support from this source. This support provided a strong impetus to research. With the change to independent status, C.D.&W. aid was no longer available and expatriate research workers within its purview ceased to be members of the Overseas Civil Service and became employees of the new government. With a view to maintaining the high level of tropical research already being performed, the Medical Research Council of Great

Britain recently proposed the setting up of a Tropical Medicine Research Board to advise the Council (a) on all medical research in or for the Colonies financed from Colonial Development and Welfare Funds; (b) on all medical research in or for the independent Commonwealth financed from the United Kingdom Exchequer; and (c) on all medical research in or for tropical or subtropical countries financed from their own budget.*

The opportunities for field-training in tropical medicine in the overseas departments and territories of France and in the states of the French Community appear to be extensive. Foremost among such posts must be listed the numerous Overseas Pasteur Institutes (Instituts Pasteur Hors-Metropole). The name of Pasteur has generally been adopted throughout the world to identify laboratories devoted to the diagnosis and control of rabies. Most of these have no connection with the mother institute in Paris. The Overseas Pasteur Institutes referred to here (see Appendix 16) have, however, contractual ties with the Pasteur Institute in Paris, and their scientific personnel is appointed in Paris, following understandings with the host government. According to the terms of their contracts, the overseas institutes place their diagnostic and analytical services at the disposal of the local health and veterinary authorities. With regard to research, each of the overseas institutes is oriented toward research on the dominant pathogens of the area and is, necessarily, engaged in applicative aspects of this research. Thus, in Algiers, malaria and leishmaniasis receive emphasis. In Tunis, the stress is on typhus, other rickettsioses and brucellosis. In Casablanca, typhus and spirochetoses; in Tangiers, rabies; in Dakar, yellow fever; in Brazzaville, trypanosomiases; in Tananarive, plague; in the French Caribbean, leprosy; and in Vietnam, cholera, malaria and melioidosis.

More interesting, from the standpoint of an organized career service, is the opportunity for research-oriented persons to serve in one of the medical research laboratories of the French-speaking tropics under the auspices of the Office of Overseas Scientific and Technical Research, a branch of the Overseas Ministry (Office de la Recherche Scientifique et Technique Outre-Mer, or ORSTOM). ORSTOM recruits young college graduates who are interested in a research career into one of its several training centers, where instruction is oriented essentially toward the practical aspects of one of several economically important disciplines. One of these centers, only, is concerned with a discipline which may be identified with tropical medicine: the Center for Medical and Veterinary Entomology. (A Center for Medical and Veterinary Helminthology has recently been established, but its activity has been so limited as to warrant exclusion here.) The Center accepts as students graduate physicians, veterinarians and pharmacists, as well as zoologists and graduates in other disciplines. After two years of study in France, for which an identifying diploma is given, they are prepared to assume the career of a research specialist, within the cadre of ORSTOM, and as such are endowed with civil service status. In 1960, there were 17 professional members of the staff of medical and veterinary entomologists (of which 8 had the M.D.) engaged in nine laboratories distributed throughout the tropics. These laboratories are identified by name in Appendix 17. It must be added that the amount of published work of the cadre of entomologists is truly remarkable, and attests to the relative success of this form of career service; in the six-year period 1954-1959, a total of 186 published titles were authored by the ORSTOM medical entomologists.

Portugal, as of this writing, has not lost political control of her tropical colonies. Field training facilities of two sorts are available to tropical medicine students. The first sort is represented by the Medical Research Institutes of Angola (Luanda) and Mozambique

* With regard to the need for making provision for research investigators whose interests are primarily directed to medical problems, the Medical Research Council of Great Britain proposed, in 1959, the establishment of a career-structure within the Medical Research Council to be devoted to this end, taking into account the following three broad types of worker:

"First are those senior men, now in key posts overseas, with years of valuable experience behind them. Given the necessary security and a relation to a home-based organization that can not only offer them a career when their posting overseas would normally expire, but ensure that, if not at one place then at another, suitable opportunities are found for them to follow their work, it is believed that many such men might prefer to continue in the work that has been their lifelong interest. The Council believe that it is possible to make such arrangements which would suit not only the individual, but the territory or overseas organization with which he is working.

"The second type of senior man is a specialized expert whose skill may be deployed in different places at different times. It is proposed that such workers be recruited to a home-based cadre to work abroad as need and opportunity offers.

"The third type is the assistant. Many young research workers are interested in the medical problems of the tropics. They hesitate to take posts overseas, however, either because they consider such a career uncertain or because they are doubtful whether their interest in tropical problems is sufficiently strong. It is proposed that the Council should give such men, in the first instance, appointments to their staff for five years, the first three of which will, in any case, be spent abroad. If work in the tropics appeals to the man, and he makes a success of it, then at the end of three years he could be given a longer appointment overseas. It is from such men that it is hoped to recruit the key personnel and directors of the future who elect for a lifetime's career in the tropical field. If, on the other hand, the man finds that he has no liking for work in the tropics, he will spend the remainder of his first appointment in a home department allied to his interests.

"The exact source, or sources, of finance in any particular case may be a complex matter; but it will be one for the Council to arrange with the various bodies concerned."

(Lourenço Marques). Created in 1955, these institutes are operated under the direction of the Institute of Tropical Medicine in Lisbon, and work is performed in intimate collaboration with the Health Services and other governmental services with links to human health problems. The Medical Research Institute in Lourenço Marques is concentrated on the study of malaria and schistosomiasis. That in Luanda deals with various diseases, including onchocerciasis, nutritional deficiencies, viroses, malaria, arthropod studies, etc. Students may at any time be detailed from Lisbon to either of these institutes for intensive training.

The second sort of opportunity is represented by the system of Permanent Missions which are allied with the health services in certain of the overseas colonies. There are three of these, namely: the Permanent Mission for the Study and Control of Diseases in Cape Verde; the Permanent Mission for the Study and Control of Sleeping Sickness and Other Diseases in Portuguese Guinea; and the Permanent Mission for the Study and Control of Diseases in Timor. These missions, although permanent, undergo periodic changes in staffing personnel, offering opportunities for the training of new persons.

In addition to the above-named opportunities for field experience, the Institute of Tropical Medicine organizes occasional missions to study specific problems relating to tropical medicine and local health in all of the overseas colonies.

Belgian colonial interests were, until recently, limited to the Belgian Congo and the trust territory of Ruanda-Urundi. The troubles which attended the acquisition of independence cast considerable doubt over the fate of the many excellent research facilities in the colony. The following account is based upon the situation which existed in the Congo just prior to independence. The area was rich in medical and public health facilities operating under private as well as public funds. Many of these facilities provided the means whereby students acquired excellent training in tropical medicine. Two research establishments, in particular, deserve attention. The Princess Astrid Institute of Tropical Medicine *(Institut de Médecine Tropicale Princesse Astrid)*, in Leopoldville, was engaged in research into the genetic basis for the hemoglobinopathies, as well as trypanosomiasis, poliomyelitis and enterobacterial pathogens. The Institute for Scientific Research in Central Africa (*Institut pour la Recherche Scientifique en Afrique Centrale* or IRSAC) was engaged in research in many disciplines identified with economic and social advancement. Of its five main centers, that at Lwiro, near Bukavu and Lake Kivu, was the principal one, having about twenty laboratories or scientific departments, including laboratories of nutrition, pharmacodynamics, medical zoology and virology. The center in Elisabethville was oriented especially toward the subject of the biochemistry of parasites; in this regard, the center worked in close connection with the medical and veterinary laboratories of the government.

In addition, the Queen Elisabeth Fund for Native Medical Assistance (*Fonds Reine Élisabeth pour l'Assistance Médicale aux Indigènes*, or FOREAMI) in Leopoldville supported applied research on tuberculosis, malaria, leprosy, trypanosomiasis and nutritional deficiencies. Also, the Provincial Medical Service Laboratories at Bukavu, Elisabethville and Stanleyville conducted research in tropical medicine as part of their regular functions.

The training facilities at the disposal of the other European countries with tropical schools are less obvious. With regard to the Netherlands, the teaching and research activities of the Royal Tropical Institute had been concerned chiefly with the problems of the former Dutch East Indies. Indonesia now no longer plays a significant part in the affairs of the Institute, and the Royal Tropical Institute has become a service institution, providing services to students of many tropical countries.

The Tropical Institute of Hamburg maintains liaison with schools and laboratories in many Latin American countries, particularly Brazil. The Swiss Tropical Institute maintains relations with certain business firms and missionary establishments in Tanganyika, and has recently entered into an understanding with the Provisional Government with regard to the *in situ* training of paramedical personnel.

Training facilities in tropical medicine in the Soviet Union

The list of postgraduate institutions engaged in teaching tropical medicine in the USSR (mentioned in Chapter 16) must be considered in any discussion of Soviet training facilities. But in addition, there are a number of research laboratories in which in-service training in diagnostic and research techniques is presumably available. These institutes are the following:

Laboratory of Medicial Parasitology
Institute of Regional Pathology
Academy of Sciences, Kazakh SSR
Alma-Ata, Kazakh SSR

Institute of Epidemiology, Microbiology and Hygiene
Ashkhabad, Turkmen SSR

(This institute embraces, among others, a Division of Parasitology, Laboratory of Virology and Rickettsial Diseases, Section of Epidemiology and Parasitology, Section of Helminthology and Section of Intestinal Infections)

Institute of Malaria and Medical Parasitology
Ashkhabad, Turkmen SSR

Institute of Malaria and Medical Parasitology
Baku, Azerbaidzhan SSR

(This institute comprises a Division of Entomology, Division of Epidemiology, Division of Helminthology, Division of Clinical Research and Laboratory of Clinical Research)

Ukrainian Scientific Research Institute of Malaria and Medical Parasitology imeni Prof. V. Ya. Rubashkin
Kharkov, Ukrainian SSR

(Comprising a Department of Clinics, Department of Entomology, Department of Epidemiology, Department of Helminthology and Laboratory of Clinical Diagnosis)

Central Institute of Malaria and Tropical Diseases
Moscow, USSR

Institute of Malaria, Medical Parasitology, and Helminthology
Moscow, USSR

(Comprising Departments of Epidemiology of Malaria, Ecology and Biology, Entomology, Experimental Parasitology, Organization and Methods, Clinical Services, Control of Parasitic Diseases, Experimental Malaria and Medical Protozoology, and Arthropod Vectors of Malaria)

Uzbek Institute of Malaria and Medical Parasitology
Samarkand, Uzbek SSR

Sukhumi Anti-Malarial Station
Sukhumi, Abkhaz ASSR

Tbilisi Institute of Malaria and Medical Parasitology
Tbilisi, Georgian SSR

Institute of Malaria and Medical Parasitology
Yerevan, Armenian SSR

(Comprising a Division of Helminthology and a Division of Protozoology)

It must be stressed that the above list is intentionally limited to those laboratories in which it is presumed training in tropical diseases as such is currently available. However, the concern of the Soviet government with epidemiological problems within its own border is extensive, and research laboratories are widely distributed throughout the country which, if not concerned directly with tropical diseases, are devoted to closely related fields. Chief among such centers is the Gamaleya Institute in Moscow, the full title of which is "Institute of Epidemiology and Microbiology imeni Honorary Academician N. F. Gamaleya." It includes, in part, the following divisions: epidemiology, typhus and rickettsial diseases, experimental therapy, infectious diseases with natural reservoirs, medical microbiology, parasitology and medical zoology, smallpox, tuberculosis, virology, brucellosis, pertussis and immunology. It must be considered that such laboratories are in a position to provide excellent training of a sort which can eventually be turned to advantage in the tropics.

Caribbean, Central and South America

The paucity of tropical medicine training centers in Latin America is striking, especially when it is considered that many of the infectious diseases which represent the major cause of morbidity in this area are precisely those classified as "tropical." However, this apparent contradiction tends to disappear when it is recalled that the practicing physician or veterinarian in the tropical Latin countries expects to acquire his "tropical medicine" through regular practice rather than specialized training. Space is not available in this report for a listing of all clinics, hospitals and laboratories in which elements of training in tropical medicine are acquired. However, certain outstanding centers must be mentioned by name.

In Mexico, the Hygiene Center and Tropical Diseases Training Station in Boca del Río, Veracruz, is administered and staffed by the School and Institute of Health and Tropical Diseases, but at the same time has maintained liaison with the Department of Health of the State of Veracruz. Each year, the Secretariat of Health sends groups of physicians and nurses for specific training. These professional people come from every part of Mexico.

The Division of Malariology of the Department of Environmental Hygiene, Ministry of Public Health of Venezuela, trains technicians from many countries in the techniques of malaria eradication. Since its inception in 1944 its school has acquired an international reputation. Personnel of the Pan American Sanitary Bureau receive training here, and, from 1944 to 1959, it graduated a total of 374 students coming from 29 countries of the Western Hemisphere and Europe.

The Venezuelan Institute of Scientific Investigations (*Institute Venezolano de Investigaciones Cientificas*, or IVIC) is a center of research and higher studies, where national scientists and some foreigners may learn modern investigative techniques. In existence since 1958, the center conducts fundamental medical research on local problems, such as schistosomiasis, hookworm disease, yellow fever, gastroenteritis and goiter. It is part of the program of the center to introduce young university graduate students to research techniques associated with these diseases. In this connection, a short course (three months) is offered in the various histochemical techniques to students from the Departments of Tropical Medicine and of Histology of the Central University and from the Division of Malariology.

The training of medical specialists is one of the various functions of the new Institute of Tropical Medicine in the University of São Paulo, Brazil. Substantial numbers of physicians attending both regular classes and training sessions are from Latin American countries other than Brazil.

The Pan American Foot-and-Mouth Disease Center, in São Bento, near Rio de Janeiro, Brazil, was established in 1951 as an international service operated by the Pan American Sanitary Bureau and financed by the Organization of American States. The Center is dedicated to the prevention, control and eradication of foot-and-mouth disease in the Americas. Besides its diagnostic and consultant services to governments, the Center conducts training courses for technical personnel from the various Latin American republics. There have been an average of two training courses held each year since the Center was inaugurated, the courses being of two or three months' duration. In addition, at any given time, the Center is host to three or four long-term trainees who are received for periods of six to twelve months.

The Pan American Zoonoses Center, Azul, Argentina, offers training services on human and animal aspects of the zoonoses to several Latin countries. Aided by funds from the Pan American Health Organization and the World Health Organization, the center offers a three weeks' course in zoonoses control. In 1960, this was attended by 15 trainees from eight South American countries, on fellowships awarded by the Organization of American States.

South Central and Southeast Asia

Facilities for training in tropical medicine were well developed in India before the Second World War. For years, the health problems of the subcontinent had compelled the attention of the British authorities, and the response was to create an excellent medical service, universities and research institutes whose services were widely available. Upon achieving independence in 1947, the new government of India inherited the administration of these facilities and, subsequently, has maintained and developed them. Each year, India attracts from many foreign countries guest scientists whose aim is the study of tropical diseases. Some of the more outstanding training centers are cited below.

The Malaria Institute of India in New Delhi pursues a program of malaria and filariasis research and mosquito control. The training of medical officers, inspectors, entomologists and sanitary engineers in these techniques is a permanent part of the program.

Tropical medicine research at the Haffkine Institute, in Bombay, includes investigations of leptospirosis, tropical eosinophilia, cholera and tropical mycoses. In addition, much attention is paid to certain infectious diseases not usually considered tropical but which are major causes of morbidity in the country; these are typhoid fever, influenza, syphilis and rabies. There is a training program for technicians in medical laboratory technology. In 1958, 16 candidates were admitted to training.

The Indian Council of Medical Research sponsors a Clinical Research Unit, under the direction of the Calcutta School of Tropical Medicine, the aim and object of which is to undertake special studies on clinical problems in relation to diseases which are particularly prevalent in India. As part of this program, the Unit undertakes the training of medical men in clinical and experimental tropical medicine. Particular attention is paid to malaria, cholera and amoebiasis.

The Central Research Institute in Kasauli (in the Punjab) conducts a training course in the diagnosis, prevention and treatment of rabies. In 1958, 15 medical officers, both military and civilian, participated.

The Pasteur Institute of Southern India at Coonoor (Madras State), in 1958, served as a place of venue for the International Training Course on Public Health Laboratory Techniques for Virus and Rickettsial Diseases. Basic techniques for the study of arthropod-borne virus diseases, rabies, poliomyelitis, influenza, Q fever and other rickettsioses are explained and demonstrated. In 1958, 15 participants from 13 countries in the Western Pacific, Southeast Asia and the Eastern Mediterranean region attended. The course was sponsored by the World Health Organization.

In Ceylon, a small number of medical officers are regularly selected for post-licentiate training in the University of Ceylon, with six months' training in general medicine and surgery leading to the Diploma in Tropical Medicine & Hygiene (D.T.M.&H.-Cey.). In 1959, four officers were selected for this training.

The Institute of Hygiene of the University of the Philippines, in Manila, has in-service training facilities which include filaria work, malaria control, and public health nutrition and health education. In addition, lectures are given on school health, mental hygiene and statistical methods.

In Taiwan, the Malaria Research Institute, near Kaohsiung, provides training in the control of malaria and other arthropod-borne diseases. The United States Naval Research Unit Number Two (NAMRU-2) in Taipei has training programs in various disciplines for postgraduate students and accepts many from other countries of South Central and Southeast Asia.

In Thailand, the Malaria Control Training Center, Chiengmai, provides training in malaria control at the practical level.

In Singapore, some training at the postgraduate level is offered in parasitology and bacteriology by these departments in the Faculty of Medicine of the University of Singapore.

Training courses in parasitology, virology and infectious diseases form part of the activities of the Institute of Public Health in Tokyo, Japan.

Oceania

There is little centralized training in tropical diseases in Oceania. That public health training courses for health workers other than assistant medical officers (including mosquito and/or malaria control staff) in the various territories are desirable received stress at the Twentieth Session (1959) of the South Pacific Commission.

Expeditions to the New Zealand Island Territories (Western Samoa, Cook, Niue and Tokelau) are regularly organized, during the long vacation of the University of Otago Medical School in Dunedin, New Zealand, for those scientific personnel who may be interested in specific island medical problems, whether or not these represent "tropical diseases."

The Central Medical School in Suva, Fiji, trains native medical practitioners (now called assistant medical officers). Emphasis, of course, is on medical problems of local origin, whether or not they are "tropical medicine." For more advanced medical training, recourse must be had to one of the four medical schools in Australia or to the school in New Zealand.

In the past, training of technical staff for specific problems of endemic disease control has been done in direct connection with each program, a procedure that is likely to continue with any future programs.

Training Activities of the World Health Organization

An account of tropical medicine training programs would be incomplete without some mention of the activities of the World Health Organization in this regard. Training of medical and paramedical personnel, especially in connection with specific programs or needs, has long been a major category in the work of WHO. In recent years the leadership of WHO in the establishment of malaria eradication programs on a global basis is well known. It is apparent that the training of most routine personnel for a program of this scope must be in the hands of the participating governments. However, key scientific personnel have not always been available to staff specific projects, and WHO has assisted materially in this respect, both by making training fellowships available and by supplying syllabuses and staff to help in the teaching at the various international and regional malaria eradication training centers which have been established throughout the world.

In addition to malaria eradication, WHO has sponsored inter-regional training courses in other specific diseases, such as schistosomiasis (Cairo, 1958) and public health laboratory techniques for virus and rickettsial diseases (Coonoor, India, 1958).

In this connection, credit should also be given to WHO for the establishment of Demonstration and Training Centers for Tuberculosis, which have been established and maintained in several cities of Burma, India, Pakistan and Syria.

Present Financial Support and Sources of Funds

Considering the limited array of field-training programs in tropical medicine which are available to United States students, there is remarkable diversity to be found in their various systems of funding.

Private funding has been and is, currently, successful. For example, third and fourth year students of medicine at Columbia University have, since 1950, been offered an elective field-course in clinical medicine which they may pursue in several countries of West Africa or the Caribbean area. Until 1948, all travel expenses were carried entirely by the student, although the host institution or hospital in the tropical country provided per diem support. In recent years, Public Health Service grant money has been made available to help defray that part of the costs previously borne by the students.

With regard to contributions in this category made by private foundations, figures are available from the China Medical Board of New York, Inc., for the support of the Louisiana State University Fellowship Program during the early years of its existence. The Board spent a total of $119,908.65 to support this program for the three and one-half year period from 1 May

1955 to 31 December 1958. Of this amount, $76,635 represented transportation costs and per diem allowances for 70 group-fellowship fellows; $25,673 was spent for per diem and transportation for the 4 special fellows, 3 consultants and administrative staff. The remainder of the sum was for overhead, equipment and miscellaneous expenses. Beginning in September 1958, a grant was secured from the National Institute of Allergy and Infectious Diseases to continue the support of this program. As of 1 April 1959, there was expended on this program from its inception approximately $189,700 (±$500), representing an average cost of approximately $1,570 per individual, including all overhead and administrative costs.

Finally, there is some interest in presenting, broadly, some figures with regard to the financing of the new program for International Centers on Medical Research and Training (ICMRT). There have been many instances of United States universities effecting liaison with educational institutions in some of the more underdeveloped countries, but these arrangements have usually been supported by resources available to the university or by government or private foundation funds. Moreover, the liaison is characteristically directed toward the development of teaching methods and facilities. The establishment of the ICMRT grants, on an institutional basis to promote medical research, represents an innovation.

At present, the details of each ICMRT grant are fitted to the particular requirements of the schools involved. In general, the amounts of funds available to each project have been of the order of magnitude of 1 to 2 million dollars, distributed over four or five years. It is understood that such programs are conceived on a continuing basis.

SUMMARY AND CONCLUSIONS

In the United States, tropical medicine is largely identified with parasitology, and academic programs, including training programs, are apt to include little of the former and much of the latter. Because the number of clinical cases of tropical diseases is limited in the United States, the best sources of training in tropical medicine are those medical schools (a) which are located within one of the metropolitan port cities, the hospitals of which attract annually a number of tropical disease patients from other countries, and (b) which are fortunate enough to enjoy the teaching services of professional men qualified to recognize and utilize in training programs such material as may be available.

Certain schools, because of geographic position, tradition or the interests of current staff members, are in a favorable position to provide training in tropical diseases. These include the School of Medicine in San Juan, Puerto Rico, the Tulane University Medical School and the Louisiana State University Medical School in New Orleans, Louisiana, the College of Physicians and Surgeons of Columbia University, New York, the Harvard School of Public Health, and the Schools of Medicine of the University of California in San Francisco and Los Angeles.

In few of these schools are tropical medicine training facilities well developed. In the schools in New Orleans and at Harvard tropical medicine is accorded departmental status. Students at Columbia are given the choice of a field elective in tropical medicine which takes them to the Caribbean area or to West Africa for field training.

Because the United States possesses only restricted territorial interests in the tropics, the natural or political demand for field training in tropical diseases are quite limited. The two principal private laboratories (the Liberian Institute in Harbel, Liberia, and the Gorgas Memorial Laboratory in Panama) do not, as a regular procedure, provide training facilities, although the Gorgas Laboratory in recent years has been cooperating with the program of Louisiana State University fellowships in tropical medicine. This last program is, at present, the most developed of training programs available to scientific personnel in the United States. Under it, teachers and research workers in disciplines relating to tropical medicine are offered training tours of the Caribbean or Central America, lasting two months and permitting the participant to familiarize himself with local research activities and view clinical cases characteristic of the areas visited.

The institution in 1960 of the program of International Centers for Medical Research and Training, in response to the International Health Research Act of 1960 (PL 86-610), will provide expanded opportunities for international medical research programs. It is anticipated that much of this work, which is intended to respond to the medical needs of the cooperating countries, will be classified as tropical medicine and will entail training programs as necessary adjuncts. United States workers can hope to profit thereby.

Governmental support of training in tropical medicine has been largely confined to the program of training grants in tropical medicine and parasitology, which was begun late in 1957. Financial support for this part of the total training grant program has increased from an initial $128,941 in 1957 to $1,024,782 in 1961, and the number of grantees from 4 in 1957 to 25 in 1961. Further increases may be anticipated; the limiting factor in the support of this program is said to be the amount of funds available. However, it must be considered that the support for parasitology has undoubtedly outweighed support for tropical medicine in this program. Evidence collected elsewhere in the report of this survey would indicate that, on the basis of the interest expressed in this discipline, a program limited to tropical medicine alone would perhaps not have been the subject of continuous expansion over the years.

In contrast to the limited training facilities which are enumerated here as available to United States nationals, the foreign training programs are extensive and reflect the needs imposed by colonial administrative responsibilities. In Great Britain, and to a certain extent in France, tropical medicine is the object of a government career service. The Portuguese government supports research teams in many of its overseas colonies, as well as two permanent research laboratories, all of which may serve in a training capacity. The fate of research and training in the Republic of the Congo (former Belgian Congo) remains in considerable doubt. Before independence was granted to this colony, Belgium supported considerable research activity in tropical medicine. The research laboratories, supported by private foundation and state funds, and the state medical services, offered wide opportunities for the acquisition of training in tropical medicine. Training opportunities in those European countries which lack colonies are more restricted and ill-defined and tend to resemble the arrangements which have been made in the United States.

A list of research laboratories which presumably offer in-service training in tropical medicine in the Union of Soviet Socialist Republics is given. The list cannot pretend to exhaust the opportunities available to the Soviet scientist in this regard, since training in epidemiologic science of a local character is extensive in this country and, as is well known, such knowledge and experience can be quickly applied when it is necessary to cope with analogous problems in the tropics.

Latin America has few tropical medicine training centers. Those which are relatively well known at present are also of recent establishment. Those in Venezuela and Mexico serve primarily the national interest. The Tropical Medicine Institute in Brazil, on the other hand, attracts scientists from all of the South American countries. Mention is made also of certain centers which provide training in tropical diseases of veterinary interest.

The area of South Central and Southeast Asia has been little developed, with the exception of India, with regard to medical training. There are, however, certain outstanding centers, which are named, and which provide training in specific diseases or for specific epidemiologic programs.

There are no tropical medicine training centers in Oceania. Key scientific personnel for research programs in this area invariably are recruited from New Zealand, Australia, France or the United States.

The World Health Organization has long engaged in training programs to provide staff for specific projects. The program of global eradication of malaria has stimulated training in this field, in many centers located around the world. In addition, training in tuberculosis, virus diseases and schistosomiasis has been supported by WHO.

In the United States, funding of training programs in tropical medicine has been left largely to the private sector, meaning either the individual participant or the private foundations. In recent years, funds from the Public Health Service have been made available for this activity, *pari passu* with Congressional awareness of the importance of tropical medicine practice and research to the interests of the United States.

Chapter 18

Career Opportunities and Incentives

Cecil M. Wootton

The purpose of this section is to explore the career opportunities in the field of tropical medicine and its allied paramedical sciences. Some of the information presented here has been derived from other portions of the report and some has been compiled for the first time.

Mechanisms for a career in this field have always been limited in the United States. Interest in tropical medicine in this country had its main inception in the Spanish American War. The legacies from that war provided small tropical protectorates which in turn offered favorable circumstances for experience in tropical medicine. It was mainly the military physician who was in a position to profit from this situation. Later a considerable number of commercial concerns began to operate in the tropics and some of these corporations instituted medical care and preventive medicine programs. However, opportunities in the field in this country have never compared with those in the European countries which have had extensive colonial interests in the tropics.

The British Colonial Medical Service was a well-organized, well-integrated body of devoted individuals under civil authority and direction. It operated extensively in many tropical areas over a long period of years and provided unequaled opportunities for physicians and a limited number of paramedical personnel to gain tropical experience. In India, colonial medicine was under the Indian Medical Service, a military organization staffed for the most part by British citizens.

The French Colonial Medical Service was a military organization staffed by medical officers of the French Army. It was an effective agency for advancing public health in the French colonies and in contributing materially to research in the field of tropical medicine. In 1944, the French Government created the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) which was designed to provide a career service for scientific personnel in 21 different disciplines for overseas research. The medical science categories include entomology and helminthology. Through arrangements with the newly independent states, some of these people have continued their work in the tropics.

In Portugal, the medical service for the colonies is under the Overseas Ministry. Appointment is made for a five-year period, of which one year is probationary. The appointment is reconfirmed every five years so that in effect tenure of office is permanent. Remuneration consists of base pay plus allowances which vary with the cost of living in the colony. Home leave of 6 months is granted every 4 years; in addition, the officer is permitted 30 days local leave each year.

Medical care, public health and medical research in the former Belgian Congo were in the hands of Belgian physicians who operated in a civilian status. In addition to official government activities in this field, a large charitable organization, Fonds Reine Élisabeth pour l'Assistance Médicale aux Indigènes du Congo Belge (FOREAMI) was active in promoting and supervising medical care and preventive medicine programs.

With an increasing number of colonies receiving an independent status, tropical medicine opportunities in the European countries are dwindling rapidly. In the British sphere, the Indian Medical Service was disbanded. The Colonial Medical Service has been markedly restricted thus creating troublesome problems for career personnel who have had long service overseas. The position of these people has been changed from one of security to one of insecurity. The plight of some 21,000 Overseas Civil Service officers having appointments from the Colonial Office or the Crown Agents led to the issuance in late 1960 of a white-paper analyzing the situation. The British Government has offered ten-year agreements to most Colonial territories providing for the assumption of the major costs in maintaining officers on duty, thus furnishing assistance to newly independent countries during their transition period.[1]

Some direct measure of relief is offered in the case of British research workers in the tropics. A new organization, the Tropical Medicine Research Board, has been established to assume the responsibilities heretofore exercised by the Colonial Medical Research Committee.[2] It is anticipated that this Board under the Medical Research Council will provide financing and tenure of office for research workers in tropical areas. It is hoped by this arrangement that it may be possible to produce a career-structure which will command the confidence of medical research workers and take advantage of the vast research opportunities in the tropics.

The situation in the former Belgian Congo is even more grim than in Britain and the repatriated medical personnel are not only faced with loss of career opportunities but are finding it difficult to locate positions in the home country or elsewhere.

The position with regard to personnel in the former French Colonial Medical Service is somewhat better for the reason that the major portion were military officers and were thus reabsorbed into the military establishment.

It will thus be seen that the changing political picture in much of the tropical world has had a major impact on careers in tropical medicine. At present, opportunities are diminishing rapidly. This state of affairs may not persist, however. The newly independent states are woefully lacking in medical and paramedical personnel. Out of pride they may not wish initially to take advantage of the services of non-nationalists. However, this feeling will probably evaporate eventually and outside aid will be welcomed until such time as the nations themselves are able to provide their own qualified personnel. This period of transition will be a difficult one. As Gear has pointed out:

> "Medicine at its best is something finer than an exercise of technical skill. In the medicine being introduced into Africa and other developing regions this broader duty is too often neglected. Yet here the need is more desperate than in the older lands where all upbringing supports understanding of such social responsibilities."[3]

International Cooperation Administration

Since the International Cooperation Administration (ICA) is one of the United States agencies responsible for administering technical assistance overseas, it was decided to make a review of the personnel in the public health office of that agency to present in this report. Assistance in this part of the survey was requested from the Office of Public Health of ICA.

ICA and the other agencies which gave technical assistance to the underdeveloped countries were considered temporary until 1 July 1955 when ICA was officially established by Executive Order as a semi-autonomous unit within the Department of State to administer part of the mutual security program. As of 31 March 1961,[4] ICA had a total of 11,078 employees, 2,012 of whom were in the Washington office, 106 overseas personnel temporarily stationed in Washington, and 8,960 employees in the field. ICA cooperated with approximately 75 countries and dependent territories through offices overseas, usually called United States Operations Missions, of which 45 were cooperating in health work. The objectives of the technical assistance health programs have not been to determine or administer foreign health programs but rather to work with other countries through consultation in the organization of health services, in developing health facilities by establishing new ones or rehabilitating existing ones, by assisting in environmental sanitation programs for the improvement of water supply and sewage disposal systems, and by introducing the concepts of preventive medicine where needed. ICA personnel has been cooperating on a world-wide basis in campaigns for the control and eradication of specific diseases, such as cholera, tuberculosis, malaria, etc., in the underdeveloped countries.[5]

In general, the health personnel overseas included physicians, nurses, sanitation experts, educators and supplemental personnel. The staff might vary in number and specialty according to the needs of the programs of the host country. ICA advisors overseas gave technical assistance by teaching, training and advising peoples of those underdeveloped countries which were in need of more trained health personnel. To date, thousands of public health workers, including physicians, nurses, sanitary engineers, health educators and others, have been trained at the request of the host countries with which ICA was cooperating. In addition, from 1955 to 1959 under the bilateral health program, 1,734 foreign national technicians have been brought to the United States for advanced studies and health training in the universities, medical centers and public health offices.[6]

Data presented in this section are based on information obtained from the Biographic Register of the Department of State, American Men of Science, ICA staffing patterns, and rosters of ICA health personnel overseas provided by its public health office in Washington and listed by country for the years 1955-1960 inclusive. The figures presented in this report are based on data concerning personnel as listed in the rosters at the end of each of the six years and includes only the personnel of those countries which are covered in this survey.

For purposes of this study, ICA health personnel has been divided into nine categories although in many instances there are overlapping titles. All personnel with the M.D. degree were counted as physicians, some of whom were medical and health educators, hospital administrators and malaria advisors as well as medical officers and public health physicians. Under engineers were included not only sanitary, industrial hygiene, and civil engineers but also malaria specialists and educators. A number of sanitarians were malaria specialists as well. Under administrators were included health and hospital administrators, business managers, executive officers, program analysts and administrative assistants. Included under "other" in the professional category were dentists, veterinarians, pharmacists, dietitians, serologists, bacteriologists, microbiologists, physiotherapists, vocational rehabilitation specialists, academic professors (under university contracts), nutritionists, laboratory directors and advisors, anthropologists, geologists, architects, statisticians and medical librarians. The non-professional group was composed of well-drillers, technicians, supply officers, maintenance specialists and clerical help.

Data by category for distribution of personnel by age groups and by professional and academic degrees were mainly collected from the Biographic Register and are presented in tables in this report. Data for salaries from 1955-1958 were based on grades as given in the Biographic Register. ICA staffing patterns provided the data on actual salaries for 1959 and 1960.

A large percentage of the number of personnel appearing in the "data not available" columns represented university contract personnel. Contracts with universities in the United States were sponsored by ICA for personnel to work with foreign institutions in educational fields related to public health. Over the six-year period, 94 of the 700 employees were engaged under this type of contract. It was not considered feasible to complete the data as these names did not appear in the Biographic Register or on the ICA staffing patterns. Background material on some M.D.'s and other professional personnel was found in the American Men of Science. No further effort was made to collect additional data on the ones not listed in these sources. A few of the contract personnel subsequently joined the regular staff of ICA.

In addition under "data not available", 32 of the 45 new employees in 1960, not including contract personnel, did not appear in the current Biographic Register, and therefore data on professional and academic degrees were not included in this survey. However, dates of birth and salaries were given in the ICA staffing patterns for 1959 and 1960.

Since three-quarters of the Washington health personnel over the six-year period represented administrative and secretarial employment, no attempt was made to collect detailed data on salaries, age or academic degrees of these persons.

ICA health personnel in survey areas

A request was made to the Office of Public Health, ICA, for the number of health personnel overseas by country and by category from 1955 through 1960. Rosters listing the names and titles of United States ICA health employees and contract personnel by country for these years were provided. Only those countries included in the areas of this survey were selected and the figures therefore do not represent the total number of ICA health employees overseas at the end of each calendar year. Lists of personnel in the Office of Public Health, Washington, were also made available.

Table 114 shows the total number of ICA health personnel in four of the five survey areas for the period 1955 through 1960. There was no health personnel listed for Oceania. The total number of personnel decreased from 350 in 1955 to 315 in 1960. A number of individuals whose name appeared only on the 1955 roster had already served tours of duty under former technical assistance programs and were transferred to ICA when it became officially established in 1955. In the Caribbean, Central and South America, health personnel decreased from 141 in 1955 to 102 in 1960 while in South Central and Southeast Asia, it increased from 93 in 1955 to 136 in 1960. In Southwest Asia, a sharp drop from 70 in 1955 to 47 in 1956 with a further decrease to 33 in 1960 can be noted. The number of personnel in Africa remained relatively constant with 46 in 1955 and 44 in 1960. Ethiopia had the largest number of health personnel in this area with an average of 22 persons over the six-year period.

In the Caribbean, Central and South America the number of personnel decreased from 1955 to 1960 in more than half of the countries listed. Uruguay and Venezuela did not appear on the 1960 list. Brazil had the highest number with an average of 18 persons over the six years. In South Central and Southeast Asia, the number of personnel remained relatively the same from 1955 to 1957. In Pakistan, the number increased from 12 in 1957 to 29 in 1958 and in Indonesia from 21 in 1958 to 36 in 1959. Both countries showed a decrease in 1960 involving primarily contract personnel. India showed a steady increase of personnel over the period. Indonesia exceeded the other countries with an average of 24 persons. In Southwest Asia, Israel appeared on the 1955

Table 114. Total number of ICA health personnel in survey area and Washington, D. C., at end of calendar years 1955-1960

AREA	NUMBER OF COUNTRIES INVOLVED	1955	NUMBER OF COUNTRIES INVOLVED	1956	NUMBER OF COUNTRIES INVOLVED	1957	NUMBER OF COUNTRIES INVOLVED	1958	NUMBER OF COUNTRIES INVOLVED	1959	NUMBER OF COUNTRIES INVOLVED	1960
Caribbean, Central and South America	20	141	18	140	17	130	17	117	19	101	19	102
Africa	4	46	3	45	3	48	3	45	4	39	4	44
Southwest Asia	6	70	4	47	4	42	4	35	3	37	3	33
South Central and Southeast Asia	10	93	10	97	11	98	11	117	11	142	11	136
Totals	40	350	35	329	35	318	35	314	37	319	37	315
Washington office		20		23		20		34		37		49

list only and its health program was terminated in 1957. Jordan was included in the 1955 roster but did not appear on the 1956 list. In 1956, Jordan's personnel were temporarily assigned elsewhere, presumably because of the political crisis. Afghanistan appeared only on the 1955 and 1956 rosters although its health program was not terminated until 1959. Personnel in Lebanon decreased from 8 persons in 1955 to 1 person in 1958 when the program was terminated. Iraq showed a progressive decrease in the number of personnel until the program was terminated in 1959. Iran had the greatest number of personnel in this area with an average of 26 for the six years.

The personnel of the Office of Public Health, ICA, Washington, increased from 20 in 1955 to 49 in 1960. In 1960, the staff consisted of physicians, nurses, engineers, malaria specialists, a health educator, and administrative and secretarial assistance.

Table 115 gives a breakdown of the ICA health personnel by category in the survey areas at the end of each of the calendar years 1955 through 1960. The number of physicians, sanitarians, educators, and other professional and non-professional personnel remained relatively the same over the six-year period. The number of nurses decreased from 79 in 1955 to 65 in 1960 and the engineers dropped from 71 in 1955 to 46 in 1960. Admin-

Table 115. Total number of ICA health personnel by category in survey area at end of calendar years 1955-1960

	PHYSICIANS	NURSES	ENGINEERS[1]	SANITARIANS[2]	ADMINISTRATORS	HEALTH EDUCATORS[3]	MALARIA PERSONNEL	OTHER: PROFESSIONAL	OTHER: NON-PROFESSIONAL	TOTALS
1955	51	79	71	22	40	22	17	32	16	350
1956	48	75	55	19	40	21	16	34	21	329
1957	50	75	46	24	30	26	18	32	17	318
1958	51	64	41	26	30	29	20	35	18	314
1959	48	63	43	29	25	29	29	34	19	319
1960	47	65	46	24	25	26	40	29	13	315
Total number of personnel from 1955-60	114	148	104	42	74	48	53	70	47	700

[1] Ninety per cent of total engineer personnel were sanitary engineers.
[2] Sanitarians listed as malaria personnel are included as sanitarians in above breakdown.
[3] Not including educators with M.D. degree and nurse educators.

istrative personnel dropped from 40 in 1955 to 25 in 1960. A sharp increase from 17 in 1955 to 40 in 1960 was evident in the number of malaria specialists.

The total number of personnel listed on the rosters over the six-year period involved 700 persons, 148 (21 per cent) of whom were nurses; 114 (16 per cent) physicians; 104 (15 per cent) engineers; 74 (11 per cent) administrators; 70 (10 per cent) other professional personnel; 53 (8 per cent) malaria personnel; 48 (7 per cent) educators; 47 (7 per cent) non-professional personnel; and 42 (6 per cent) sanitarians.

As indicated above, there was some overlapping of categories, such as nurse educators and medical educators holding an M.D. degree who were included under their respective professional categories, as well as sanitarians who were also malaria experts. No individual was included under more than one category.

Methods of recruitment

Other federal agencies lent technical support to ICA health programs through assignment of trained health staff to work directly under ICA supervision either on a reimbursable detail or by interagency agreements. The Public Health Service of the Department of Health, Education, and Welfare was the predominant participating agency in the ICA health programs. The public health units of the overseas missions, as well as the Washington office, were staffed in part by commissioned officers of the Public Health Service and by civilian personnel employed directly by ICA. Personnel was also secured for the overseas missions through contracts with various universities in the United States and by employment of foreign nationals hired overseas.

Names of personnel on ICA rosters were checked against the Public Health Service lists of commissioned officers made available by the Division of Commissioned Officer Personnel, PHS, for each of the six years of the survey. Table 116 indicates the distribution of health personnel in relation to the method of recruitment. From 1955 to 1960, ICA direct employment in the survey areas rose from 151 to 196, while the number of participating personnel decreased. Over the six-year period, the ICA health personnel overseas by source was 347 (50 per cent) direct-hire, 259 (37 per cent) commissioned officers of the Public Health Service, and 94 (13 per cent) contract personnel.

Of the 114 physicians over the six-year period, 54 (47.3 per cent) were commissioned officers of the Public Health Service. Of the 148 nurses over the same period, 80 (54 per cent) were commissioned officers. Fifty-three (50.9 per cent) of the 104 engineers, 18 (42.8 per cent) of the 42 sanitarians, 21 (39.6 per cent) of the 53 malaria personnel, and 18 (37.5 per cent) of the 48 educators were in the Commissioned Corps.

The Washington office had 3 commissioned officers in 1955 and 7 in 1960. Employees hired directly by ICA increased from 17 in 1955 to 42 in 1960. The total number of Public Health Service officers over the six-year period was 12.

Distribution by age group

Dates of birth for personnel included in this survey were taken from the Biographic Register of the Depart-

Table 116. Total number of ICA health personnel in survey area and in Washington office at end of calendar years 1955-1960 in relation to method of recruitment

	OVERSEAS MISSIONS					WASHINGTON OFFICE			
	DIRECT-HIRE	PHS (REGULAR)	PHS (RESERVE)	CONTRACT	TOTALS	DIRECT-HIRE	PHS (REGULAR)	PHS (RESERVE)	TOTALS
1955	151	47	117	35	350	17	3		20
1956	151	37	108	33	329	19	4		23
1957	142	37	112	27	318	19	1		20
1958	148	23	104	39	314	26	7	1	34
1959	170	22	91	36	319	31	8		39
1960	196	24	76	19	315	42	7		49
Total number of personnel from 1955-60	347[1]	259		94	700	67	12		79

[1] Included under ICA "Direct-Hire" are a small number of personnel on detail from participating agencies other than the Public Health Service, such as the Children's Bureau of the Department of Health, Education, and Welfare.

Table 117. Distribution by age group of ICA health personnel by category in survey area, 1955-1960, inclusive

	1955									
	20-24	25-29	30-34	35-39	40-49	50-59	60-69	70 OR OVER	DATA NOT AVAILABLE	TOTALS
Physicians		4	6	6	14	13	4	1	3	51
Nurses		2	5	14	35	18	1		4	79
Engineers		3	5	14	26	16	6		1	71
Sanitarians			6	2	9	1	1		3	22
Administrators		1	3	8	19	6			3	40
Health educators			3	10	4	3			2	22
Malaria personnel			3	2	10	1	1			17
Professional		2	3	3	11	9	1		3	32
Non-Professional				1	4	3			8	16

	1956									
	20-24	25-29	30-34	35-39	40-49	50-59	60-69	70 OR OVER	DATA NOT AVAILABLE	TOTALS
Physicians		2	8	8	13	9	4	1	3	48
Nurses		1	7	14	32	16	3		2	75
Engineers	1	2	3	7	23	11	7		1	55
Sanitarians		1	5	3	5	2			3	19
Administrators		1	5	6	19	4	2		3	40
Health educators			3	7	6	3	1		1	21
Malaria personnel			4	3	8	1				16
Professional		1	1	5	9	11	1		6	34
Non-Professional			1	1	7	4			8	21

	1957									
	20-24	25-29	30-34	35-39	40-49	50-59	60-69	70 OR OVER	DATA NOT AVAILABLE	TOTALS
Physicians			5	6	17	16	2	1	3	50
Nurses		1	4	13	34	17	3		3	75
Engineers		5	2	3	20	7	8		1	46
Sanitarians		1	5	7	5	2	1		3	24
Administrators			3	4	10	8	3		2	30
Health educators			4	11	7	3			1	26
Malaria personnel			3	5	8		1		1	18
Professional		1	1	5	6	14	1		4	32
Non-Professional			1	1	6	6			3	17

	1958									
	20-24	25-29	30-34	35-39	40-49	50-59	60-69	70 OR OVER	DATA NOT AVAILABLE	TOTALS
Physicians			4	5	18	16	1	2	5	51
Nurses			1	11	28	17	3		4	64
Engineers		5	1	1	14	10	9		1	41
Sanitarians		1	6	8	4	2	1		4	26
Administrators				4	16	7	1		2	30
Health educators			7	8	10	3			1	29
Malaria personnel			3	7	8	2				20
Professional			3	3	10	11	3		5	35
Non-Professional			2		5	5			6	18

	1959									
	20-24	25-29	30-34	35-39	40-49	50-59	60-69	70 OR OVER	DATA NOT AVAILABLE	TOTALS
Physicians			2	2	17	18	3	1	5	48
Nurses			2	13	31	10	4		3	63
Engineers		2	2	3	17	13	5		1	43
Sanitarians		1	6	11	5	3	1		2	29
Administrators		1	1	1	11	7	1		3	25
Health educators			5	6	13	4	1			29
Malaria personnel		2	4	9	8	5			1	29
Professional			2	5	9	8	5		5	34
Non-Professional			2	1	5	4	1		6	19

	1960									
	20-24	25-29	30-34	35-39	40-49	50-59	60-69	70 OR OVER	DATA NOT AVAILABLE	TOTALS
Physicians			1	7	13	18	7		1	47
Nurses			2	9	29	17	7		1	65
Engineers		1	1	4	19	15	5		1	46
Sanitarians		1	5	8	6	3	1			24
Administrators		1		2	12	6	2		2	25
Health educators			2	9	11	2	2			26
Malaria personnel		2	5	11	10	10	1		1	40
Professional			2	4	8	7	3		5	29
Non-Professional			1	1	5	2	2		2	13

ment of State, American Men of Science, and the December 1960 ICA staffing patterns. Table 117 shows the age distribution of ICA health personnel by category in the survey areas for the years 1955-1960 inclusive. In 1955 and 1956, approximately two-thirds of the physicians were over 40 years of age and in 1957-1960 more than three-fourths were over 40. In each of the six years approximately three-fourths of the nurses were over 40, one-half of whom were in the 40-49 age group. In 1955, two-thirds of the engineers were over 40 years of age and in the remaining five years more than three-fourths were over 40. With the exception of 1955, more than half of the sanitarians were under 40 years of age. Of the administrators over the six-year period, more than two-thirds were over 40 years of age. In 1955, 1957 and 1958 more than one-half of the health educators were under 40 years of age, while in 1956, they were evenly divided above and below age 40. In 1959 and 1960, more than one-half of the educators were over 40. With the exception of the year 1955, the number of malaria personnel was divided equally above and below age 40. Three-fourths of the "other" professional and more than three-fourths of the non-professional personnel were over the age of 40.

Over the six-year period, the greatest number of personnel in all categories was in the 40-49 age group with the second largest number in the 30-39 age group. The following tabulation illustrates the percentage of personnel in each of these two groups.

Year	*Total number of personnel*	*Age 40-49*	*Per cent*	*Age 30-39*	*Per cent*
1955	350	132	37.7	94	26.8
1956	329	122	37.0	91	27.6
1957	318	113	35.5	83	26.1
1958	314	113	35.9	74	23.5
1959	319	116	36.3	77	24.1
1960	315	113	35.8	74	23.4

Professional and academic degrees

Reference was made to the Biographic Register of the Department of State and to the American Men of Science to collect data for tabulating the educational levels of ICA health personnel. Position classification of certain types of personnel is not always in accordance with the amount of education. For example, certain personnel who carried the title of "sanitary engineer" were classified under this category even though their biographic sketches showed only college attendance with no academic degree. This applied also to architects who were included under the "other" professional category. A few of these listed no degree but had several years of college or university education.

Table 118 gives the distribution of professional and academic degrees for 595 of the 700 ICA health personnel

Table 118. Professional and academic degrees held by ICA health personnel by category in survey area, 1955-1960

	BACHELOR'S DEGREE	MASTER'S DEGREE	DOCTORAL DEGREE	M.D. ONLY GIVEN	COLLEGE BUT NO DEGREE	NO DEGREE	DATA NOT AVAILABLE	TOTALS
Physicians[1]	22	44	15	33				114
Nurses	41	76	2		5[2]	3[3]	21	148
Engineers[4]	47	34	3		4		16	104
Sanitarians	14	14	1		4	2	7	42
Administrators	29	16	1		13	5	10	74
Health educators		30	11				7	48
Malaria personnel	9	13	17			1	13	53
Professional	11	16	27		3	1	12	70
Non-Professional					3	25	19	47

[1] Other than the M.D. degree.
[2] Other than the basic professional nursing education.
[3] Only RN was given.
[4] Ninety per cent carried the title of "sanitary engineer".

by category employed during the period 1955 through 1960. It was not possible to obtain data from the above sources on 105 employees.

The highest degrees for physicians other than the M.D. are included. For 33 of the 114 physicians, it was not possible to obtain other degrees. Fifteen held other doctoral degrees of which 6 were doctors of public health, the remainder being Ph.D. or equivalent. Forty-five were also MPH.

In addition to the basic professional nursing education possessed by all of the 148 nurses, 2 held doctoral degrees, 41 had bachelor's degrees and 76 held master's degrees. Of the latter number, 18 were MPH. Five nurses had received some college education and for 3 only RN was given. It was not possible to obtain data on the degrees of 21 nurses.

Of the 104 engineers, 90 per cent of whom carried the title of "sanitary engineer", 47 had bachelor's degrees, 34 master's degrees of which 7 were MPH, 3 held a doctoral degree, 4 had some college work and for 16 information was not available.

Of the 42 sanitarians, 1 had a Ph.D., 14 held a bachelor's degree, 14 had a master's degree of which 8 were MPH, 4 had attended college, 2 had no academic degree and data for 7 were unknown.

In the administrative group of 74, 29 held bachelor's degrees, 16 had master's degrees and 1 held a Ph.D., 13 had attended college or business school, 5 listed no degree and information for 10 was not available.

Of the 48 health educators, all held a degree higher than the bachelor's; 30 held a master's degree of which 23 were MPH, and 11 held doctorates including Ph.D. and Ed.D. It was not possible to obtain data for 7 educators.

Of the 53 malaria personnel, 17 held doctoral degrees, 13 had master's degrees, 9 the bachelor's degree, 1 had no degree, and for 13 no data were available.

In the "other" professional group, 27 held a doctoral degree, 16 a master's degree, and 11 a bachelor's degree, 3 had had some college work, 1 gave no degree and information for 12 was not available.

In the non-professional category, 3 had had some college education, no degree was listed for 25, and data for 19 were not obtainable.

Of the total 700 personnel over the six-year period, 176 (25.1 per cent) held doctoral degrees; 199 (28.4 per cent) held master's degrees; 151 (21.6 per cent) held bachelor's degrees; 32 (4.6 per cent) had attended college; 37 (5.3 per cent) listed no degrees, and data for 105 (15 per cent) were not available. Of the total personnel, 114, or 16.2 per cent, held the MPH.

Salaries for ICA health personnel

It was not possible to obtain the exact salaries of ICA health personnel for the full six-year period. Data for salaries from 1955 to 1958 were based on salary grades as given in the Biographic Register of the Department of State. For 1959 and 1960 data were taken from ICA staffing patterns. It was decided to select only five of the nine categories to be used in the survey on salaries. Grades for ICA mission personnel are based on three of the Federal Government pay scales: International Cooperation Administration (ICA), Foreign Service Reserve (FSR), and Foreign Service Staff (FSS). Positions are classified on the basis of the job description and the general procedures used throughout the government for civilian service. The position classification staff of the Division of Personnel, ICA, had the responsibility of allocating the grades for each position in ICA missions. Positions of chief in the health divisions are generally classified as FSR 2-3 ($14,900-$17,030; $12,535-$14,665) or ICA 3-4 ($13,955-$15,255; $12,445-$13,955). Under a ruling of the Civil Service Commission, medical officers are paid at the top rate of the grade. Grades for positions of chief nurses and chief sanitary engineers are usually FSR 3-4 ($12,535-$14,665; $10,645-$12,445) and ICA 4-5 ($12,445-$13,955; $10,645-$12,145). Generally, a person newly assigned to one of these positions receives the minimum rate of the applicable grade with annual increases of one step.

Since the number of ICA health personnel involved per year in this survey was minute compared to the total number of physicians, nurses, etc., in the United States, no attempt has been made to compare ICA salaries with other professional groups. However, references are included as a matter of interest.

Table 119 gives the median salaries for ICA physicians, nurses, engineers, sanitarians and health educators in the total survey area for 1959 and 1960. The data were based on information recorded in the ICA staffing patterns for December 1959 and 1960. Table 120 gives the salary ranges for ICA physicians with the public health divisions overseas during the six-year period. In 1960, half of the 42 physicians were in the $12,000-$14,900 salary range and 16, or 38 per cent, were in the $15,000-$17,900 bracket. The median salary for 42 physicians in 1960 was $14,700.

Medical Economics, Inc., has conducted a continuing survey of earnings and expenses of some 3,199 cooperating physicians in the United States.[7] The report revealed that the 1959 median net earnings for male, self-employed physicians before income tax but after practice expenses was $22,100. The median tax deduction was $4,900. For self-employed specialists the 1959 median was

Table 119. Median salaries for ICA health personnel by category in survey area, 1959 and 1960[1]

	1959		1960	
	NUMBER OF PERSONNEL	MEDIAN SALARY	NUMBER OF PERSONNEL	MEDIAN SALARY
Physicians	41	$13,900	42	$14,700
Nurses	60	9,200	64	9,800
Engineers[2]	41	11,500	45	12,400
Sanitarians	25	8,800	24	9,600
Health educators	29	10,400	26	11,000

[1] Figures are rounded to the nearest hundred.
[2] In 1959, 35 of the 41 engineers were "sanitary engineers"; in 1960, 40 of the 45 engineers were "sanitary engineers". The remainder were industrial hygiene engineers.

$24,800 net earnings before taxes; the general practitioner's net earnings was $20,000 before taxes, while the comparable median figure for salaried, male United States specialists was $15,140. After taxes, the salaried man's median family income was $14,070 compared with $20,900 for the self-employed specialist. However, the salaried professional man had more benefits such as retirement plans, social security, paid vacation and sick leave, and sometimes health and life insurance. The median net earnings of salaried specialists before taxes in government, including federal, state and municipal agencies, was $13,800 while in private industry it was $19,100. In a preliminary study of salaries of scientists made by the National Science Foundation,[8] it was found that those having the medical degree and working in the field of medical science had a median salary of $13,000 in 1960. Those with the Ph.D. degree had a median salary of $12,000.

In Table 120, two-thirds of the 64 ICA nurses in 1960 are shown to have been in the $9,000-$11,900 salary range and 17, or 27 per cent, were in the $6,000-$8,900 range. The median salary for 64 nurses in 1960 was $9,800. Data obtained from the Public Health Service showed that public health nurses in official agencies in 1959-1960 earned an average annual salary of $4,600; nurse educators in hospital schools received an average of $4,500 and in collegiate schools, $5,200.[9] For those employed by the United States Civil Service in 1961, salaries for beginning public health nurses ranged from $5,355-$6,345 and those for public health nursing supervisors from $6,435-$7,425.[10] For commissioned nurses in the Public Health Service as of January 1958, salaries including base pay and subsistence allowance ranged from $3,242-$4,343 for a junior assistant (comparable to the rank of Ensign in the Navy) to $7,688-$12,395 for a director (comparable to a Captain in the Navy).[11]

Table 120 shows the salary ranges for engineers for the period 1955 through 1960. In 1960, 31 (69 per cent) of the 45 engineers were in the $12,000-$14,900 bracket and 10 (22 per cent) were in the $9,000-$11,900 category. Of these 45 engineers, 40 of whom were listed as sanitary engineers, the median salary was $12,400 in 1960. In the same National Science Foundation study mentioned above, the median salary for 3,548 sanitary engineers was found to be $9,000 in 1960. In an earlier report made by the Public Health Service,[12] median income of 3,825 sanitary engineers from principal employment was $8,300 in 1956-1957 varying with the type of employer. The median income for those employed by government was $7,800, business or industry $8,700; self-employed $14,200 and college or university faculty engineers, $7,200. However, within government, the median for federal civilian sanitary engineers was $8,800. The salary data for the Federal Government did not reflect the 10 per cent increase at that time.

As shown in Table 120, 15 sanitarians in 1960 were within the $9,000-$11,900 salary range and 8 were between $6,000-$8,900. The median salary in 1960 for 24 sanitarians was $9,600.

Table 120 indicates the salary ranges for health educators. In 1960, 14 fell within the $9,000-$11,900 bracket and the remaining 12 were divided equally between the $12,000-$14,900 and the $6,000-$8,900 salary ranges. The median salary for 26 educators in 1960 was $11,000. These figures do not include the nurse educators or those educators holding the M.D. degree.

In a 1959-60 study of colleges and universities both public and private, the Office of Education, Department of Health, Education, and Welfare reported on 11-12 month mean salaries for deans and faculty members in professional and graduate colleges.[13] In the colleges of medicine, the deans in clinical medicine received a mean

Table 120. Salary ranges for ICA health personnel in survey area, 1955-1960[1]

PHYSICIANS	OVER $18,000	$17,900-15,000	$14,900-12,000	$11,900-9,000	$8,900-6,000	DATA NOT AVAILABLE	TOTALS
1955			15	24	2	10	51
1956			17	23	2	6	48
1957			26	19		5	50
1958		2	26	15	1	7	51
1959		11	25	4	1	7	48
1960	3	16	21	2		5	47

NURSES	$14,900-12,000	$11,900-9,000	$8,900-6,000	DATA NOT AVAILABLE	TOTALS
1955		19	56	4	79
1956		22	49	4[2]	75
1957		20	52	3	75
1958	1	26	33	4	64
1959	2	29	29	3	63
1960	6	41	17	1	65

ENGINEERS[3]	$17,900-15,000	$14,900-12,000	$11,900-9,000	$8,900-6,000	$5,900 OR LESS	DATA NOT AVAILABLE	TOTALS
1955		4	50	14	1	2[4]	71
1956		4	42	7	1	1	55
1957		3	35	6	1	1	46
1958		10	23	6		2	41
1959	1	15	18	7		2	43
1960	2	31	10	2		1	46

SANITARIANS	$14,900-12,000	$11,900-9,000	$8,900-6,000	$5,900 OR LESS	DATA NOT AVAILABLE	TOTALS
1955		3	15		4	22
1956		1	14	1	3	19
1957		7	13	1	3	24
1958		9	11		6	26
1959		11	13	1	4	29
1960	1	15	8			24

	HEALTH EDUCATORS[5]				
	$14,900-12,000	$11,900-9,000	$8,900-6,000	DATA NOT AVAILABLE	TOTALS
1955		10	10	2	22
1956		13	6	2	21
1957	1	18	6	1	26
1958	2	17	9	1	29
1959	3	15	11		29
1960	6	14	6		26

[1] Data for 1955-1958 were based on salary grades as stated in Biographic Register of Department of State; data for 1959-1960 were based on information obtained from December ICA staffing patterns.

[2] Two nurses were on leave without pay for one year.

[3] Ninety per cent of the engineers were "sanitary engineers".

[4] One engineer was on a non-reimbursable basis.

[5] Medical educators holding the M.D. degree and nurse educators are not included.

salary of $19,640; professors $16,580; associate professors $12,260; assistant professors $10,110; and instructors $7,630. In preclinical medicine, professors averaged $13,500; associate professors $9,940; assistant professors $8,090; and instructors $6,490. In the schools of nursing, deans received an average of $9,890; professors $8,520; associate professors $7,420; assistant professors $6,270; and instructors $5,340. In the schools of engineering, deans received a mean salary of $13,900; professors $11,600; associate professors $8,630; assistant professors $7,380; and instructors $6,040.

Turnover of ICA health personnel

It was difficult to determine the actual turnover of health personnel without access to personnel records. The absence of names which appeared on previous roster lists did not necessarily indicate the separation of these personnel from ICA. Some names disappeared in one year and reappeared the next. Some of the personnel were transferred to a country outside the area of this survey; or stationed temporarily in Washington for training, reassignment or medical treatment; or serving with an ICA division other than public health at the end of the calendar year in question.

From the data collected, it is interesting to note that the names of 144 of the 350 health personnel on the list in 1955 appeared on the ICA staffing pattern at the end of 1960. However, not all of these personnel were assigned to the public health division in 1960. Of the 144 individuals, 107 had served with other technical assistance programs overseas prior to 1955. Almost one-half of the 83 new employees in 1956 were listed on the staffing pattern in December 1960.

In the Washington office, 20 of the 79 health personnel over the six-year period had tours of duty overseas, some earlier than 1955.

Additional benefits and allowances[14]

Foreign assignments are generally made for a minimum of two years duration in one foreign country but may be extended. After the initial tour of duty, transfer to another country is frequently possible.

Opportunity for in-service training is sometimes offered to selected employees. Language training is given where needed. Annual leave on the basis of years of federal service and sick leave are accrued. In addition, upon completion of a two-year tour of duty, home leave of 30 working days is granted to civilian employees provided they are being reassigned overseas. Transportation for the employee and his dependent family from their residence in the United States to the overseas post as well as shipment of household goods and personal effects are provided at government expense.

In addition to base salaries, certain allowances when applicable and varying with living conditions are paid to ICA employees while on overseas assignment. Rates for each post are determined by the Department of State.

A post differential of 10 to 25 per cent of base salary is allowed if the post is classified as a hardship station by the Department of State.

A post allowance is granted to an employee officially stationed where the cost of living is considered by the Department of State to be substantially higher than in Washington, D. C.

If living quarters are not furnished by the Federal Government, employees receive a housing allowance, the amount depending on the post, salary and dependency status of the employee.

An educational allowance is granted to provide adequate elementary and secondary education for an employee's children.

Other Opportunities in the United States and Abroad

In addition to the International Cooperation Administration, it is desirable to mention briefly a few national and international institutions and organizations which offer opportunities to personnel in the field of tropical medicine and public health.

The Federal Government

As pointed out in Chapter 12, the federal agencies involved in intramural research work in the field of tropical medicine are the Department of the Army, the Department of the Navy, the Public Health Service and its National Institutes of Health, the Veterans Administration and the Department of Agriculture. The professional and subprofessional personnel engaged in this type of research activity totaled 626 (211 and 415 respectively) or 11.6 per cent of the total Federal Government research personnel in all intramural medical and health-related research in 1958.

The principal agency of the Federal Government concerned with the health of the nation is the Public Health Service of the Department of Health, Education, and Welfare. Over 25,000 Commissioned and Civil Service personnel are employed in this Service. The Commissioned Corps is a professional career organization for physicians, dentists, sanitary engineers, nurses, scientists and other related personnel, and comprises both Regular and Reserve units. About 2,000 physicians are now on active duty with the Commissioned Corps. The three major areas of activity in which medical officers serve are in medical and hospital care, medical research, and preventive medicine and public health.[15]

In the international field, the Public Health Service, through the government technical assistance programs, is cooperating with health officials in other countries in providing professional guidance in the development and improvement of the local medical and health services. Commissioned officers have the opportunity of serving with various international organizations and committees both in an active and an advisory capacity.

Competitive examinations are held for candidates for the Regular Corps. Appointments are made by the President, by and with the consent of the Senate, while the officers of the Reserve Corps are appointed on behalf of the President by the Secretary of Health, Education, and Welfare. Candidates for the Regular Corps are usually commissioned in the three lower grades: Junior Assistant, Assistant and Senior Assistant. Experience and training determine the grades for commissioned officers in the Reserve Corps, and the number of personnel fluctuates according to the needs of the programs.

The Corps is similar to the Armed Services in regard to rank and tenure, pay and allowances. The rank of the Public Health Service officer is based on his professional training and experience and is equivalent in grade with those of the Armed Forces as follows:

Public Health Service	*Navy*	*Army*
Junior Assistant	Ensign	Second Lieutenant
Assistant	Lieutenant (jg)	First Lieutenant
Senior Assistant	Lieutenant	Captain
Full grade	Lieut. Commander	Major
Senior grade	Commander	Lieut. Colonel
Director	Captain	Colonel

Pay and allowances for officers of the Public Health Service are scheduled under the Career Compensation Act. Pay is based on cumulative years of service, rental (with and without dependents) and subsistence. Including subsistence and dependents, the pay scale indicates that under two years' service a junior assistant would receive approximately $4,200 a year; a senior assistant nearly $6,000; a senior approximately $8,000; and a director about $9,300. With over four years' service, the junior assistant grade with dependents and subsistence would be approximately $5,300; an assistant grade $6,100; a senior assistant grade $6,800; a senior grade $8,700; and the director grade $10,250. A director with over 30 years' service, including dependents and subsistence, would receive $14,000. Veterinarian officers receive an extra $100 a month incentive pay; medical and dental officers who have completed active service as a physician or dentist receive $100 extra per month as incentive pay for less than two years' service; $150 for over two years; $200 for over six years; and $250 for over ten years. Rental and subsistence allowances are tax free.

Besides the salary and allowances, commissioned officers have the benefit of medical services for themselves and their dependents, paid annual and sick leave, liberal retirement pay as well as social security benefits.

In addition to the Army and Navy research laboratories abroad, the Federal Government sponsors the Middle America Research Unit (MARU) of the National Institutes of Health located in the Canal Zone. It was established in 1957 as an interservice organization with participation by the United States Public Health Service and the Department of Defense. In 1959, there were 7 professional and 20 supporting personnel on the staff.

Medical schools

Results of a survey conducted by the Louisiana State University School of Medicine of teaching of tropical medicine and parasitology in medical schools in 1959 (Chapter 16) revealed that tropical medicine is presented in 67 schools and parasitology in 75 with 151 teachers of tropical medicine and 246 teachers of parasitology. However of these, 100 teach in both areas and 4 are on the staff of two different medical schools, thus giving a net total of 293 teachers of tropical medicine and parasitology.

Information, as presented in Chapter 12, on this same teaching survey showed that only 46 institutions reported research work in tropical medicine and parasitology. Of the 123 staff members engaged in this type of research work, 21 were full-time research workers and the remaining 102 were teachers who devoted part time to research in tropical medicine and parasitology.

Private organizations

One of the few United States private research centers established abroad is the Liberian Institute for Tropical Medicine in Harbel, Liberia, under the direction and guidance of the American Foundation for Tropical Medicine, Inc., of New York.[16] University medical schools in the United States have utilized the Institute for research and graduate training in the fundamental problems of diseases of both man and domestic animals in the tropics. The Institute offers the unique opportunity for research on tropical diseases in their natural element. Operating as an international center for research, its facilities were offered to the World Health Organization and agreements have been worked out with research centers and schools of tropical medicine in other countries of the world. The Institute maintains the only outpatient clinic in the area. In 1959, the staff consisted of 12 professional personnel. In addition, a number of visiting scientists used the research facilities during the year.

Another institute, functioning in Central America, is the Gorgas Memorial Laboratory established in 1929 as the research unit of the Gorgas Memorial Institute of Tropical and Preventive Medicine, Inc.[17] The land and buildings were donated by the Republic of Panama with the understanding that the laboratory would be used for conducting research investigations in tropical and preventive medicine. It is a private institution supported, uniquely, by annual appropriations from the United States Congress as well as grants-in-aid from the National Institutes of Health. In 1959, the staff was composed of 9 professional personnel with a supporting group of 41, including technicians, laboratory aides, field supervisor, labor, administrative and clerical help. In addition to the research duties, staff members serve as consultants in the fields of public health and tropical medicine to various government health agencies in Panama and throughout the world, as well as to industrial organizations in the tropics. Staff members are often invited to lecture at the medical school of the University of Panama. Staff assistance and facilities are offered to visiting scientists interested in the field of tropical medicine. The Laboratory collaborates with the Middle America Research Unit in the Canal Zone and effort is made not to duplicate the research work in the two laboratories. Here again, these centers provide an ideal situation for studying tropical diseases in their natural environment.

Another opportunity for health personnel is provided by the United States industrial firms operating in the tropics. American enterprise became aware of the need to improve living conditions and to set up hospitals and clinics in the underdeveloped areas in order to keep a healthy working population. In the 24 industrial medical installations responding to the questionnaire, most of which were located in the Caribbean, Central and South America, there were a total of 313 physicians, 33 dentists, 853 nurses and 417 technicians in the hospitals, inpatient and outpatient clinics and dispensaries in 1958. More specific information by areas is given in Chapter 9 of this report. It is becoming increasingly customary, however, to employ professional people amongst the citizens of the country where the operation is located.

Missionaries provide opportunities for medical and paramedical personnel abroad in their hospitals and clinics. Presented in more detail in Chapter 9 are the data collected on the number of personnel staffing the medical missions. From the data available for 1957-1959, the number of personnel in the hospitals and inpatient and outpatient clinics of the missions for the five areas covered in this survey were 2,696 physicians, 31 dentists, 5,738 qualified nurses, 6,631 nurses helpers and 529 technicians.

One institution in the United States which has developed its own technical assistance program overseas is the College of Medical Evangelists, Loma Linda, California, operated by the Seventh Day Adventists. It has a doctorate faculty of more than 700 individuals and over 2,000 full-time employees. One of the nine schools of the College is the School of Tropical and Preventive Medicine which is responsible for the foreign medical activities and operates in close conjunction with 235 medical units throughout the underdeveloped areas of the world. The School has instituted a Research and Assistance Program,[18] the purpose of which is "to give medical assistance, with emphasis on health education and preventive medicine in underdeveloped areas of the world." Research in tropical and preventive medicine and training of the native population to carry out the public health activities are primary objectives. The underlying philosophy of the program is "to help the people to help themselves." In 1956, members of the faculty surveyed an area in Tanganyika, Africa, for the purpose of initiating a pilot project.[19] Four to five years was considered sufficient to develop the program. Upon completion of the schedule, the American field personnel would move on to another selected area to undertake a similar program and the remaining trained native staff would continue the public health activities in their communities under the supervision of their local physicians. The School still, however, would maintain an interest in the further development of the project. As of this writing, support is still in the planning stage.

International organizations

The World Health Organization (WHO),[20] an agency of the United Nations, is dedicated under its constitution to work for "the attainment by all peoples of the highest possible level of health." Established as a permanent organization in 1948, WHO had in September 1960 a total membership of 92 full-member countries and 3 associate members. Upon request, WHO advises governments on building or strengthening their public health services, such as the improvement of sanitary conditions, and in education and training of the health personnel of the member countries. In 1960, WHO provided 163 nurses to 45 countries to help with improving and expanding the nursing service through education and training of local nurses and mid-wives. WHO sanitary engineers have visited countries to help train personnel and to provide technical assistance in developing and improving water supply and waste disposal systems. In 1960, 90 teachers representing preventive medicine, nursing and the basic medical sciences were sent by WHO to 24 countries on request. They assisted the local institutions in training their own staffs to teach.

The medical research program of WHO is unique in that it is the first permanently established endeavor in the field of international research. Initiated in 1958, because of problems encountered in its own public health activities, the program was intensified in 1960. The Director-General of WHO carries out the program upon the recommendation and advice of its various scientific committees and advisory groups. The Organization is in a position to evaluate needs and sponsor research in countries which are financially unable to support investigations of their local health problems. Primary importance is placed on communicable disease research with special emphasis on diseases of the tropics. Arrangements are made to support the research work in selected national laboratories, and this support is often supplemented by individual research grants. In addition to aiding in research investigations, attention is given to the standardization of nomenclature and techniques, the establishment of reference centers, the training of research workers, improving communication between scientists of many countries, and assisting in the development of national research programs.

In 1955, recognizing the need for a global malaria eradication program, the governments of the world at the VIII World Health Assembly resolved that "The World Health Organization should take the initiative, provide the technical advice, and encourage research and coordination of resources in the implementation of a programme having as its ultimate objective the world-wide eradication of malaria."[21] A Malaria Eradication Special Account was established to receive voluntary contributions to finance this project. Under this program, WHO is sponsoring an international collaborative research program in the United States, Great Britain and Africa in an effort to develop new insecticides and methods of malaria eradication. The United States, through its International Cooperation Administration, supports the malaria eradication program and contributes substantially to the Special Malaria Funds of the Pan American Health Organization and the World Health Organization.

Through the cooperative efforts of WHO, PAHO and ICA, trained international technical and administrative personnel are assisting the governments participating in the eradication program until their own staff becomes qualified to carry on the national programs. The United Nations Children's Fund (UNICEF) also has aided in providing supplies and equipment needed for the malaria eradication program.

As of September 1960, the staff of WHO totaled 2,041. The personnel included those internationally and locally recruited and were distributed as follows: Headquarters (Geneva and U.N.) 639; Africa 97; The Americas 68; Southeast Asia 143; Europe 99; Eastern Mediterranean 120; Western Pacific 95; Area and Zone Offices 40; field staff 629; liaison with other offices, such as UNRWA, 14; staff on loan to WHO, on payroll of Pan American Health Organization or on leave without pay 34; and short-term consultants 63.

SUMMARY AND CONCLUSIONS

Career opportunities in the field of tropical medicine in the United States have been limited in comparison with those of the European countries which had large colonial holdings in the tropics. Both the British and French Colonial Medical Services have provided career opportunities for professional personnel through their medical services and research activities in the colonies. With the independent status of many of the former possessions, however, career opportunities for European scientific personnel have diminished, although agreements have been negotiated with some of the newly independent states to continue assistance until the countries can provide their own qualified personnel. In the former Belgian Congo, Belgian medical personnel, who operated in a civilian capacity, have been less fortunate in their adjustment to the new situation and some difficulty has been encountered in relocating. Portugal has a career service and maintains medical establishments in her colonies.

A review of the opportunities and incentives for United States professional personnel interested in the field of tropical medicine and public health is presented. Since the International Cooperation Administration is one of the United States agencies administering the program of technical assistance abroad, a survey was made of its health personnel on duty at the end of the calendar years 1955-1960, inclusive, in the areas covered in this report. Rosters of ICA health personnel overseas and in Washington for the six-year period were provided by the Washington Office of Public Health, ICA. A total number of 700 health personnel assigned to countries included in the survey during the six-year period were reviewed by category in relation to the method of recruitment, age groups, salary levels, and professional and academic degrees. ICA health personnel present in countries not included in the survey, such as Korea, were omitted from the tabulations.

The 700 health personnel were separated into the following categories: 114 physicians; 148 nurses; 104 engineers (of whom 90 per cent were sanitary engineers); 42 sanitarians; 74 administrators; 48 health educators; 53 malaria specialists; 70 "other" professional and 47 non-professional personnel. In some instances, there were overlaps in categories. For example, all individuals holding the M.D. degree were included as physicians even though some were hospital administrators or medical educators. Nurse educators were included under the category of nurses; sanitary engineers and sanitarians who were listed as "malaria personnel" were included in their respective professional categories. The total number of personnel as listed on the rosters in the countries covered by the survey decreased from 350 in 1955 to 315 in 1960.

The Office of Public Health, ICA, recruits its overseas staff by direct employment of civilian personnel, commissioned officers of the PHS on detail to ICA, and through personnel under contracts with universities. Of the total personnel over the six years, 347 (50 per cent) were hired directly by ICA, 259 (37 per cent) were commissioned officers of the Public Health Service, and 94 (13 per cent) were university personnel under contract. From 1955 to 1960 the number of PHS commissioned officer personnel decreased while the number of employees hired directly by ICA increased.

Data were assembled from the Biographic Register of the Department of State in regard to age and professional and academic degrees. A tabulation of ages of personnel by category revealed that the greatest number were in the 40-49 age group with the second largest number in the 30-39 group. Of the total personnel, 176 (25.1 per cent) held a doctoral degree; 199 (28.4 per cent) a master's degree; and 151 (21.6 per cent) a bachelor's degree. One hundred and fourteen (16.2 per cent) were also MPH.

Data based on salaries as given in ICA staffing patterns for 1960 indicated that 50 per cent of the physicians were in the \$12,000-\$14,900 salary range and 38 per cent were in the \$15,000-\$17,900 range with a median salary of \$14,700. Of the 45 engineers (40 of whom were sanitary engineers) 69 per cent were in the \$12,000-\$14,900 salary range and 22 per cent in the \$9,000-\$11,900 group. The median salary was \$12,400. Approximately two-thirds of the nurses and sanitarians and more than one-half of the educators were in the \$9,000-\$11,900 salary range with respective median salaries of \$9,800, \$9,600 and \$11,000. In addition to the basic salary, certain other allowances as determined by the Department of State and based on living conditions, are made where applicable, such as post differential, a cost-of-living allowance, quarters allowance and an educational allowance for children. Home leave, if the employee is to be reassigned overseas, and paid annual and sick leave are granted.

From the data available it was determined that 144 of the 350 individuals listed on the 1955 health roster were still on the ICA staffing pattern at the end of 1960, and 107 of these had served overseas with other technical assistance programs before 1955.

In addition to the ICA health programs, other opportunities for professional personnel interested in the field of tropical medicine and public health were mentioned briefly. In the United States Government, the Departments of the Army and the Navy, the Department of Agriculture, the Veterans Administration, the Public Health Service and its National Institutes of Health sponsor research programs related to tropical medicine. As the federal agency responsible for the health of the country, the Public Health Service through its Commissioned Corps offers career opportunities to doctors, nurses, sanitary engineers and other health-related personnel. The pattern of the Commissioned Corps is similar to that of the Armed Services in regard to rank, tenure, pay and allowances, and opportunity is provided for overseas assignments. The Gorgas Memorial Laboratory located in the Republic of Panama supports research investigations in tropical and preventive medicine from funds supplied by the United States Government. In the Canal Zone, the Middle America Research Unit of the National Institutes of Health, in collaboration with the Department of Defense, supports research on tropical diseases in their natural environment. The Liberian Institute for Tropical Medicine, a private research center in West Africa under the direction of the American Foundation for Tropical Medicine, Inc., of New York, also provides facilities for research in the tropics. American industrial firms operating in the tropics and missionary centers throughout the underdeveloped world offer opportunities to medical and paramedical personnel in their hospitals, clinics and dispensaries. The School of Tropical and Preventive Medicine of the College of Medical Evangelists, Loma Linda, California, has launched a pilot project in Tanganyika, Africa, to promote health education and preventive medicine by training the local people to carry out the public health activities.

In the international area, the World Health Organization provides opportunity for varied activities in the health field throughout the world. At the request of member countries, health personnel are sent to advise on the local health problems and to educate and train the native personnel to assume responsibility for their own public health programs.

The medical research program sponsored by WHO supports needed research in selected laboratories of its member countries and provides assistance in the standardization of nomenclature and techniques, the establishment of reference centers, the training of research workers, and in the development of national research programs. In cooperation with other agencies, it is responsible for the world-wide malaria eradication program.

From the data assembled for this portion of the report, it is evident that career opportunities are very limited in this country and abroad for American health personnel in the field of tropical medicine. Interest in tropical medicine has declined since the end of World War II. Because the opportunities are limited, the field fails to attract individuals in the medical and paramedical sciences. In the medical schools, it is rarely taught as a separate course. In 1959, parasitology was taught separately in only 25 out of 75 medical schools, while in the remaining 50 it was absorbed into other courses. In medical schools other than those associated with a School of Public Health, only one school had a separate department of tropical medicine and only two gave departmental status to parasitology. Emphasis on the study of medical problems peculiar to this country has led the United States to neglect the exotic diseases. However, with the present international policies of the United States and its technical assistance programs in the underdeveloped countries, the need for attracting and training students in tropical medicine becomes more apparent. The development of teaching of tropical medicine in the United States could be encouraged through the mechanism of institutional grants.

Strong incentives to select tropical medicine as a career are lacking today. The ICA, through its assistance programs, offers opportunities overseas for health personnel in the field of tropical medicine, but as a career service there is no assurance of continued employment in this area in the United States. After the minimum tour of duty overseas, length of employment depends on the work performance of the individual but also, and more importantly, on the needs of the ICA programs. For the most part, the salary levels are on a par with those available to scientific personnel in other areas in the United States but are not commensurate with the difficulties of living and working in the underdeveloped countries. Recognizing the shortage of medical officers, the Civil Service Commission effected a ruling that physicians be paid at the top step of the position grade as an incentive measure. There are too few of these additional benefits to attract the individual for overseas duty.

In the Federal Government, today, the most promising career opportunities available in tropical medicine and international health to medical and paramedical personnel are in the uniformed services. The Armed Forces and the Commissioned Corps of the Public Health Service offer careers to physicians, nurses and other health-related personnel. The Departments of the Army and Navy provide opportunities for research in the field of tropical medicine in their laboratories both in this country and overseas. The Public Health Service and its National Institutes of Health also maintain research facilities for investigations in the field of tropical medicine and public health.

With the uniformed services, tenure of office is generally assured and salary levels with additional allowances and benefits are reasonable.

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Chapter 19

Future Manpower Needs in the Field of Tropical Health

Willard H. Wright

Some three years ago when the design of the survey was first formulated it included a provision for an estimation of manpower needs in the field of tropical medicine in the United States over the next ten years. This portion of the plan has been retained throughout several revisions.

In the interim, circumstances have intervened to change some of the basic concepts concerning the future of tropical medicine. Some of these changing patterns have introduced certain imponderables which add difficulty to the task of estimating manpower needs by extrapolating from data gathered in the survey.

It is anticipated that there will continue to be a certain amount of research in tropical medicine in this country. The several recent surveys concerning manpower needs in the medical and biological sciences during the next decade have all visualized expanded requirements for personnel. On the basis of such predictions, it is reasonable to assume that additional research will be conducted in the disciplinary fields which go to make up tropical medicine.

Since the inauguration of this survey, the political conformation of the tropical world has changed materially, and it may be assumed that other similar changes will occur during the remainder of the present decade. The past three years have witnessed the emergence of a score or more of new nations carved for the most part out of the colonial territories of certain European powers. In addition to this type of alteration, there have been changes in political ideology in certain countries included in the survey area. These swiftly moving events have had and will continue to have a certain effect on the foreign policies of the United States Government, policies which in turn will influence trends in the field of tropical medicine.

As an example, when this survey was planned, the International Cooperation Administration of the Department of State was conducting cooperative health projects in only two countries in Africa. While the health program of the successor, the Agency for International Development, has not at this writing been announced, it may be assumed that technical assistance in the health field may be augmented so that some of the newly independent republics will profit thereby.

With the exodus of European personnel, many of the newly emerged African nations find themselves in dire need of medical and health manpower. The extent of such need is exemplified by the Ford Foundation's survey of high level manpower in Ghana.[1] The shortage of medical personnel is the most serious of Ghana's manpower shortages. The goal of the Ministry of Health is to quadruple the number of doctors by 1970. This will require 1,200 doctors. Of this number about 450 could be supplied by Ghanaians if the numbers studying medicine overseas are maintained, but in addition it will necessitate 700 to 800 expatriate physicians. Even if these goals are met, Ghana will still have only one doctor for every 7,250 of population and will continue to be undersupplied for several decades. In this connection, it should be remembered that Ghana became an independent country much earlier than did the other newly formed African republics and therefore has had more opportunity to study manpower needs. There is no doubt that some medical and health personnel for these countries will have to come from the more developed areas; whether any appreciable percentage will be supplied by the United States is an imponderable question at this time. It is also questionable whether the United States can afford to be prodigal with its supply of physicians in view of the findings of the Bane Committee[2] which indicated that 11,000 medical graduates will be essential by 1975 to maintain the present ratio of physicians to population in the United States. This number is 3,600 more than were graduated in 1959.

The expansion of research in the medical sciences is visualized as requiring by 1970 an increase of 76.7 per cent in personnel and for the biological sciences an increase of 73.1 per cent.[3] A more recent estimate would indicate an increase in medical research manpower from the current level of about 40,000 to about 80,000 in 1970.[4]

As previously indicated, it is not reasonable to assume that a similar increase can be forecast for manpower needs in the field of tropical medicine. In spite of difficulties in estimating such needs, it is proposed to examine the data which have been assembled in this survey in order to determine the relation of such needs to the overall requirements projected for 1970.

For the purposes of this chapter, professional personnel are represented by individuals at the doctorate level, including those possessing one or more of the following degrees: M.D., D.D.S., D.V.M., Ph.D., Sc.D. Scientific personnel are defined as including those individuals with educational qualifications below the doctorate level but possessing one or more of the following degrees: M.S., M.P.H., M.A., B.S., A.B., or an equivalent degree in one of the engineering sciences.

Membership in the American Society of Tropical Medicine and Hygiene

One way of gauging future interest of tropical medicine is to examine trends in the membership of this Society over a period of years. These trends indicate to some extent the ebb and flow of interest in the field. The Society was organized in 1904 as the American Society of Tropical Medicine and was amalgamated with the National Malaria Society in 1952. In 1936, the membership of the former Society was 419. It increased to an all-time high of 1,309 in 1945 at the close of World War II, when many military personnel became interested in the subject for the first time. Such interest, however, was only temporary, since the membership had dropped to 966 by 1951. After the amalgamation of the two societies, the new American Society of Tropical Medicine and Hygiene began with 1,074 members, the increase being largely represented by 108 of 527 members of the National Malaria Society who chose to transfer their membership to the new society. (Actually, there were many duplications in the memberships of the two societies.) Since 1952, the extent of membership of the new society has not changed substantially.

This trend in membership portrays a fact already evident to workers in the field, that military operations in the tropics are usually a source of stimulated interest. This increased interest, however, is of a fleeting nature.

If membership in the American Society of Tropical Medicine and Hygiene is any indication, one would be forced to conclude that during the past ten years there has been practically no increase in the number of individuals interested in tropical medicine and no expansion in activity in the scientific disciplines which go to make up the field.

Americans Engaged in Medicine and Public Health in the Tropics

This group is represented by the professional personnel connected with three types of organizations surveyed in this report, viz., medical missions, American commercial firms operating medical facilities in the tropics, and the technical assistance programs of the former International Cooperation Administration.

Medical missions

In the medical missions included in this survey, there were in 1959 a total of 2,696 physicians, 31 dentists and 5,738 graduate nurses. Complete data are lacking concerning the total staffing of medical missions in the tropics. The missions represented in this report are largely Protestant facilities, since circumstances beyond the control of the survey staff rendered it impossible to secure an adequate representation of medical installations sponsored by various Catholic orders. Many of the missions represented were operated under the auspices of organizations in foreign countries and may be presumed to have been staffed for the most part by citizens of those countries. It is conservatively estimated that about one-fourth of the above-mentioned professional personnel were American citizens.

The future of medical missions in certain areas would seem to be in doubt. Changes in political ideology have forced medical missions to withdraw from certain countries after their properties were seized. Unstable political climates have served as a threat to the lives of mission personnel in other areas. In Africa at least, it would seem that medical missions have already reached their apogee and that the encouragement which they have received under colonial administrations will not be duplicated by the emerged and emerging independent states.

Thus, portents of the present and the future would lead to the belief that there will be no expansion in medical mission programs and that, on the other hand, such programs as now exist may have to be considerably curtailed. Consequently no increase in professional personnel can be visualized for this sector of medicine in the tropics.

Industrial medical facilities

The inadequate representation in this report of medical installations operated by American firms in the tropics indicated that there were engaged in such facilities a total of 313 physicians, 33 dentists and 853 graduate nurses. No effort was made to determine the nationality of such personnel but for several years it has been the policy of American firms operating in the tropics to hire physicians and nurses locally. Unless there should be a radical change in the present policy, it is not anticipated that there will emerge an increased demand for medical and paramedical personnel on the part of American commercial firms which maintain medical facilities in the areas represented in this survey.

Technical assistance programs of the former ICA

With few exceptions the technical assistance programs of the former International Cooperation Administration in the health field were conducted in countries embraced within the geographical regions of this survey. An analysis of the professional and scientific personnel engaged in these programs was presented in Chapter 18. In 1959 a total of 319 individuals was assigned to field projects in the survey area and 37 to the Washington office. Of the technical personnel in the field, 80 were in the professional category and 164 were scientific personnel. In 21 cases information regarding educational levels was not available. The Washington staff included 5 professional and 9 scientific employees.

As stated previously, no public announcement has been made concerning health assistance programs which may be undertaken by the Agency for International Development. The extent to which health projects will be emphasized in the Alliance for Progress program is also still a matter of question. Under the circumstances, it does not seem feasible to offer any predictions as to the need for health personnel in future technical assistance programs.

Americans Engaged in Research in Tropical Medicine in the United States and Overseas

Various portions of this report deal with research in tropical medicine and in most instances effort has been made to secure data on the numbers of individuals engaged in research. The types of research institutions surveyed included medical schools and schools of public health, pharmaceutical firms, government departments and private institutions devoted mainly to research in this field. In addition, a study of research grant and fellowship programs, both public and private, provided some further evidence concerning tropical medicine research. There are of course duplications in some of the data but these are known for the most part and cognizance will be taken of them in connection with the analysis of manpower needs in research.

Professional and scientific personnel engaged in tropical medicine research in 1958-1959 are listed below:

United States Government	211
Private research institutions	32
Medical schools and schools of public health (full-time, non-teachers)	21
Pharmaceutical firms (number estimated)	215
Academic institutions	12
Fellows	16
Total	507

The U. S. Government intramural research in tropical medicine is carried out mainly in the United States but certain investigations are conducted in units stationed overseas. Certain of the private institutions represented in the above tabulation are located outside of the United States. As with certain overseas government research, these private institutions employ professional and scientific personnel who are not citizens of this country. Nationals of other countries have been excluded in the above listing.

In the pharmaceutical industry, almost one-fourth of the professional and scientific personnel are not engaged in research but are concerned with quality control and production. Insofar as possible, this type of personnel has not been included in our calculations.

Data concerning staffing of the newly established international research and training centers sponsored by the National Institutes of Health and which are concerned with medicine in the tropics have not been included here for the reason that these projects are still in the process of administrative development.

Personnel engaged in tropical medicine research in this country represents only a minor fraction of the total scientific and professional manpower occupied in all medical and health-related research. In fact, data from this survey indicate that only 1.28 per cent of the total of 39,700 were conducting research in tropical medicine. Even if tropical medicine research should be increased by 100 per cent during the next ten years, as has been visualized for all medical research,[4] the additional personnel would scarcely constitute a material drain on total manpower resources. No doubt, the main expansion in research will come in the chronic and metabolic disease fields and in environmental health, since these constitute the principal areas requiring additional attention in this country over the period of time represented. It is doubted that research in tropical medicine will be expanded to the extent of 100 per cent and a more reasonable estimate would allow increased support to the extent of 20 to 25 per cent. It is true that a considerable increase has taken place in grant support from the National Institutes of Health in the biological sciences since the data in Chapter 14 of this report were compiled. However, there has been little corresponding increase in research grants in tropical medicine as defined in this report.

Personnel Engaged in the Teaching of Tropical Medicine in the United States

In the survey of the teaching of tropical medicine in this country as reported in Chapter 16, 76 of 82 medical schools provided information. Of the 76 schools, 67 listed 397 individuals as being engaged in the teaching of tropical medicine and/or medical parasitology. However, 104 of the 397 teachers represented duplications, since they either participated in the teaching of both subjects or taught in more than one medical school. Thus there was a net total of 293 instructors in these two fields, or an average of 4.4. Nine of the reporting schools apparently did not teach either subject.

The Bayne-Jones report[5] forecast a need in this country of 14 to 20 new medical schools by 1970. In estimating the need for additional faculty representation in the new schools for instructors in tropical medicine and parasitology, the mean of these two figures may be taken. Assuming that 17 new medical schools come into being by the above-mentioned date, and assuming that all of the new schools would include these subjects in their curricula, there would be a need for about 75 new instructors.

The survey reported in Chapter 16 was not successful in securing adequate data from schools of public health, some of which are known to teach courses in tropical public health and related subjects. The catalogues of the schools in this category have been examined. The number of full-time instructors in these subjects approximates 22. There is some doubt that new schools of public health will be established in this country in the next decade or that the schools now in existence will substantially augment instruction in tropical medicine. Thus, expansion is not visualized in this area.

SUMMARY AND CONCLUSIONS

Since the inauguration of this survey, the political complexion of the tropical world has changed materially and these changes have exerted certain influences which add to the difficulties of gauging manpower needs in the field of tropical medicine over the next decade. The task has been rendered somewhat easier with regard to research needs by reason of the fact that several authoritative surveys have been made concerning required expansion in the medical and biological sciences over this period of time. Yet it is not anticipated that tropical medicine will require or could achieve the 100 per cent increase in research personnel which has been visualized for the needs as a whole.

One means of following the interest in the field of tropical medicine in the United States is to examine the membership list of the American Society of Tropical Medicine and Hygiene over a period of years. This Society came about as an amalgamation in 1952 of the American Society of Tropical Medicine and the National Malaria Society. Since that time, the total membership of the Society has changed little, a fact which lends support to the conviction derived from many data in this report that interest in tropical medicine in this country may be described as in a static rather than dynamic phase.

Americans engaged in the field of tropical medicine may be divided into three categories, viz., those associated with medicine and public health in tropical countries, those engaged in research in the field, and those serving as instructors in this and related subjects in medical schools and schools of public health.

In the first category are Americans serving in medical missions abroad. It is estimated that approximately one-fourth of the total of 2,696 physicians, 31 dentists and 5,738 graduate nurses represented in such missions surveyed in this report were American citizens. However, the future of medical missions in certain areas would seem to be in doubt and there is hesitancy in forecasting need for additional professional personnel for such facilities.

Americans also serve in medical installations maintained by American business firms in tropical countries. Inadequate data from this survey indicate that 313 physicians, 33 dentists and 853 graduate nurses were staffing the facilities represented. No doubt many of these individuals were nationals of foreign governments, since it has been the policy during recent years to hire local professional personnel in such installations. Because of this, no increase is visualized for American personnel in the facilities in question.

Formerly, the International Cooperation Administration carried out health programs in many countries in the tropics. The future of this particular segment of technical assistance programs has not been announced by the successor organization, the Agency for International

Development. It is thus not possible to predict manpower needs for such programs.

In 1958-1959, an estimated total of 507 American professional and scientific personnel was engaged in tropical medicine research in this country and overseas. It is believed that any future expansion in this area will be much less than that forecast for medical and biological research in general and will probably not exceed 20 to 25 per cent.

The addition of new medical schools during the next decade will probably require some increase in instructors in tropical medicine and related disciplines. The additional number will be small, however, and will probably not exceed 75.

While no finite figure can be given on the number of Americans employed in all activities relating to tropical medicine, the number is such a small fraction of the total professional and scientific personnel engaged in the medical and biological sciences that any future expansion in personnel should not constitute any strain on total manpower needs over the next decade.

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Part VII

Chapter 20

Research Needs in Medical and Hygienic Problems of the Tropics: An Assembly of Informed Opinion

Willard H. Wright
and Collaborators

The preparation of this section represented a task of considerable magnitude for which the staff of the project was not qualified and for which the members of the Advisory Committee hesitated to accept full responsibility in spite of the variety of talents and experience represented. After a discussion of the problem in the meetings of the Advisory Committee, it was decided to enlist the aid of individuals who were qualified in various fields of medicine in the tropics and who for the most part had had experience in tropical areas. Accordingly, with the advice of Committee members, a list was drawn up and submitted to the Committee for approval, following which the various individuals were contacted and their cooperation requested.

In selecting this group of consultants, attention was given to geographical distribution for the reason that many diseases do not always exhibit the same manifestations in all parts of the tropics. Effort was made also to include in the list individuals engaged in research, as well as those concerned with clinical medicine, in order to benefit from the combined experience of these groups. In the case of diseases with vectors or intermediate hosts, some selection was made of authorities experienced in control procedures.

In order to limit the scope of the review, only the 34 diseases agreed on by the Advisory Committee as constituting the public health problems of greatest importance in the tropics were considered from the standpoint of research needs. In addition, diseases of domestic animals of importance in the tropics were covered, as was the subject of tropical climatology. The list of consultants approached and the subjects for which these individuals were requested to offer advice will be found in Appendix 18. The research suggestions received from this group have been reproduced in Appendix 19. For the purposes of the narrative report, the suggestions have been summarized mainly by the members of the Advisory Committee and the summaries are presented herein.

The original request for assistance was addressed to 140 individuals, of whom 108, or 77.1 per cent, replied. Of these persons, 89, or 63.6 per cent, forwarded research suggestions. Nineteen of those who replied originally were unable for various reasons to cooperate in furnishing suggestions, although some sent documents which were helpful. In addition to the above-mentioned consultants, members of the Advisory Committee also supplied suggestions.

Of the 34 human diseases covered by the survey, 3—pneumonia, plague and tuberculosis—are not represented in this section; unfortunately no replies were received from any of the individuals selected to advise on needed research in these fields. Coverage was inadequate in the case of typhoid and paratyphoid fevers, whooping cough, hydatid disease, and diseases of domestic animals, in that few suggestions were received.

The present review of research needs in medicine in the tropics is not unique for the reason that many organizations concerned with public health conduct such reviews from time to time. The World Health Organization functions in this way through its various expert committees and its study groups. More recently, its Advisory Committee on Medical Research has been intimately concerned with such problems. In the United States, the Tropical Medicine and Parasitology Study Section of the National Institutes of Health has sponsored four conferences on research needs in tropical medicine, the last of these having been held at New Orleans, Louisiana, in April 1960. Many other organizations are also actively interested in research in diseases of the tropics. The Commission for Technical Co-operation in Africa South of the Sahara is one of these and other regional bodies devote some attention to such problems from time to time.

Research Suggestions by Consultants

Diseases of high endemicity

Bacterial diseases

Bacillary dysentery

Consultants: Patrick Collard and Albert V. Hardy
Rapporteur: William W. Frye

The disease and disorders in which diarrhea is the outstanding manifestation continue to be a leading cause of morbidity and mortality in infants and children in many parts of the world. As a common disease of adults in underdeveloped areas, they are an important cause of economic loss. These diseases have not received the attention which their importance indicates, in part due to difficulties of investigation where the disorders are prevalent. Moreover, since the nature of the problem undoubtedly varies from area to area, the findings in the more developed countries cannot be applied to conditions in less developed areas. There is therefore an urgent need for investigations designed to provide more effective means of control.

The studies suggested fall into four broad types. The more basic studies, as of etiology, epidemiology and nutritional status, should be designed to provide the information required for the evaluation of effective control. These problems will require intensive studies of comparatively small population groups selected to be widely representative and located with ready access to the laboratory facilities required.

The second type of study should be designed to evaluate the effectiveness of specific control measures. This calls for limited observations on comparatively large population groups.

The third line of approach would be limited to specialized studies on specific aspects of the problem.

The fourth line of study should be the development of "pilot" or demonstration control programs which should be directed toward the transformation of knowledge acquired in research to lifesaving and disease preventing programs.

Through cooperative planning, special studies on nutrition, pathology and careful study of the etiology are essential. The part played by enteric viruses is still unknown, and their relationship to bacterial infections uncertain.

Leprosy

Consultants: J. A. Kinnear Brown, R. V. Wardekar and James A. Doull
Rapporteur: James A. Doull

The number of leprosy cases in the world is estimated as around 10 to 12 million. About 80 per cent are in the tropics. More than one-quarter are estimated to be more or less severely disabled by reason of extensive anesthesia, contractures, plantar ulceration or other complication or sequelum. Both upper and lower extremities are frequently involved in the same patient and leprosy cripples more hands than any other infectious disease.

Cultivation of the Bacillus

The basic need is a method of cultivation of *Mycobacterium leprae.* Success would permit study of its biologic characteristics and comparison of strains from various sources with one another and with other mycobacteria. It would also open the door to many practical applications which are urgently needed, such as:

(1) Earlier diagnosis. There is a period of latency between exposure and appearance of signs of manifest disease which may be several years. Cultural or serologic methods might shorten this in persons known or suspected to have been exposed.

(2) Criteria for cure. Treatment is now continued indefinitely because bacilli of unknown viability may be demonstrated in nerves or skin.

(3) A method of recognition of "non-cultivable" acidfast bacilli in healthy persons and in possible vectors.

(4) Preparation of a specific antigen to replace lepromin in immunologic studies.

(5) Preparation of an attenuated or killed vaccine to replace BCG.

(6) Extension of animal inoculation experiments.

(7) A method of screening drugs for therapeutic use.

Search for a Susceptible Animal

Recently, lesions localized to the site of injection but otherwise strongly resembling those of leprosy have been produced in the ear and testis of the Syrian hamster by injection of lepromatous tissue from a patient. Multiplication of *M. leprae* has also been reported in the footpad of the white mouse. Because of the long period between inoculation and appearance of definite lesions and also because of the short life of these animals, there is urgent need for a method of earlier detection of the infection. At the same time, the search should be intensified for a susceptible animal with a longer life span.

The Human Host

Studies of leprosy incidence in persons exposed to leprosy in the household indicate that resistance is far more frequent in adult life than in childhood. Reactivity to lepromin which may indicate some degree of resistance also becomes more frequent as age advances.

There may be an inherited predisposition to leprosy. If so, some evidence of it might be obtained by observations of the frequency and type of leprosy in exposed identical twins as compared to fraternal ones. There may also be a greater tendency in some family groups than in others for one type of the disease, that is, the lepromatous or the tuberculoid, to predominate.

Epidemiology

Reported geographic variations in prevalence, type and severity of leprosy require epidemiologic investigation for confirmation and possible explanation. There are many environmental variants such as water supply, bathing habits, and frequency of cutaneous injury; and there is the possible role of an insect or an arthropod in transmission. Some inadequacy of the diet is a possible predisposing cause which has not been investigated in the light of modern knowledge.

Studies of the prevalence of the different types of leprosy, designed in particular to discover the relative importance of the different types as sources of infection, should be carried out in several parts of the world. At present it cannot be stated with certainty for any area whether the tuberculoid type is an important factor in the spread of the disease; or even more fundamental, whether the disease is declining or increasing.

The significance of natural reactivity to lepromin and its origin should be studied both in human populations and in animals.

Pathogenesis

Much of the discussion and controversy concerning the classification and prognosis of leprosy is attributable to the limitation of observations to readily accessible patients and to a relatively short period of time. In certain countries, for example, indeterminate lesions are regarded as potentially lepromatous; in some others, they are regarded as of no practical importance. A broader spectrum of cases should be studied, including all grades of severity from the so-called incipient lesions of children to those of advanced disease. Combined clinical, histopathologic and epidemiologic studies are required to determine the kinds of changes that take place and the frequency with which they occur.

Early lesions in the peripheral nerves have received little attention from the neuroanatomist and the physiologist. The fine cutaneous nerve endings may be the primary point of invasion and the bacilli may be carried upwards to the main trunks. Here also studies with modern knowledge and equipment are strongly indicated.

Treatment

The urgency of the search for new drugs in tuberculosis—on which leprosy has depended as a sort of stepchild—has materially lessened. This is unfortunate because the most effective drugs in leprosy—the sulfones—are extremely slow in action. Ulceration of the nasal septum heals much more slowly than was originally thought. About one-half of lepromatous patients continue to show bacilli in cutaneous lesions after three years of intensive treatment. Relapse sometimes occurs after apparent clinical and bacteriologic arrest.

Treatment is made less effective by the repeated occurrence of reactions. These are unpredictable, to a large extent uncontrollable, and may lead to a fatal outcome. Many drugs are claimed to give beneficial results in reaction but none has been given adequate evaluation.

There is increasing evidence that many of the contractures, paralyses and ulcerations of leprosy are remediable by surgery and physiotherapy. Studies are necessary in various countries of high endemicity to learn the frequency of remediable disablement and the feasibility of providing rehabilitation measures.

Prophylaxis

Vaccination with BCG has been advocated for the prevention of leprosy chiefly because vaccination induces reactivity to lepromin which in turn is regarded as indicative of some degree of resistance. Carefully planned and long continued field studies are required to measure the effect of BCG vaccination on the incidence of leprosy. This comment applies equally to the use of small doses of sulfones which are being used in some countries because of supposed prophylactic value.

Research Personnel and Facilities

In relation to the needs, the opportunities and the sums spent for treatment and institutional care, the expenditures for leprosy research are almost insignificant. Competent investigators are required and funds to support them for an indefinite period and to supply them with adequate facilities.

Meningococcal infections

Consultants: Donough O'Brien for S. T. Achar, B. B. Waddy and George M. Saunders
Rapporteur: George M. Saunders

Four expert consultants were chosen in this field, one each from Madras, India, Dakar, Republic of Senegal, Kampala, Uganda, and the London School of Tropical Medicine and Hygiene. One reply was received from the Institute of Pediatrics in Madras by Dr. Donough O'Brien who wrote for Dr. S. T. Achar and one from Dr. B. B. Waddy of the London School of Tropical Medicine and Hygiene. Dr. O'Brien's report indicated that meningococcal meningitis is not a particularly pressing problem in India and is not the commonest form of pyogenic meningitis. Therefore, it was not felt warranted that any special priority be given for investigation in this area.

Dr. Waddy, on the other hand, reported that epidemics of cerebrospinal meningitis occur from time to time in all parts of the world and that in countries in Africa in geographical relation to the Sahara meningitis occurs on a scale not approached in any other region. He mentioned specifically extensive epidemics occurring in cycles in the savannah areas of the Sudan and in Ghana. The seasonal incidence of the epidemics is very clear, occurring during the dry season, in dry areas only, and ending when the humidity rises. This seasonal and cyclical occurrence associated with dryness, low relative humidity and in populations living mostly in mud-roofed and mud-walled houses with little light and ventilation raises many questions concerning the possible effects of the various environmental factors upon the meningococcus and the host.

Comment

It is well known that meningococcal infections, particularly meningitis, occur from time to time in epidemic proportions in various parts of the survey area. Examples are the serious epidemics which have occurred in Chile and other South American countries within the past two or three decades and also the annual epidemics of varying severity which have been reported from Africa. In addition to the information given by Dr. Waddy, a recent report of an epidemic of meningococcal meningitis in Nigeria and Ghana was given by Dr. G. A. Myers (Industry and Tropical Health IV, 167-172, 1961).

The last sizeable epidemic in that area occurred during the early months of 1960. During the first five months of that year there were nearly 34,000 cases reported to health authorities in Nigeria, with nearly 2,500 deaths. The author commented upon the possible relationship between meteorological factors (low relative humidity), together with overcrowding, as favoring the epidemic spread of the infection.

Although meningococcal infections do not appear to rate among the most important diseases of the tropics, from time to time severe epidemics may have serious adverse effects upon the health and productivity of population groups in some tropical areas. If any research efforts are warranted, with due regard to the overriding needs of other more important diseases, two areas for possible study might be considered. The first is a search for the most effective and practical means of chemoprophylaxis and treatment which might be applied to a whole population. Various antibiotics and sulfa preparations have been suggested. The second is a study of the environmental factors affecting the meningococcus as well as the host which permit the recurrence of epidemics of meningococcal meningitis with a special reference to meteorological data, the incidence of upper respiratory infections, the crowding of populations in closed areas during working and sleeping hours, the presence of intercurrent infections, the state of nutrition of the population and the virulence of the meningococcus.

Typhoid and paratyphoid fevers

Consultants: Kho Lien Keng and George M. Saunders
Rapporteur: George M. Saunders

Two expert consultants were chosen in this area. One from Djakarta, Indonesia, and the other from Cairo, U.A.R. One reply was received and that from Dr. Kho Lien Keng from the University of Indonesia. This consultant emphasized the need for a simple method for diagnosing typhoid and paratyphoid fever, especially in places without adequate laboratory facilities. On the basis of a limited number of cases, it was stated that a diagnosis of infection with typhoid or paratyphoid organisms can be made correctly by means of peripheral blood examination and examination of the bone marrow. The main criteria for diagnosis which were given indicate that the method is not really simple and that it is subject to considerable error in interpretation.

Additional comments were made in a report submitted by Dr. Albert V. Hardy of the Florida State Board of Health on recommended studies of acute diarrheal diseases. Dr. Hardy emphasized the importance of the various enteric pathogens in the etiology of diarrheal disease and the need for accurate bacteriological studies in order to identify the *Shigella* and *Salmonella* organisms in sample surveys and the importance of the role of malnutrition in the prevalence of the various enteric infections.

Comment

A survey of the environmental sanitation facilities in tropical areas indicates that there is a widespread lack of domestic water supplies, water-borne sewer systems or even latrines. In many areas, particularly in South America, in towns of 2,000 or less, it is the exception rather than the rule that any municipal water supply or sewer system is available. It was pointed out by Gabaldon (Industry and Tropical Health IV, 14-28, 1961) that, although in many urban centers in the tropical world typhoid and paratyphoid are of little importance in causing mortality, they still are of much importance as a cause of morbidity. Returns from the survey area on various immunizations given indicate that in a five-year period (1954-1958) about 27 million TAB immunizations were given, the majority in Central and South America. Of possible interest would be a study of the prevalence of *Salmonella* infections in various areas related to the proportion of the population given TAB vaccine.

It seems apparent that the impact of typhoid-paratyphoid infections on the health level of populations in tropical areas must be assessed in connection with other enteric infections acquired and disseminated in the same way. Furthermore, the reciprocal effects and relationships of diarrheal diseases and the nutritional state of populations must be considered. As the nutritional, educational, social and economic levels of populations rise, the diarrheal diseases tend to fade out of the picture as important causes of morbidity.

Whooping cough

Consultant: Margaret Pittman
Rapporteur: Thomas H. Weller

(1) An effective vaccine is available but research is needed to:

(a) Improve efficiency of vaccine production by development of standardized media based on knowledge of exact growth requirements.

(b) Improve and evaluate existing tests for reactive substances responsible for untoward toxic reactions.

(c) Develop *in vitro* method for assay of protective antigen content.

(2) Research needed to develop simple laboratory test for evaluation of immune response in vaccinated child.

(3) Research on technique of immunization needed:

(a) To determine minimum effective booster dose schedule.

(b) To determine selection of subject group in terms of maximum control and minimum expense under varying ecologic and social conditions in the tropics.

Spirochaetal diseases

Treponematoses (Syphilis and yaws)

Consultants: T. Guthe, C. J. Hackett and Thomas B. Turner
Rapporteur: Oliver R. McCoy

Laboratory Investigations

(1) Cultivation of treponemes on artificial media with the particular aim of determining the antigenic structure. Progress in such studies would permit rational classification of pathogenic treponemes and lead to better understanding of relationships between the diseases they produce.

(2) Improvement of diagnostic tests and more rigorous evaluation of those presently used with the purpose of evolving a simple, specific, sensitive and reproducible serological test.

(3) Metabolic studies of treponemes as a basis for chemotherapeutic investigations based on precise knowledge rather than trial and error.

(4) Experimental infections and cross-immunity studies in animals to determine relationships between various treponematoses.

Field Investigations

(1) Development of new drugs, especially antibiotics, with the aim of discovering inexpensive, long-acting drugs without allergic hazards.

(2) Assessment of currently used drugs through long-term follow-up examinations.

(3) Extended epidemiological studies with special attention to sections of the population which tend to act as reservoirs of infection and the sections where the attack rate is the highest.

(4) Serological surveys to evaluate results of treatment campaigns after intervals of five to ten years.

(5) Clinical-pathological studies to lead to better understanding of latency and relapse.

(6) Investigation of the possibility of immunization in animals and in man.

Viral diseases

Influenza and other respiratory disease of viral etiology

Consultants: Sir Christopher H. Andrewes, Thomas Francis, Jr. and Albert B. Sabin
Rapporteur: Albert B. Sabin

Excepting for limited periods when influenza epidemics sweep across the world, the influenza viruses are responsible for only a small portion of respiratory illness caused by recognized and as yet unrecognized viruses. The basic research problems in the field of influenza and other viral respiratory infections are not very different in tropical and temperate countries. However, field studies involving clinical, epidemiologic and virologic studies on the role of the many recognized and some as yet unrecognized viruses of the respiratory tract as a cause of human disease in the tropics, are needed to provide information of importance to public health in the tropics.

Measles

Consultants: K. McL. Cobban, D. B. Jelliffe and Albert B. Sabin
Rapporteur: Thomas H. Weller

(1) A workable method of active immunization is urgently needed.

(2) Studies are indicated to establish why measles is a more malignant disease in the tropics, i.e., whether due to virulence of virus or to host factors such as malnutrition and parasitism.

Mumps

Consultants: K. McL. Cobban and D. B. Jelliffe
Rapporteur: Thomas H. Weller

Mumps is not considered a serious problem in the tropics and therefore is not deserving of priority of attention.

Poliomyelitis

Consultants: John R. Paul, Isamu Tagaya for Masami Kitaoka and Albert B. Sabin
Rapporteur: Albert B. Sabin

In recent years epidemics of classical infantile paralysis have been occurring with increasing frequency in the economically underdeveloped countries of the subtropical and tropical regions of the world. This may be expected to become an even greater problem with further increases in movements of population and improvements in general sanitation and hygiene. The recent introduction of oral poliovirus vaccine provides a tool with which elimination of this disease from large parts of the world has already been undertaken. It has already been shown, however, that the high incidence of enteric viruses among the young children in the subtropical and tropical countries can interfere with the effectiveness of this vaccine, unless it is administered rapidly to most of the children in a given region, as was done in a careful field study in Toluca, Mexico, in 1959. The most urgent need for research on poliomyelitis in the subtropical and tropical regions is to determine by long-range epidemiologic and virologic studies whether the "Toluca" model of poliomyelitis elimination, combined with a practical maintenance program of oral vaccination of newborn children during the first six months of life, can free these areas from the fear of recurring epidemics of infantile paralysis.

Research groups engaged in such studies on poliomyelitis would be in a very good position to gather important information on the role of the very large number of other recently recognized and many still unrecognized enteric viruses in the diseases of infancy and childhood in these areas, and comprehensive plans for research activities on the elimination of poliomyelitis should also include work on the public health importance of the other enteric viruses.

Trachoma

Consultants: G. B. Bietti, Phillips Thygeson and Albert B. Sabin
Rapporteur: James A. Doull

Trachoma affects an enormous number of people, estimated by the World Health Organization as 400,000,000. It is the greatest single cause of serious loss of vision and of blindness. It is worldwide, is associated with poor hygienic conditions and is especially prevalent in areas that are arid and dusty.

The Virus

The etiologic agent is a virus of the psittacosis-lymphogranuloma group. Recently several strains have been cultivated on the yolk sac of the chick embryo, where they induce the formation of inclusion bodies morphologically similar to those found in conjunctival scrapings. Certain of these strains have produced conjunctivitis and inclusion bodies in monkeys and in human volunteers. Cultivation has opened the way to physical, chemical and biologic studies of the virus. Comparisons are now possible of strains isolated from patients in various parts of the world with one another and with other similar viruses, especially that of inclusion blennorrhea. Specifically needed are studies of virulence of these viruses for animals and for man and of the types of clinical manifestations that they produce; of the antigenicity and immunogenicity of various strains, and of their sensitivity to drugs.

Clinical Observations

Trachoma may be difficult to diagnose in the early stages and also when the underlying disease is masked by secondary infection. Improved diagnostic methods (cytologic, cultural or serologic) should be sought especially to aid in differentiation from other forms of follicular conjunctivitis.

An important practical problem is the determination of cure in trachoma. The effect of topical application of corticosteroids and of chemical and mechanical irritation in reactivating dormant infection is an associated problem as is also the value of the disappearance of inclusion bodies as a criterion of cure.

There is need for comparative clinical evaluation of the therapies now considered to be effective, i.e., broad and medium spectrum antibiotics, sulfonamides and sulfones, and of any drugs which in the future show antiviral action in laboratory tests. The objective is safe and effective chemotherapy at low cost, requiring days instead of weeks or months as at present, and otherwise suitable for mass campaigns in underdeveloped countries.

Epidemiology

There are many features in the occurrence of trachoma on which carefully planned community and family studies could throw light, such as geographic and seasonal distribution, sex, age and social selection and the effect of household exposure. Factors that may influence the severity of the disease such as the age at which it is acquired should be searched for. In each community, efforts should be made to learn the most probable local mode of transmission and in this connection the presence of possible insect vectors should be noted.

Multidisciplinary Studies

The advantages and in fact the necessity of combined clinical, laboratory and epidemiologic investigations of trachoma are self-evident. Several well-staffed and fully-equipped centers strategically located throughout the world are needed for a proper study of this important disease. Examples of studies requiring a multidisciplinary approach are: the definition of the clinical and histologic manifestations associated with each strain of the virus; the development of cytologic, cultural and serologic criteria for diagnosis; recognition of viral and bacterial secondary invaders; search for virus in apparently healthy persons; surveys of complement-fixing levels among contacts and noncontacts in relation to age, sex and other variables; controlled trials of drugs; trials of a specific vaccine if this should become available, and determination of satisfactory criteria of cure.

Parasitic diseases

Ancylostomiasis

Consultants: Paul C. Beaver and H. F. Nagaty
Rapporteur: William W. Frye

In considering the control of ancylostomiasis, two general aspects may be stressed:

(1) The remedial measures based on accurate detection and successful treatment of the disease, and (2) effective interruption of transmission of the infection by means of environmental conditioning which simultaneously would be advantageous to the people and disadvantageous to the parasite.

The problems involved in heavy and light infections and the question of natural elimination should be carefully studied. What should be done with light infections as far as treatment is concerned is still a question. Even though there may be no evidence of disease, the light infection still contributes to soil contamination, and thus to new infection.

Better chemotherapeutic agents are needed. We also need more information regarding the environmental conditions which may be altered to assist in the control of transmission. We must know more about disinfection and natural de-contamination of the soil in mass control of the disease.

Filariasis

Consultants: Frank Hawking, Emile Massal and N. G. S. Raghavan
Rapporteur: Oliver R. McCoy

Laboratory Investigations

(1) Study of mechanism of periodicity to elucidate the physiology of the parasites.

(2) Study of filarial parasites of wild animals with the aim of discovering new types of experimental infections in laboratory animals. Such infections would be particularly useful in tracing developmental stages of adult parasites, in testing new therapeutic agents and in study of pathology.

(3) Studies of histopathology, immunochemistry and enzyme reactions as related to pathogenesis of human filarial diseases.

Field Investigations

(1) Studies to improve the use of hetrazan in mass-treatment campaigns and to test other drugs which show promise.

(2) Studies to improve control of mosquito vectors with insecticides, larvicides and plant poisons to destroy vegetation in breeding areas. The need is especially great for insecticides with residual effect against *Culex fatigans* in rural regions.

(3) Study of animal reservoirs in relation to epidemiology of human infection.

(4) Dynamics of transmission including biology of mosquito vectors and quantitative factors in relation to spread of infection.

(5) Development of drugs which can be administered orally and which will affect both adult and larval stages without significant side effects.

(6) Use of antigens and other substances to ameliorate lymphangitis and related symptoms.

(7) Investigation of reasons for the variation in the state of sensitization of infected persons and the relationship to clinical symptoms.

(8) Improvement of surgical methods for management of elephantiasis.

Malaria

Consultants: C. A. Alvarado, F. J. C. Cambournac, G. Robert Coatney, F. J. Dy, Arnoldo Gabaldon, George Macdonald and Paul F. Russell
Rapporteur: Paul F. Russell

The majority of the research suggestions concerned problems related to control and eradication. Certain of these pertained to local conditions but in the main a broader view was assumed by most of the collaborators.

Research may be divided into three categories, viz., (1) evaluation of operational difficulties and methods for collating and assessing data; (2) applied research applicable to problems encountered in the field; and (3) fundamental research which may not be immediately concerned with the practical aspects of control and eradication.

The first category concerns operational problems, some of an administrative nature and others associated with patterns of human behavior. There is an indicated need for overcoming some of the shortcomings in the planning and implementation of antimalarial activities; for greater effort in public health education in order that in some sectors more popular support may be forthcoming; and further study of the habits and customs of population groups in order that such factors may be recognized early and not constitute an impediment to antimalarial activities.

The second category includes problems related to control and eradication goals. In host-parasite relationships, there is need for greater insight into strain behavior, especially varying patterns of *Plasmodium falciparum* infection; genetic factors having a bearing on the tolerance of the individual to infection, particularly as related to hemoglobin types; the duration of infection in untreated individuals; the duration and period of infectivity in asymptomatic parasitemia; detection of asymptomatic carriers; and more practical, economical and efficient surveillance methods.

Within this category lie also requirements for greater knowledge concerning anopheline vectors and their control. These needs include further studies on the biology of vectors, especially the exophilic species; the importance of genetically distinct strains of vectors; the influence of insecticides on behavior patterns in vectors; the mechanism and dynamics of resistance to insecticides; and the prevention of the development of resistance through the employment of mixtures of insecticides inducing genetic changes of a single type.

The importance of new chemotherapeutic approaches was emphasized by all of the consultants. Some of the goals include the development of compounds producing cures in one or two doses and drugs with a long lasting suppressive repository action for oral and/or parenteral administration; elucidation of the mechanism of drug resistance by the parasites and methods to obviate such resistance; and a critical evaluation of medicated salt as a suppressive measure in isolated population groups. It was pointed out succinctly that "the ideal antimalarial, containing the virtues of causal prophylaxis, suppression, rapid and complete curative action, sporontocidal effect, inability to create parasite resistance, absence of toxic effects, palatability and low cost, is still waiting to be discovered." This may be a completely elusive goal but its attainment would go far toward solving many current difficulties.

Problems in the third category are those of a fundamental nature which may provide information of practical importance. Some of these problems are concerned with a study of the genetic patterns of insecticide resistance in laboratory colonies of anophelines, the biochemistry of malaria parasites, basic aspects of immunity in highly endemic areas, and the significance of simian malaria in the epidemiology of the human disease.

Schistosomiasis

Consultants: N. Ansari, F. S. Barbosa, J. Gillet, Y. Komiya and Hans Vogel
Rapporteur: Oliver R. McCoy

Laboratory Investigations

(1) Development of drugs which are more effective and less toxic than those now in use. There is particular need for a drug which acts on the young post-invasion stages of the parasite. The possibilities of prophylactic drugs should be studied.

(2) Development of new molluscicides, preferably compounds which possess residual activity. Also, studies on the mechanism of action of molluscicides. A wider range of chemicals is needed to meet the diversity of ecological conditions where snail vectors are found.

(3) Biological and physiological studies of snail vectors, including such problems as reasons for hibernation and seasonal fertility and the culture of snail tissues.

(4) Physiological studies of adult schistosomes,

particularly in relation to nutritional factors which influence growth and egg production.

(5) Pathogenesis of infection by all stages of the parasite, including the eggs. Also, biochemical and physiological effects of schistosomiasis on the host.

(6) Study of resistance of humans against superinfection, the extent to which it exists and the mechanism of protection.

(7) Development of new techniques of laboratory diagnosis as well as standardization of procedures now being utilized.

(8) Cultivation of schistosomes in tissue culture and in artificial media.

Field Investigations

(1) Ecological studies of snail vectors and accurate surveys of their distribution.

(2) Search for biological methods of controlling snail vectors, for example, molluscophagic fish and crabs and pathogenic micro-organisms.

(3) Tests and surveys to determine potential snail vectors and differences in susceptibility of known vectors.

(4) Epidemiological studies of the role of wild and domestic animals as reservoirs and in active spread of infection.

(5) Comparison of methods of control involving various combinations of sanitation, health education, therapeutics and molluscicides.

(6) Study of the application of improved methods of irrigation engineering and methods of agriculture in reducing the density of snail vectors.

Amoebiasis

Consultants: R. Elsdon-Dew and Henry E. Meleney
Rapporteur: William W. Frye

There is still confusion and marked disagreement regarding the relationship between the presence of *Endamoeba histolytica* and the occurrence of disease. This for the clinician has led to a vicious cycle in an attempt to link any symptom presented by a patient with the chance finding of the parasite in the stool.

The present status of classification—in other words, *E. histolytica* and *E. hartmanni*—and the question of a non-pathogenic form create still further confusion between the laboratory and the physician.

At the present time most research workers are convinced that more attention be placed on the studies of host-parasite relationships in order to determine what factors induce invasiveness and whether these factors can, in any way, be modified to insure that the amoeba living in the human gut retains its commensal status.

A study of the natural history of amoebiasis is essential for the complete understanding of the disease. A long-term study of a population group is essential at the present time. A careful study of spread in mental institutions, including personal hygiene, environmental factors and possibly a consideration of chemoprophylaxis, is also essential.

From the point of view of diagnosis, there is need for the development of a more sensitive but highly specific serological test for the diagnosis of *E. histolytica* infections. The development of a practical diagnostic test using the fluorescent antibody technic would be most helpful.

Stress has been placed by all investigators on the need for detailed studies on the host-parasite relationship based on clinico-laboratory studies.

Nutritional diseases

Kwashiorkor and other nutritional disorders

Consultants: J. F. Brock, B. S. Platt, Nevin S. Scrimshaw and George M. Saunders
Rapporteur: George M. Saunders

Some thirty separate problems were identified as requiring research. Although separate, most are related directly or indirectly to the others. Among those stressed as important were the need for studies on the epidemiology of various types of nutritional disorders including kwashiorkor, marasmus, the nutritional anemias, eye diseases and others; the need for studies to determine the factors responsible for the development of nutritional disorders, especially in children, and the effect of nutrition, past and present, of mothers on the fetus and offspring; the need for studies to differentiate more clearly the various more or less specific types of nutritional diseases; the need to develop practical dietary measures to prevent and cure them; the need for the establishment of standards for "normals" in nutrition and growth for the various geographic areas. Special emphasis was placed on the lack of knowledge of the role of protein deficiencies in relation to disease, on the interchange of scientific personnel and equipment between areas in order to provide them in areas where they are most needed but usually lacking, and on the development of technics for disseminating knowledge of food science and nutrition to affected populations.

Comment

It seems obvious that in attempting to identify areas where research is to be recommended, one cannot isolate one or more nutritional disorders for separate studies without regard to all environmental and host factors which influence their occurrence. The economy of an area, the ratio of producing hands to consuming mouths, the availability of essential nutrients and the knowledge of their proper use, and the direct and indirect effects of infectious diseases on nutrition are all important and interrelated factors.

As Dr. George Harrar of the Rockefeller Foundation so aptly said "There are three basic elements in any sound foreign aid program to an underdeveloped area—education, agriculture and public health." (Industry and Tropical Health, IV, 79-83, 1961.)

He further pointed out that since more than two-thirds of the world's population is involved in the practice of agriculture, this regulates to a substantial degree the life of the individual farmer, his family and the community. Agricultural production commonly requires the combined efforts of the farmer, his wife and children, with the consequent neglect of education, and the development of public health measures.

The result is usually a population struggling for survival without the knowledge or tools to improve its way of life, a population burdened by illiteracy, infectious and parasitic diseases and inadequate nutrition. Much is already known about the mechanisms which bring about nutritional diseases and about ways to prevent them. The great need is to put this knowledge to practical use by providing affected populations with the means for public education and the tools necessary to apply what is known.

Diseases of relatively low endemicity at present but potentially great because of epidemic character in past and present unprotected populations

Bacterial diseases

Cholera

Consultants: A. H. Abou-Gareeb and Joseph E. Smadel
Rapporteur: Oliver R. McCoy

Laboratory Investigations

(1) Determination of the basic physiological-biochemical condition which results in profuse diarrhea in cholera and other infections.

(2) Development of an acceptable animal model of cholera gravis.

(3) Determination of which antibody, if any, in convalescent cholera cases is associated with resistance to disease.

(4) Reinvestigation of the immunizing properties of cholera vaccines.

Field Investigations

(1) Carefully planned field trials to evaluate the efficacy of new vaccines as well as those now in use.

(2) Study of the role of carriers and persons with *Vibrio cholera* diarrhea, but without cholera gravis, in the spread of disease in epidemics and in its maintenance in endemic areas.

(3) Extension and simplification of present procedures for correcting fluid and electrolyte imbalances in the acute cholera case with the view of making these lifesaving measures available to cholera patients who cannot be hospitalized.

Spirochaetal diseases

Relapsing fever (all forms)

Consultants: M. Baltazard and Hélène Sparrow
Rapporteur: Paul F. Russell

Tick-borne Relapsing Fever

The comments reviewed the distribution and relative public health importance of tick-borne relapsing fever. The disease is of serious consequence in the Middle East and contiguous parts of the U.S.S.R., where it is caused by *Borrelia persica* and transmitted by *Ornithodoros tholozani.* In Africa, it is caused by *B. duttonii* and transmitted by *O. moubata.* Epidemiological and/or experimental verification is needed of the apparent fact that man can be infected several times by different strains of the same species of spirochaetes with each time the same complete symptomatology. Much more needs to be known concerning the action of insecticides on *Ornithodoros* in different types of habitat. The apparent absence of an animal reservoir for the Asian and African tick-borne relapsing fevers warrants a study of the action of different antibiotics on these two forms, with the view that chemotherapy might be employed as a control measure.

In pure research, more needs to be known concerning genetic variations in the numerous species of *Ornithodoros* with a view of regrouping and simplifying the present classification. Similar studies should be made with the large number of described species of spirochaetes. The behavior of all of these species in the human louse requires study. Another problem concerns the "antigenic mosaic" associated with every strain of spirochaete giving rise to possible relative cross-immunity between apparently different strains.

Louse-borne Relapsing Fever

It is pointed out that this form, for which no vaccine exists and which leaves an immunity of only short duration, may at any moment become pandemic as it has done many times in the past. The recent demonstration of an endemic focus of the disease in the high plateau of Ethiopia offers a fruitful opportunity for further study of the origin of the pandemics of the past and could conceivably provide data looking to the prevention of similar outbreaks in the future. Specifically, studies are needed on the ability of the numerous strains of tick spirochaetes to infect lice and to determine whether mutant strains exist with a firm affinity for both ticks and lice. Further work is needed in Ethiopia on better differentiation of strains of spirochaetes, reasons for the persistence of the focus, and problems of immunity, especially as regards reasons for the extreme seriousness of the disease for the black race.

Leptospirosis

Consultants: William S. Gochenour, Ricardo Veronesi and J. W. Wolff
Rapporteur: Albert B. Sabin

Leptospirosis, as a zoonosis affecting man predominantly—although not exclusively—as an occupational hazard, requires special studies on the nature and distribution of various serotypes of leptospires in various domestic and wild animals in tropical areas, where relatively little work has been done thus far. In tropical areas where agriculture and animal husbandry are being promoted, research in this field would be valuable, especially for devising preventive measures to protect workers and domestic animals against the hazards of leptospiral infections.

Rickettsial diseases

Typhus fever (all forms)

Consultants: A. L. Craddock and Paul Giroud
Rapporteur: Paul F. Russell

Tick-borne Typhus Fever

Suggested research concerns problems in epidemiology such as the reasons for the sporadic nature of the disease and its uncommon occurrence where ticks are widely distributed; the distribution and density of various species of infected and non-infected ticks in East Africa; the feeding habits of ticks in relation to transmission of infection; and what part, if any, local tissue immunity at the site of the bite is concerned in limiting the frequency of infection.

Louse-borne Typhus Fever

Confirm or disprove the hypothesis regarding the possibility of maintaining strains of epidemic typhus in animals and in their tick parasites; determine the possibility of transformation of type between epidemic, murine and "boutonneuse" strains; determine the possibility of typhus as a cause of abortion and its possible association with vascular disease, especially vascular lesions of the limbs, blood vessels of the brain and the fundus of the eye.

Viral diseases

Dengue

Consultants: W. McD. Hammon and Albert B. Sabin
Rapporteur: Albert B. Sabin

Until recent years, dengue has been recognized chiefly as a problem in non-endemic areas harboring the mosquito vectors when the viruses were imported, and in endemic areas when large numbers of susceptible foreigners arrived for military or other duties. The recent demonstration by Hammon and his associates that an occasionally fatal form of hemorrhagic fever in native children in the Philippines, Thailand and Singapore is caused by some types of dengue virus emphasizes the need for further research on the role of dengue viruses in human disease of native populations in the dengue endemic areas of the tropics. Since the number of recognized antigenic types of dengue virus has recently increased from two to five, further research on the actual number of antigenic types and on the extent of their immunogenic relationships is urgently needed not only for achieving greater understanding of the role of these viruses in human disease but also for a rational approach to the use of vaccines. Further studies should be made of the attenuated live virus vaccines that have already been developed for the first two types of virus, as well as of similar vaccines that may be developed with the newer types, to determine their potential practical usefulness. Basic studies are also needed on the possible existence of "jungle" reservoirs of dengue viruses, on whether any animal plays a significant role in maintaining the dengue viruses in nature and on the arthropod vectors of the newer types of dengue virus.

Dengue, like yellow fever, deserves separate and special emphasis in programs of research on arthropod-borne virus diseases, because, in the past, it occurred in epidemics involving hundreds of thousands and even millions of people, and under certain conditions it may do so again.

Smallpox

Consultants: C. Henry Kempe and R. Sanjiva Rao
Rapporteur: Thomas H. Weller

(1) Need to establish nature of air-borne infectious dose and the mechanism responsible for hemorrhagic smallpox.

(2) Investigation of possible chemoprophylactic agents.

(3) Evaluation of supportive medical therapy, e.g., steroids.

(4) Need to investigate technique of primary vaccination with reference to validity of concept that degree of immunity is directly correlated with area of scar or with size of vesicle.

Yellow fever

Consultants: Augusto Gast-Galvis, J. Austin Kerr, Kenneth C. Smithburn, Fred L. Soper, Max Theiler and Wilbur G. Downs
Rapporteur: Wilbur G. Downs

The need for more complete explanation of the cycle of yellow fever transmission in nature, both in the Old World and in the New World, is re-emphasized. The adequacy of the established primate-mosquito-primate cycle to explain maintenance of virus in inter-epidemic periods is challenged. Need for further work on non-primate host possibilities involving possibly vectors other than the currently recognized mosquito vectors, and possibly including virus transport mechanisms as yet unrecognized or unproven, and on concepts of virus dormancy, is signalled.

Studies on the biology of *Aëdes aegypti* are indicated. In the New World, such studies are needed in connection with intelligent operation of a program to eradicate the species from the United States. For many reasons this is a very necessary step in the progress of the program to eradicate *A. aegypti* from the New World. In Africa, the position of *A. aegypti* as a forest dwelling species, in turn capable of maintaining itself in villages and cities, needs study in connection with intelligent planning of yellow fever control.

Clinico-pathological studies on yellow fever in human populations are indicated to enable clinicians to make more speedy diagnoses of suspect cases. A rapid—"bedside"—diagnostic test is particularly needed. Difficulty in diagnosing the mild case, whether sporadic or in an epidemic, is formidable.

Treatment of the hemorrhagic complications of severe cases (directed toward prevention of such serious complications) requires more knowledge of the pathophysiology than is at present at hand.

Prevention of infection through more effective vaccination schedules (i.e., more useful to the public health worker), such as those employing simultaneous vaccinations with 17D yellow fever vaccine and smallpox vaccine, merits further study. Further information is also needed on the duration of immunity produced by 17D vaccine.

Parasitic diseases

Leishmaniasis

Consultants: Leonidas M. Deane, Marshall Hertig and P.E.C. Manson-Bahr
Rapporteur: Willard H. Wright

Many problems in leishmaniasis are associated with the marked variability of the clinical symptoms, the virulence of the organism and the epidemiology of the disease. It is pointed out that kala-azar has virtually ceased to exist in India, Central Asia and the Mediterranean area following malaria eradication programs and that the cutaneous form has also disappeared for the most part from Iran and Iraq after extensive employment of residual sprays. In the Sudan and East Africa the position is very different. The disease is apparently still extending its range. Here research is being carried on to determine reservoir hosts and the species of sandflies responsible for transmission. In Kenya, special attention is being given to the importance of termitaries and the role of *Phlebotomus martini* in the spread of the disease. A trial is in progress to assess the value of a live vaccine prepared from a ground squirrel strain of *Leishmania* in the prevention of kala-azar.

Additional research is deemed necessary in the following categories:

(1) Techniques of epidemiological research need to be developed to determine infection past and present in man and animals suitable for bush work far from any laboratory center. Methods include serological, biochemical and intradermal tests.

(2) Basic knowledge is needed of the sandflies of the region, their susceptibility to infection with *Leishmania*, their life history, feeding habits, and other aspects of their ecology.

(3) Information is required on the role of other biting insects and direct contact in the spread of kala-azar in epidemic conditions.

In the New World basic needs do not differ materially from those in Africa and elsewhere. The problem of reservoir hosts still requires solution. In areas where the dog is the reservoir, its relative importance in this regard should be assessed. The capacity of man and dog to attract and infect the sandfly vectors should be studied, as well as the duration of infection and the relative prevalence of infection among human and canine populations. Similar observations should be made on feral reservoirs if and when these can be determined. The importance of the human host as a reservoir of infection should also be considered. The ability of aberrant cases and treated patients to infect sandfly vectors should be determined, since it has been pointed out that the parasites have been found in liver smears as long as one year after clinical cure. The frequency of the so-called "aberrant forms" of kala-azar requires elucidation and information is needed on the possibility of asymptomatic infections occurring in man.

More information would be desirable on the systematic position of "species" of *Leishmania* of man. The establishment of reference centers for the maintenance and study of strains from various geographical areas would be helpful. In such centers, it would be salutary to maintain various strains in culture, in the deep freeze and in susceptible lower animal hosts for comparison by electron microscopy and the newer immunological techniques.

Effort should be made to develop more adequate methods of diagnosis for use in epidemiological surveys. Research should be directed toward the improvement of serological methods of testing in order to provide more specific and more potent antigens.

Chemotherapy has not proved entirely satisfactory for African kala-azar or for certain forms of cutaneous and mucocutaneous leishmaniasis in the Western Hemisphere. More potent drugs are needed and attention must also be paid to the occurrence of relapsing strains and the development of post-kala-azar dermal leishmaniasis.

Diseases of relatively low endemicity but high mortality or serious complications

Viral diseases

Rabies

Consultants: Karl Habel, P. Lépine and Albert B. Sabin
Rapporteur: Albert B. Sabin

The control of rabies in the tropics, as elsewhere, depends on full knowledge of the maintenance of the virus in nature, especially in wild species. Accordingly, future research on rabies in the tropics must concern itself especially with the natural reservoirs of the virus and the factors governing its persistence in tropical wild life. Practical studies are also needed on the optimum utilization of the live virus vaccine for dogs and cattle, as well as on the development of a more useful vaccine for human beings, and the local and systemic immunotherapy of bitten individuals with concentrated antirabies gamma globulin.

Parasitic diseases

Hydatid disease

Consultant: Calvin W. Schwabe
Rapporteur: Willard H. Wright

An extremely important area for further research is in the epidemiology of the disease. For parts of North America, it is known that a wildlife cycle is important in maintaining unilocular hydatid disease. In some areas, the level of infection in domestic ruminants and man is not explainable by the known levels of infection in domestic dogs. It seems probable that multilocular disease is more widespread than known at present; further studies are needed on this type of infection.

A critically felt need is for an anthelmintic considerably more effective than arecoline hydrobromide for use against the adult stage in dogs under field conditions. Required is a well set up program for the systematic screening and laboratory and field trial of known, new and potential anti-cestodal drugs. Simplified methods for drug screening would reduce the cost and time required for such investigations.

Of considerable value would be an effective ovacide, both to reduce the risk of infection to those investigating the disease and to disinfect mass dog treatment sites. Such a chemical could be employed as a dip for infected dogs following treatment. Little is known concerning the bionomics of ova of *Echinococcus granulosus;* information concerning length of survival under different climatic and environmental conditions would be of value in control.

Diagnosis of human hydatid disease could be enhanced through the development of more potent and specific antigens. Effective chemotherapeutic measures are needed for the treatment of the disease in man. Biochemical and physiological studies might aid in achieving both of these objectives.

Onchocerciasis

Consultants: Thomas A. Burch, F. C. Rodger and Luis Vargas
Rapporteur: Willard H. Wright

Problems in onchocerciasis in the Western Hemisphere and Africa differ somewhat because of the differences in the epidemiological patterns of the disease. In many respects, however, research needs are similar.

Attention is called to the necessity for standardizing survey procedures in order that data supplied by different investigators can be compared. More information is needed on the distribution of the disease in Central and South America and in Africa.

In the epidemiology of onchocerciasis, more studies are in order on the ecology of *Simulium* vectors, their feeding preferences and relative efficiency in transmitting infection. Methods should be devised for maintaining laboratory colonies. Accurate sampling methods are required to determine the size, composition and relative ecological importance of *Simulium* populations in a given area. Precipitin tests would be helpful in surveying feeding preferences of different vectors and potential vectors.

Few facts have been produced on the life cycle of *Onchocerca volvulus*. Further investigation should be made of the route of migration of the metacyclic forms after entrance into the body, the life expectancy of male and female worms, the metacyclic forms and the microfilariae and the volume, cycles and length of production of microfilariae. Effort should be expended toward accomplishing the *in vitro* cultivation of adults and larvae. The development of a lower animal host for *O. volvulus* would greatly enhance opportunities for study of many of the above-mentioned objectives.

For diagnostic and epidemiologic use, more effective and specific antigens are needed for immunologic tests.

Ocular involvement represents the most important manifestation of the disease. More knowledge is needed on the distribution of ocular disease in relation to the distribution of infection. In many areas in which infection is widespread eye lesions are uncommon. Studies are in order to elucidate the factors concerned in the development of ocular lesions, especially in relation to the intensity of exposure, the degree of infection, the degree of immunity, and the influence of inadequate diet, particularly as concerns vitamins A, B_1 and B_2.

Control measures could be improved through the development of insecticides with a prolonged residual action. More effective methods are needed for the application of insecticides and larvicides, especially in the Americas where the terrain is rugged and the breeding places of the chief vector are difficult of access.

Chemotherapy of onchocerciasis is far from ideal at the present time and more effective drugs are needed, keeping in mind the possibility of chemoprophylaxis.

Chagas' disease

Consultants: Emmanuel Dias, J. L. Pedreira de Freitas and Cecilio F. Romaña
Rapporteur: Willard H. Wright

Considerable attention has been paid to Chagas' disease in some countries with the result that knowledge has accumulated concerning the distribution, epidemiology and clinical manifestations of the condition. In other countries, little research has been accomplished and information is lacking on the public health importance of the disease. Control projects have been attempted in some areas whereas in others basic epidemiological data are so lacking that efforts at control cannot be exercised. The basic need, therefore, is to stimulate additional studies in many Latin American countries.

Further research should be conducted on the pathological manifestations due to *Trypanosoma cruzi*. In some endemic areas it has been shown that the parasite is responsible for damage to the heart and the digestive tract. There is a tendency to consider such damage as a regional characteristic of the disease. It seems likely, however, that absence of knowledge concerning the occurrence of such lesions in other areas is due mainly to lack of recognition.

Additional studies are needed on the vectors in different areas, especially as concerns their ecology and their relative susceptibility to infection with *T. cruzi*. Investigations should also be carried out on the habits of those species not so strictly adapted to the human habitation in an effort to evaluate their possible role in maintaining *T. cruzi* in nature.

While considerable success has been achieved in the control of the disease in some areas through the use of residual insecticides, more information should be sought concerning methods of application and spacing of sprays, as well as more effective chemicals.

The problem of transmission of *T. cruzi* through blood transfusion is an important one. While gentian violet has proved to be a valuable prophylactic agent against *T. cruzi* in blood, investigations should be extended to the usefulness of other chemicals in this regard. In view of *T. cruzi* infection in a high percentage of blood donors in some areas, a rapid presumptive serological test for the diagnosis of Chagas' disease in blood banks would be of great value.

One of the greatest needs in connection with the disease concerns the development of effective chemotherapeutic compounds. It is possible that chemoprophylaxis might be of value as a control measure in hyperendemic areas, if suitable drugs were available.

African trypanosomiasis

Consultants: M. A. de Andrade Silva, T. A. M. Nash, M. Vaucel, K. C. Willett and S. G. Wilson
Rapporteur: Thomas H. Weller

General

Shortage of interested and qualified research workers is seriously affecting progress.

Studies On Disease In Man

(a) Further knowledge needed of factors determining pathogenesis:

(i) Investigation of nature of chronic infections and of self-limitation of process.
(ii) Is man's resistance to *T. gambiense* increased by prior exposure to one of

the common trypanosomes non-pathogenic for man?

(b) Need for improved diagnostic procedures:

(i) Better antigens for serologic diagnosis.
(ii) Evaluation of blood culture in mass surveys.

(c) Therapy:

(i) Need for less toxic drugs for treatment of infections of central nervous system.
(ii) Need for effective non-toxic compound that can be given by mouth in mass chemoprophylactic or treatment campaigns.
(iii) Better knowledge needed of metabolic action of drugs. In chemoprophylaxis is infection prevented or is it contained at a low level?

Laboratory Studies On Trypanosomes

(a) Development of culture media needed permitting of maintenance of the pathogenic trait; elucidation of factors determining virulence.
(b) Development of techniques for the differential diagnosis of species of polymorphic trypanosomes as recovered from the salivary glands of the tsetse.

Epidemiology

(a) Evaluation of the role of the chronically ill human as a reservoir of infection.
(b) Evaluation of different species of game as reservoirs of human (and of cattle) trypanosomiasis.

Studies On the Vector and Its Control

(a) Further knowledge needed of biology of species of *Glossina:*

(i) Establishment of host preference of different species; if control attempted by slaughter of game should be limited to species of high preference.
(ii) Investigation of factors determining range of certain species of tsetse, and in particular, the reasons for sudden extension into new areas.
(iii) Development of better techniques for laboratory rearing of tsetse flies.

(b) Studies on control methods:

(i) Improved residual insecticides, and methods of application; development of techniques to attack far-ranging savannah species.
(ii) Investigations in East Africa on reasons for success or failure of discriminative clearing.

New diseases concerning which present knowledge is limited, but which appear to be of considerable health importance

Arthropod-borne viral infections (excluding yellow fever)

Consultants: Ottis R. Causey, J. A. R. Miles, Joseph E. Smadel, Kenneth C. Smithburn, R. M. Taylor, Max Theiler, Telford H. Work, Albert B. Sabin and Wilbur G. Downs

Rapporteur: Wilbur G. Downs

This subject or field has expanded tremendously in the past decade. Adequate coverage has not even been approached in such areas as the general physical, chemical, and immunological characterization of the viruses (well over 100) now known to be in the general grouping. The disease-producing potential (human and/or animal) is only partially known for several agents, and quite unknown for the majority. Geographical epidemiology is only beginning to be explored. Epidemiological aspects involving insect vectors, (mosquitoes, ticks and other arthropods) and vertebrate hosts (mammals, birds, reptiles and amphibia) are largely unexplored. Possibility of transportation of virus by movement of vectors or of vertebrate hosts is possibly of great importance and has yet been only very inadequately explored.

So vast is the field and so scant has been the coverage to date that it is not necessary to belabor the subject of specific research needs—the generalizations above will suffice.

Several of those submitting suggestions have stressed the need for additional regional laboratories, strategically placed to exploit various bio-geographical areas of the world, and with facilities for (1) isolation of viruses from arthropod and vertebrate hosts, (2) virus identification, (3) virus diagnostic services, and (4) immunological surveys. It is felt that attention should be focused most particularly on agents proven to be or likely to be of importance in causing human or domestic animal disease. Collaborative international cooperation is felt to be a prime need.

Control of infection either through immunization or through interruption of transmission is another unexplored field. For a limited few of the viruses, vector control programs exist. Immunization procedures exist for a limited few of the viruses. Treatment of infection is a quite unknown field. Much further work is needed, including initial assessments of the need for control in connection with each virus agent individually. A prominent consideration here will be the economic impact of the disease in question on human or animal populations (for most of the viruses the disease itself is unknown). After the assessment of need, the question of method requires assessment. Problems, such as vaccination, control of vectors (in many instances as yet unknown), and interruption of transmission cycles (such cycles are in many instances unknown), present themselves.

Diseases of domestic animals

Consultants: M. Abdussalam for Martin Kaplan, M. A. de Andrade Silva, W. G. Beaton, A. Rafyi, K. C. Willett, S. G. Wilson and William A. Hagan

Rapporteurs: William A. Hagan and Willard H. Wright

Consultants were selected largely on a regional basis in order that sufficient coverage might be obtained on geographical variance in the manifestations of many of the animal diseases. Unfortunately, all consultants did not reply, thus leaving geographical gaps in the research suggestions. Certain of the zoonoses have been adequately considered under the human diseases.

Biological reference centers. A need is developing rapidly for regional centers for the collection, typing and storage of disease agents, normal sera, antisera and vaccines. Certain laboratories in some of the regions of this survey have undertaken the classification of certain disease agents and have been concerned on a limited scale with attempted standardization of some vaccines. Present facilities, however, are wholly inadequate.

Foot-and-mouth disease. Many problems are regional in nature because of the varied distribution of virus types. In South America, sub-types to O and A have been found and this observation may prove of importance in vaccination. In Africa, in addition to the three classical virus types, there are present three distinct types unknown elsewhere. Control by vaccination is thereby rendered more difficult than elsewhere, and will remain so even if vaccines against these types become available. Four virus types, O, A, C and Asia I, have been identified in tropical Asia and no doubt sub-types will be discovered. Effort is being made to develop a vaccine for Asia I. Control would be far less difficult if a polyvalent vaccine were available, at least for virus types confined to one continental region. Fundamental research is needed on genetic constitution of foot-and-mouth disease virus with a view of discovering essential causes and mechanisms of variability.

Equine encephalomyelitis. The disease is important in tropical America and further effort is required to elucidate its distribution and epizootiology. Only limited identification has been made of virus types, with a consequence that the distribution pattern is known for only a few countries. More studies are in order on the bird-mosquito-bird chain of transmission and search should be continued for the inter-epizootic reservoirs of the virus. The development of an effective polyvalent vaccine against Eastern, Western and Venezuelan types would be a valuable contribution to control. The adaptation of attenuated viruses to supplant present formalinized preparations should be investigated.

Anaplasmosis. Lack of control measures warrants further research attention to this disease. The nature and life cycle of the infecting organism needs to be elucidated. Further studies are desirable on modes of transmission and the possible role of insect vectors not heretofore identified. Development of an effective vaccine would be of great value. Additional research might lead to an effective treatment.

Blue tongue. Basic studies are needed on *Culicoides* and other potential vectors of the virus, in order to clarify the epizootiologic picture. Development of an effective method of chemotherapy would probably shorten the period of convalescence and would be useful in areas in which the disease is not enzootic and vaccination is not regularly employed.

African horse sickness. The epizootiology of the disease should be studied in Southwest and South Central Asia, where extensive outbreaks occurred in 1959 and 1960. Effort should be made to establish the cause of severe reactions following immunization in some areas. Studies are needed to determine virus reservoirs during inter-epizootic periods.

Rinderpest. The control of rinderpest in domestic animals in enzootic areas rests largely on the degree of application of recognized vaccines. However, adequate vaccination coverage is a costly procedure. Research is desirable to determine the reservoirs of the disease and their relative importance in maintaining infection during inter-epizootic periods, be these domestic or feral.

In Africa, rinderpest has provided some solution in past times to the problem of cattle surpluses. However, animal protein is needed to supplement inadequate native diets. Many obstacles stand in the way of marketing. These concern inadequate per capita income to purchase meat, livestock quarantines and better methods of moving animals to market. Research on the persistence of the virus and methods for detecting it in carcasses might lead to easement of quarantine restrictions.

Tick-borne diseases. These are most important in Africa and Southwest Asia. Research is needed on the development of resistance to acaricides. Additional knowledge of tick vectors would aid in control. Effective chemotherapeutic methods would save animals once the diseases have made their appearance.

Contagious bovine pleuropneumonia. The fundamental factors responsible for the establishment of immunity are little understood, as is the nature of such immunity. Development of more effective vaccines depends on the accumulation of additional knowledge concerning the immune mechanism. Additional research is needed on the epizootiology of the disease and to develop a reliable test to detect incipient or latent infections.

Brucellosis. More reliable methods are required for diagnosis in sheep, goats and swine, and potent vaccines are needed for these animals.

Trypanosomiasis. Studies should be conducted on the relative immunity of African breeds of dwarf cattle and of game animals, on variations in virulence of different geographic strains of *Trypanosoma congolense* and *T. vivax*, and reduction in virulence by passage through various species of tsetse flies.

Cheaper and more effective drugs which do not induce resistance should be developed, as well as chemoprophylactic compounds with longer residual activity. Basic research on mechanism of drug action needs to be extended and further exploration should be made of the possibility of active immunization.

The chief method of control in the past consisted in either partial or complete bush clearing. More recently, dependence is being placed on insecticides, where the fly habitat is restricted either naturally or seasonally by climatic conditions. Under these circumstances, insecticidal control is more practicable and economical. However, such conditions pertain only to limited areas. More information is needed on the employment of insecticides against the far-ranging savannah species. Knowledge of resting habits of the tsetse flies is essential to the effective use of insecticides.

Research needs in human and animal tropical biometeorology

Consultants: George Burch, Frank P. Ellis, J. C. D. Hutchinson, G. E. Lambert, D. H. K. Lee, W. V. Macfarlane, R. K. Macpherson, Bernard Metz, C. H. Wyndham and Frederick Sargent, II

Rapporteur: Frederick Sargent, II

"Biometeorology is that branch of ecology which studies the interrelations between the geochemical and geophysical factors of the atmospheric environment and living organisms. The extent of the environment which the biometeorologist studies ranges from the bottom of the root zone in the soil to the highest atmospheric levels involved in the dissemination of pollen and spores. Not only do biometeorologists investigate in the natural atmosphere but they are also interested in man-made atmospheres such as those found in buildings, shelters, and the closed ecological systems of submarines and satellites. As implied in this definition, biometeorology is an interdisciplinary science, for the scholars working in this field represent all branches of meteorology and all branches of the biological sciences." (S. Petterssen: *Atmospheric Sciences, 1961-1971.* Nat. Acad. Sci.—Nat. Res. Council, Washington, 1962.)

Within the scope of the present report we shall limit our considerations of the research needs in biometeorology to the humid and arid tropical regions of the world and to the human beings and domestic animals which live or which may be introduced in those regions. Specifically, we shall discuss the type of investigations which should define more precisely the impact of the tropical atmospheric environment on the health and working capacity of the animal and human populations of those geographical regions. Each of us is fully cognizant that many of the problems cited do not arise from the action of the atmospheric environment alone. The maintenance of health and an effective working capacity derives from an ability of the individual to adapt successfully to the total tropical environment: to the atmospheric (or material) component, the biotic component, the cultural component, and the conceptual component (D. H. K. Lee: *Climate and Economic Development in the Tropics*, New York, 1957). The problems we raise are actually those of animal and human ecology; here we shall emphasize their biometeorological aspects.

There are a number of scientific organizations which have an interest in the biometeorological problems of these geographical areas. Among them are the Arid Zone and Humid Tropics Commissions of United Nations Educational, Scientific, and Cultural Organization, Food and Agriculture Organization, World Health Organization, PROHUZA (Centre d'Etudes et d'Informations des Problèmes Humains dans les Zones Arides), Commission for Technical Cooperation in Africa South of the Sahara, International Society of Biometeorology (Committee on

Tropical Biometeorology), and American Meteorological Society (Committee on Bioclimatology; Study Group on Bioclimatology). These bodies are already actively investigating many of the problems that we shall enumerate. In fact, all of these organizations are represented informally by the scholars who have contributed thoughts and ideas to this report.

Atmospheric environment

Meteorological data needed to assess severity of climate. In order to be able to make a critical assessment of the relative severity of various tropical climates, the meteorologist must provide the biologist with more detailed and extensive data than are summarized in the current meteorological handbooks. Although the available data are useful for comparing in a broad way the climates of different areas, they are of very limited value when one attempts to estimate, for example, the frequency with which certain critical levels of dry bulb and wet bulb temperatures are exceeded either singly or in particular combinations. When judging the effect of a climate on man or in comparing one climate with another, it is important to have such an estimate. The limitation could be overcome if the meteorological data contained some estimate of the daily variation in the measurements. Averages alone can be misleading.

It is indeed surprising that meteorological data are not tabulated in terms of means and standard deviations from the means. It is not possible to estimate the standard deviation from either the average highest or lowest temperatures for the month or from the absolute maximum or minimum temperatures. Furthermore, from the biologist's viewpoint, such single extreme values are of little use. However, from means and standard deviations, assuming a normal distribution of temperature about the mean (or deriving an appropriate mathematical model to take account of any consistent skewness), one could estimate, with reasonable accuracy, the percentage of observations which will exceed biologically meaningful levels of air temperature or relative humidity. For example, a particular level of air temperature could be taken to represent a critical value above which discomfort would be experienced by the majority of inhabitants. By a mathematical manipulation of the means and standard deviations it would be possible to assess the number of occasions on which this critical level would be exceeded either on a monthly basis or per annum. It is not difficult to see how considerably the usefulness of meteorological data could thus be enhanced for the biologist.

An even more serious limitation from the biologist's point of view is the usual method of reporting relative humidity. The "average daily humidity" for each month is given for 0800 or 0900 hours and for 1400 or 1500 hours. The wet bulb temperature at the time of the maximum dry bulb temperature, calculated from the relative humidity at 1500 hours, would be higher than the true figure in many instances, because the coincidence of the maximum dry bulb temperature occurring at 1400 or 1500 hours would be rare. Likewise, the observations for 0800 or 0900 hours would most certainly not be associated with the "average minimum dry bulb temperatures." In summer months, when these data are most important to the physiologist, the dry bulb temperature tends to rise sharply after sunrise and relative humidity alters rapidly also. The judgment of night comfort must be made on the minimum dry bulb temperature and its associated relative humidity. These data cannot be obtained from the meteorological tables in their present form. Since there appears to be no alternative for the biologist but to examine the actual meteorological records and abstract from them relevant data, consideration must be given to what data need be extracted. In order to assess the extent of heat stress during the day one must know the average dry bulb temperature, and the associated relative humidity, for the minimum period that it is considered will produce adverse human reactions, physiological and psychological. The air condition of the hottest hour of the day is a reasonable compromise to adopt for this purpose until scientific evidence is forthcoming for accepting either a shorter or a longer time interval. The raw observations which are required for this assessment include (a) the average dry bulb temperature for the hottest hour of the day, (b) the average relative humidity for the hottest hour of the day, (c) the wind force over the period 1100 to 1700 hours, and (d) the presence of solar radiation, or preferably the average black globe temperature in direct sunlight, for the hottest hour of the day.

For assessing heat stress at night three different times of the night must be examined because of differences in activity and dress. The first is the period of the evening meal when presumably dress will conform to some minimum conventional standard and when the increase in metabolism due to the specific dynamic action of the protein in the evening meal will add to the heat stress of the climate. The second is the period about midnight when the family has retired and needs to be free from extraneous stimuli and irritations in order to fall asleep. The third is the time of the lowest dry bulb temperature, in order to determine whether discomfort, which might be experienced in the earlier part of the night, falls to a level at which restful sleep is possible even for a limited period. The meteorological data required for this assessment are (a) dry bulb temperature and associated relative humidity for the hours 2000 and 2400 and at the time of the lowest dry bulb temperature in the 24 hours, and (b) the force of the wind and its direction.

Other problems. The biologist and the meteorologist must collaborate in the solution of problems relating to the health and working capacity of man and domestic animals in tropical regions. This viewpoint certainly is emphasized in the consideration just preceding of meteorological data which the biologist requires for his research. Other biological problems which will utilize more detailed meteorological observations than are now in hand are (a) formulation of convective properties of naturally occurring turbulent air flows in relation to the size and surface of an interposed body; (b) clarification of factors determining heat load resulting from incident solar and thermal radiation (the measurement of heat exchange by radiation, especially solar heat gain, is of special interest in Australia, for example, on account of the large population which is engaged in agriculture and other outdoor occupations); (c) codification of radiative properties of sky, terrain, trees and buildings in relation to type; (d) lack of ability to deal quantitatively with variable and transient heat flows characteristic of natural conditions; (e) elucidation of the carcinogenic effect of sunlight.

Standardization of anatomical, physiological and psychological differences among biotypes. Living organisms exhibit remarkable individual variability, a characteristic which makes biometeorological investigations particularly difficult to control. Of primary importance is the establishment of definitive standards of normal, both for different biotypes and also for various geographical regions. Since the biochemical and functional variability of organisms has not been systematically investigated, it is frequently most difficult to evaluate reports claiming to have demonstrated an association between the variability of some atmospheric element and a biological process. This state of affairs is particularly true of such organisms as animals and man for they exhibit diurnal, circadian, and other rhythms which may be independent of the meteorological environment. Because these rhythms contribute to the total variability of organisms, their presence may confound biometeorological correlations. Furthermore, animals and man exhibit a hierarchy of organismal variability ranging from most closely regulated biophysical and biochemical properties of the body fluids, such as temperature, acidity, and osmotic pressure, to less closely regulated processes, such as sedimentation of red blood cells, renal clearance, and rate of urinary flow. While this hierarchy probably represents the adaptive capacity of the organism, its relation to the problems of physiological and chemical anthropology need detailed study.

There are a number of specific areas wherein these general remarks are applicable. In the case of studies of human beings, for instance, the customary "standard man" has been the medical student of the mesothermal regions. Geographical studies of physiological and anthropological traits are hampered because regional and demographic standards are not available.

We are most ignorant of the biology of tropical populations. A very important problem is the study of physiological differences between the peoples of hot dry and hot moist regions. Such standardization as we have discussed is basic to making comparative studies between the autochthon and the immigrant European.

There have been many reports in the literature concerning the relative efficiencies of the Negro or "black" man over the white man in tropical climates. The consensus of opinion is that the Negro is able to cope more effectively with tropical climates than the white man. Whether this difference is related to racial or genetic factors or to training and acclimatization has not been fully evaluated. This type of investigation should be undertaken not only for normal people but for people with various types of diseases. The cardiovascular system in particular should be the focus of this kind of investigation.

Intimately related to the study of organismic variation is the question of whether there are biochemical and physiological differences which have been selected by natural processes to differentiate tropical biotypes from those living in cool climates. Although it is probable that the human species originated in the tropics, most of our knowledge of human physiology relates to mesothermal man. To enlarge knowledge of various human biotypes, investigations should be made of racial groups distributed over a wide range of latitudes. Such groups might be Europeans and aboriginals in Australia, Bantu in Africa, and Indians in North and South America. The racial homogeneity of these groups should be established by collaboration with anthropologists. Further light might be shed on these problems by studying the responses of different racial groups to migration either from the Equator toward the Pole or in the opposite direction. The physiological events should be followed carefully for at least two years.

A wide variety of observations might be included in such broad geographically oriented physiological studies. We might accept as a working assumption that the chief characteristic of tropical living is a high water turnover for evaporative cooling and the fact that all functions associated with water intake, distribution, and elimination are relevant to tropical living. Metabolic functions are closely related, for a depression of heat production is clearly useful when the external heat load is high. These two linked phenomena, evaporative cooling and reduced heat production, have consequences in both biochemical and physiological aspects of mammalian life in the tropics. Thus the types of measurements that might be useful are:

(a) Estimation of water turnover and the distribution of water in the intracellular, extracellular and gut spaces of the body. This should be done for all age groups from the newborn to the aged and for pregnant and lactating women.

(b) Sodium and potassium content, turnover and distribution in the body. Some vegetarian groups of human beings in the tropics have high potassium intakes and low sodium. The relation between nutrition, water evaporation and small amounts of sodium is a very interesting problem. The part undertaken by sodium in the water and sweat movements in the tropics requires further quantitation.

(c) Renal studies on the control of water and salt in both dry and humid tropics are very few still for man.

(d) Endocrine consequences of hot environments. (1) The concentration in the blood, the daily output and the turnover of thyroxin and triiodothyronine in tropical peoples are still largely unknown. (2) The apparent depression in the output of cortisol by mammals exposed to hot environments has importance in metabolism but the full significance of this is not yet worked out. Blood levels of cortisol and similar adrenal steroids together with studies on the turnover of such steroids near the Equator would be very valuable. (3) The reproductive efficiency and milk production of adapted and unadapted races living in hot environments is still very largely obscure. A reduction in the conception of white people living about 20° from the Equator in Australia has been reported, but the cause of such reduction during summer is not known. (4) If adequate facilities are available for the measurement of pituitary hormones particularly TSH, ACTH, FSH and LH, these could yield some of the most useful data on endocrine aspects of adaptation.

(e) Biochemical and intermediate metabolism studies on adapted groups would ultimately be necessary for analysis of any differences found.

(f) The nervous system is intimately involved with nearly all aspects of the adaptive process. Some phases of nervous activity that could be studied are: (1) Autonomic functions in circulatory redistribution particularly to skin and kidney. With these the central control of sweating and the nature of the change in output of sweat on acclimatization as well as failure of sweating in those not acclimatizing are also relevant. (2) The central regulation of fluid and food intake as well as of activity in relation to the hot environment is clearly of great survival value but the exact information from the body that leads to the homeostatic regulation could do with a good deal more investigation. (3) Habituation to heat appears to be a function of spinal cord interneurones and the nature of this elementary type of learning is important for the understanding of changes in response of those exposed to strong and continuous stimulation.

The influence of tropical climates on nutrition, growth, and variations in man's build needs investigation. It is generally stated that the ratio of body mass to surface area is low for people living in tropical environments as compared to that of people living in cooler areas of the world. The truth of this and the degree of its relationship to climate, independent of diseases and other factors, are not known.

For many years there has been speculation on the anatomical and physiological effects on man of residence for a number of generations in hot climates; but little definite information has been obtained. In the Antipodes there is an immigrant population of nearly common origin and common current economic and nutritional status, living in an extraordinary variety of climates. It would seem that these peoples would provide the best material for such studies of possible divergence of human populations resident in varying climates, yet so far no use has been made of them.

Physiological reactions to atmospheric environment. Here we shall discuss those problems which deal with the effects of exposure to changes in the atmospheric environment in the unacclimatized subject. In a subsequent section we shall deal with the problems of acclimatization *per se*. A major problem is to elucidate the degree to which weather changes are directly responsible for alteration in bodily function. The human being exhibits a considerable degree of physiological and psychological variability. How much of this variability is inherent? How much of it can be ascribed to the constantly changing atmospheric environment in which the organism exists? The assumption has been made by many workers that, because there is a statistical correlation between weather changes and one or another measure of organismic variability, the weather has caused this variability. In some cases experimental proof has established the validity of this assumption; in many cases it has not. Related to this matter are the analysis to time trends and physiological responses to environmental stress and analysis of interval effects upon responses to environmental stress.

A second problem is the determination of the physiological and psychological significance of variability in environmental conditions. The tropical regions of the earth are less variable from the meteorological point of view than are the mesothermal zones. An investigation of this problem might contribute greatly to our understanding of the long-range effects of living within an air-conditioned environment.

The third major problem is the prediction of physiological reactions to heat. In order to make reliable forecasts it will be necessary to perfect a system of obtaining indices of thermal stress resulting from the simultaneous operation of several atmospheric variables with regard to both thermal comfort and also working capacity for various population groups.

Comfort. In the hot, humid tropics the upper limits of air conditions for comfort might be exceeded during the night as well as during the day. In the typical hot, dry climate of a desert similar effective temperatures which are excessive during the day are usually followed by nights which are cool. Thus, climatic conditions in hot, humid tropics would, in the long term, have a more severe effect on inhabitants with respect to discomfort, disturbances of the psyche, lowering of morale and fall-off in performance of work. As far as is known no quantitative studies have been made to determine the relative effects of these two different climatic conditions on human reactions. As a background to such an evaluation certain basic information on comfort is required. Surveys are needed to establish the comfort zone of families living in various regions of the tropics and subtropics. Specifically studies should be designed to provide information of the following points related to comfort during the day: (1) The influence on the upper limit of comfort should be examined of the level of metabolism, exposure to direct sunlight, and the amount of clothing. (2) No information exists on the rate at which individuals moving from temperate regions adjust to a new level of thermal comfort in the tropics; it cannot be assumed that the rate of adaptation of comfort is in any way associated with the physiological reactions in acclimatization. (3) In the monsoon regions of the world the question needs to be examined of the relative effects of unrelenting discomfort during the day for prolonged periods before the rains come on psychic disturbances, morale and human performance compared to the effects of intermittent discomfort in the short, dry spells—when the discomfort might be more severe—which are relieved by cooler periods during heavy rains.

The needs related to comfort at night include the following: (1) There appear to be virtually no population surveys, except those of Wyndham and Macpherson, to establish the upper limits of comfort at night in hot, humid tropical areas. There is need to carry out similar surveys in other tropical and subtropical regions to examine a possible relationship between severity of climate and upper limit of night comfort. (2) Any such survey should examine the interrelationships between night effective temperatures and amount of bedclothing, discomfort, presence of sweating, and disturbance of sleep. (3) At night more than half of the body, lying on a bed, is shielded from the effects of air movement. This affects the relative influence of air movement on comfort. Still air at night is, therefore, called "oppressive" at effective temperatures which during the day are labeled as comfortable. The relative effects of air movement at high relative humidities on comfort at night as expressed by the effective temperature scale needs special study.

The determination of the levels of thermal comfort of the inhabitants of various regions in the tropics and the determination of upper desirable and upper tolerable levels of warmth for acclimatized residents and immigrants should provide important information for air-conditioning design and serve as a guide in regulating conditions of employment in industry.

Performance. Laboratory studies on human performance in hot conditions show that there is a deterioration in performance somewhere between 81° and 86° F effective temperature. The tasks used in laboratory hot rooms are synthetic compared with those in industrial work and the social-psychological relationships of the subjects of the experiments are quite artificial. However, a validation of Mackworth's and of Pepler's main conclusions has been made recently in Wyndham's laboratory. The study was carried out in an ordinary working place in a mine on a normal task, shoveling rock in a "development end," in a situation where the air conditions could be altered at will. Similar studies are needed in other practical work situations to validate further the conclusions reached in laboratory studies. Hot industries in the tropics provide an admirable situation for such studies and also for examining the possible effects of heat on work performance of men in various states of "natural" acclimatization, acquired from residence in various tropical and subtropical regions.

The following proposals are made which might be helpful in planning such experiments: (a) Industrial tasks should be chosen in which performance can be measured simply and accurately with appropriate electronic recording apparatus. (b) Suitable apparatus should be installed near the workmen for continuously recording the various heat-stress factors. (c) Weekly means and variances in performance should be expressed in relation to mean effective temperatures and their variances; the daily variation in performance should be examined in relation to the diurnal variation in effective temperature. (d) An attempt should be made to select tasks which require different levels of muscular effort and intellectual activity. A 10 per cent decrease in muscular effort in industry or in military tasks can probably be offset by increased mechanization. A similar fall in the decision-making capacity of industrial executives or of military commanders could lead to both disastrous and costly mistakes.

The above proposals are directed towards industrial and military activities in the tropics. An equal, and perhaps more important, research effort should be put into the assessment of the effects of living in tropical climates on the rate of physical and intellectual growth of children who are of the second and third generation in tropical regions. This investigation could be carried out by choosing schools in temperate and tropical areas which are closely matched and by making appropriate anthropological, mental and sociological studies.

There is another important problem. The effects of heat on work performance are usually expressed in relation to effective temperature scale. No comprehensive study has yet been made to examine the question of whether this scale gives correct weighting to the relative effects of the various heat-stress parameters on human performance. The effective temperature scale is essentially a measure of temperature sensation; the predicted four-hour sweat rate index is used for assessing physiological reactions to various conditions of work and heat. It is possible that a new scale or index is needed in order to give correct relative weighting to the effect of the various heat-stress parameters on human performance.

Additional problems which need study in relationship to working capacity in tropical regions are: (a) inadequate measures of submaximal physical performance, especially under natural conditions, (b) insufficient information on the impedance to physical performance offered by various aspects of terrain, (c) uncertainty on the short-term effects of nutritional state upon work capacity and performance, (d) determination of the relationship between wind speed and impedance to locomotion.

Doctor Lambert has studied the action of climatic factors on the frequency of accidents in industry at different seasons and during the 24-hour period. Accidents were most frequent during the hot season, but contrary to what one might expect the hourly frequency was not greatest during the period of maximal diurnal heat, but during the hours preceding, namely, 4:00 a.m. to 12 noon. This latter interval was the time when many circadian rhythms were reversing and thus the disturbance of the biological rhythm might be the cause of the high incident rate rather than the temperature *per se*. An analogous variation occurred among the natives of the Sahara. This matter needs further detailed study, particularly to unravel the mechanism of these seasonal and diurnal variations.

Problems relative to age, sex and state of health. There have been few worth-while studies of women of any race in warm environments, although Tillet's studies on girls "used to attending ovens" published as long ago as 1764 suggests that women may be more tolerant than men. Very little is known about the reactions to heat stress in the very young or the very old. The infant is surely vulnerable to heat stress too. Do we know how vulnerable? Does life in a warm climate accelerate aging, or does it assist one to grow old elegantly and at ease? Is it a good thing to retire in the tropics?

According to the *Guide* of the American Society of Heating and Ventilating Engineers (1960), little is known of the thermal requirements of the unconscious person in the operating theatre, and these requirements, when they are identified, may well be different in the tropics or in the antarctic from the requirements in Washington, D. C. It has even been suggested that the anesthetized person may be a "poikilotherm." Has enough attention been paid to the environmental requirements of the operating-room team? Recent correspondence in the *Lancet* certainly raises doubts on this score.

There is a need to study the influence of tropical climates on disease in man. Practically all of the fundamental investigations have been either on animals or on normal man. It is well known that many acute diseases are reversible if the physician is able to tide his patient through the acute phase of illness. This is a particularly important problem in aged people, and a hot and humid environment, when air conditioning is not available, may make the difference between success and failure in treatment. There is a need, therefore, to study the reactions of the abnormal physiologic states in man to tropical climates. Furthermore, sick people cannot adjust readily to stress, including that due to climate. There is a need to learn more about the mechanisms of poor adjustment.

Indices for assessing heat stress and predicting physiological reactions to heat

Assessment. Despite all the thought which has been given to the matter, there is no really satisfactory index or scale for assessing the effects of a wide variety of combinations of air temperature, humidity, air speed, radiant heat, clothing, work rate, and duration of exposure which may be encountered in the tropical, or any other, thermal environment. The effective temperature scales, the predicted four-hour sweat rate (P4SR), the wet bulb globe thermometer index, the heat-stress index of Belding and Hatch, and the wet bulb temperature all have their particular applications, but there is pressing need for someone to review just what these applications are and to warn against the misuse of these various systems. Such a review should indicate in terms of each index recommended for use, optimum and limiting environmental conditions for various common types of activity at work or in the home. Some such review is an essential preliminary to any broad survey of the thermal environment in the tropics, if there is to be any hope that different groups of investigators will speak the same biometeorological language.

Prediction. The need for a method of predicting the relative effects on the physiological reactions of man of the four heat-stress parameters of an air condition and also the effects of metabolism and amount of clothing is met most successfully by the British physiologists' predicted four-hour sweat rate index (P4SR). A number of recent studies have validated the relative weightings given to the various heat-stress factors.

The P4SR index can be recommended for immediate use, on present evidence, in industrial situations and in the tropics for assessing the relative heat stress of various conditions of heat and work. The index cannot be used, however, to predict the actual physiological reactions of men working under hot conditions. This is due to the fact that a different regression line is needed for each new population of heart rate, or sweat rate, or rectal temperature plotted against P4SR values. Race, sex and the state of acclimatization all affect the intercept of the regression lines on the "y" axis and also its slope. Hence, if it is necessary to predict these physiological reactions for a particular industrial or tropical population, a "calibration" must first be made of these reactions against P4SR values before the index can be used in a general way to predict actual sweat losses, etc. To extend the usefulness of the index, an intensive effort should be put into obtaining the appropriate regression lines for sample populations in different parts of the tropics and subtropics. This study should include samples of the indigenous populations and also "expatriates" from temperate regions at various stages of their residence. Incidentally, information would also accrue on the "natural" state of acclimatization to heat of peoples in tropical regions.

It is not possible to predict with any confidence, based on statistical probability, the limits of air conditions and rates of metabolism at which the populations at risk in various industries and in different parts of the tropics are liable to suffer heat collapse and/or heat stroke. This main criticism may be leveled against current limits of "tolerable" air conditions. First, the limits generally apply to specially selected, trained, and highly acclimatized young men used in experiments. A second criticism is that the criteria of tolerability differ widely. The third criticism is that the sample populations studied are too small for reliable statistical estimates to be made of the probability of men from similar populations in various combinations of work and air conditions either reaching a heat stroke level of body temperature or of collapsing. The industrial executive sending men to work in a hot mine or the military commander detailing troops to fight in a tropical area is not satisfied with the loose criteria ("some men" or "an increasing number of men" will become incapacitated) which comprise the substance of the present tolerable limits. They want the statistical probability of the population at risk suffering from heat collapse and/or heat stroke at the air conditions they will work or fight. They want these probabilities in the same precise statistical terms which they are accustomed to deal with in assessing sickness and accident rates. On present data this cannot be done.

It is strongly urged, therefore, that a new approach be made to the question of tolerable limits of air conditions and that they be based on rigid statistical criteria of heat stroke risks and that samples of men at risk in the tropics and industry "in their natural state of acclimatization" be studied in order to make these assessments. A portable, low-cost climatic tent has been developed by Doctor Wyndham for this purpose and is suitable for hot, humid climates. (See, for example, C. H. Wyndham et al., Arbeitsphysiol., *18*:112, 1960.)

Another approach might be to tackle the problem as an epidemiological one and collect data on the numbers of men exposed to air conditions at which there is a risk of heat collapse and heat stroke and, also, the actual incidence of heat collapse and heat stroke, as they occur over a period of two or three years, at various air conditions. By this means the probable mortality and morbidity rates, in cases per thousand per annum, can be worked out. A similar epidemiological approach could be employed to relate the rates of psychic disturbances and of skin diseases due to heat, to some index of the air conditions, such as effective temperatures, in order to give precise expression to the air conditions at which these conditions increase significantly. The institution of such surveys in hospitals where large groups of servicemen are aggregated in tropical areas, such as Aden, would prove useful.

It has been contended with some justification that, while it is most important for industrial executives and military commanders to know precisely the risks of heat collapse and heat stroke to which they will expose their men at various rates of work and air conditions in order to take appropriate preventative measures, men would not voluntarily work to those limits except under such high motivation as financial incentives or the individual's concept of his duty during wartime. It is therefore important to search for less rugged limits than those which expose men to heat collapse and heat stroke but which are based on sound physiological principles. Accomplishing this end would replace the confusing array of physiological criteria for work in heat that one finds in the literature, none of which appears to have a sound basis, but each of which has strong adherents.

Three proposals have been suggested to initiate research on this problem. One is an epidemiological study to establish whether living in tropical areas shortens the lifespan and whether certain diseases can be shown to be specifically contributory to this effect. In this survey one would exclude tropical infections. The second possible criterion is the air conditions at the upper limit of the thermoregulatory zone for various rates of work. Above this limit rectal temperature, for a specific rate of work, rises to a new level so that one can contend that the body's two thermoregulatory mechanisms, evaporation of sweat and tissue heat-conductance, have reached the physiological limit of temperature regulation. This approach has scientific elegance and has been employed successfully by C. H. Wyndham for Bantu miners and A. R. Lind for British miners. The third possibility is that by plotting heart rates and sweat rates against rectal temperatures from a sample of acclimatized men from a large series of experiments over a wide range of heat-stress conditions, one can establish the characteristic form of the curve for these relationships. Present data suggest that the relationship is linear for both sweat rate and heart rate with rise in rectal temperatures between 99° and 102° F. With further rise in rectal temperature above the latter level, heart rates and sweat rates reach their maximum values (from which it can be inferred that evaporation and tissue conductance of heat are near "saturation" point) and the curve tends towards an asymptote. Moreover the scatter of individual sweat rate and heart rate values about the means becomes very great. The interrelationships of these physiological reactions at which sweat rates and heart rates reach their maximum values when plotted against rectal temperatures have important practical significance as the limit of physiological regulation. Above this limit rectal temperature can be expected to rise sharply and the circulatory system to be liable to heat collapse.

Acclimatization. The consultants agree that a great deal is yet to be learned about the phenomena of acclimatization to heat. This knowledge is needed not only for the good of tropical peoples but also for those living at high or low latitudes. Investigations by the Royal Navy in Singapore (R. K. Macpherson: Medical Research Council Special Report Series No. 298, 1960) established several fundamental points. (1) Provided the nutritional status is similar and that the subjects are in an equal state of health, training, and acclimatization, there are not very great differences between various ethnic groups of the human race in their responses to work at high temperatures. (2) The responses of "artificially acclimatized" naval ratings in a temperate country did not differ greatly from those of "naturally acclimatized" ratings in the tropics and were very similar to those of "artificially acclimatized" ratings in the tropics. These findings are directly relevant to the application of the results of work in climatological centers in temperate latitudes to meet the needs of tropical communities—provided that they can be confirmed by measurements of a more extended range of physiological and biochemical observations than are presently available. (We shall consider their applicability in a subsequent section.)

Very little is known of the process of acclimatization after the first 14 or 21 days of exposure to unaccustomed warmth for Caucasians. Even that knowledge is only based at present on measurements of body temperature, heart rate, sweat output, and a few components of sweat. One experiment in Singapore (R. K. Macpherson, *op. cit.*) suggests that acclimatization was not yet complete after exposure for five months for four hours a day, six days a week, to standard work in a hot environment. Little is known of psychological acclimatization which accompanies the physiological process. Studies over periods of years rather than days are needed and they will be difficult to contrive.

Most laboratory studies on Caucasians working at high temperatures have only lasted two to four hours daily. There is a paucity of information about more prolonged or repeated exposures within the same 24-hour period or about continuous exposure. Certainly duration of exposure is one of the vital variables to weigh in the balance in assessing any environmental situation.

The mechanisms of acclimatization, especially the role of the adrenal cortex and of volume pressor receptors in the regulation by the kidney of Na and Cl excretion, continue to provide material for academic research of an esoteric nature. Of more immediate practical significance, however, is the fact that very little is known of the range of acclimatization of peoples in various states of "natural" acclimatization in different tropical and subtropical regions of the globe. Nor is it clear how much one can increase the state of acclimatization by hot room procedures, or how men subjected to these artificial methods of acclimatization compare with individuals living normally for many years in tropical climates. Nor is there much knowledge of the part played by sex and race in adaptation to heat. Differences in surface areas, in the ratio of surface area/gross body weight, in the ratio of surface area distributed between the trunk and the extremities might all influence the natural state of heat reaction of individuals of different sex and race. On the other hand, the temperatures and humidities at which men live might play a predominant role in their reactions to heat and might overshadow differences in anthropometry. Also there might be important genetic factors in heat acclimatization which would be evident in men who have lived a nomadic hunting existence in the hot climates, such as the Kalahari Bushmen, Arab tribes in the Sahara, and Australian aborigines. None of these factors in their relation to the state of acclimatization has been worked out fully.

It is of paramount importance to obtain data on the natural state of acclimatization of peoples in various parts of the tropical and subtropical world. This study should include both the indigenous peoples and also Caucasian "expatriates" from temperate regions and various stages of their residence in tropical parts. By this means a comprehensive picture could be built up of the influence of race and of local climate on man's natural state of acclimatization. A survey of heat adaptation of this nature on a world-wide scale is of great importance because the tropical areas of the world could, if developed to their full industrial and agricultural potential, sustain much larger populations than at present. In view of the predicted population explosion towards the end of the century great priority should be given to this question. It is indeed surprising that so much more emphasis has been given to studies of cold adaptation on a world-wide scale by peripatetic physiology teams and that numerous international conferences and symposia have been held on the subject whereas by contrast the problems of heat adaptation have attracted much less attention. If one excludes military considerations, this great disproportion of interest and actual research effort would appear to be unfortunate. The peaceful, industrial and agricultural development of tropical areas is probably going to be one of the Western world's biggest challenges in the next half century.

There are, in addition, a number of *ad hoc* problems which warrant consideration. They relate to the rate at which acclimatization is acquired by different methods. Would one or two days of work in severe heat in a temperate climate before transporting men by air to the tropics reduce the risks of heat collapse and heat stroke on arrival? What, in fact, is the best method of acclimatizing large numbers of men transported from temperate to hot, humid climates? Can one recognize by means of a man's rectal temperature reaction to a standard stress of work in heat the relatively heat intolerant cases?

Nutritional requirements. Many of the natives of the tropical regions are subsisting on a diet which provides submarginal amounts of essential nutrients. The majority of them can better be described as being in a state of chronic hyponutrition rather than malnutrition. When these chronically undernourished individuals are employed in modern industry, it has been found that major metabolic adjustments must occur before they can properly utilize the calories and nutrients supplied them. For several months native workers require 5,000 kg-cal. per day to accomplish the same work that European workers can accomplish on less than 4,000 kg-cal. This difference has been shown to arise from a considerable protein anabolism and a generalized weight increase. This fact must be taken into account in the calculation of rations for the native worker during the period of adjustment. Considerable work yet remains to be done on establishing the requirements of water and salt and the effect of restriction of the intake of these nutrients on the ability to work and on renal function. Among many of the natives there exists a very tenuous nutrient balance which is sufficient to support light work for long periods of time but not heavy work for even short periods. Furthermore, their nutrient balance is easily disturbed by such clinical conditions as diarrhea and vomiting.

Housing, ventilation and air conditioning. In towns in the hot humid tropics such as Darwin in Australia, there are approximately 200 days and 120 nights in the summer when the air conditions with still air are uncomfortable even for individuals adapted to the climate. Consideration in building design has therefore to be given to the question of whether this degree of stress can be relieved sufficiently by providing good ventilation in the hotter hours of the day and night or whether the use of air conditioners is essential.

During the hotter part of the day there is generally adequate natural convection to provide 100-150 feet/minute air movement indoors provided that houses are sited in such a way as to make maximum use of prevailing winds, and that free air flow is allowed for by replacing walls by louvres. The number of uncomfortable days at Darwin would be reduced from 200 to 140 if 150 feet/minute of air movement could be provided by natural or artificial means.

At night, however, the situation is quite different. The proportion of calm periods at night is high in the summer and may rise to 50 per cent in some months. Providing a wind velocity of 150 feet/minute reduced the number of uncomfortable nights from 120 to about 60 at Darwin. Ceiling fans in living rooms and bedrooms in the hot humid tropics should be regarded as an essential, not a luxury, item if air conditioning is not possible.

Consideration should be given to improving present methods of providing air movement. Is the ceiling fan the final answer? The question of the desirable air velocity at night needs to be investigated as half the body is shielded from the air movement. High velocities may be more acceptable, but in hirsute individuals this can cause unpleasant side effects.

One of the important issues in building design for the tropics is whether air conditioning of working and living spaces is essential or desirable. The costs to the relevant authority of air conditioning all houses, administrative buildings, parts of process plants, workshops, etc., would, even if the necessary power were available, be considerable. All of the evidence from the scientific literature on comfort and from current surveys points to the fact that the "set-point" of man's upper limit of comfort is very labile, being lower in peoples living in temperate regions than in tropical areas. Furthermore, the readjustment of the "set-point" appears to occur over a relatively short space of time, altering in a matter of days. Air conditioning of working and living spaces might introduce factors that would interfere with the "natural" state of adjustment in comfort sensation. If a major proportion of the waking time is spent in air-conditioned spaces, then the "natural" adjustment in comfort sensation to a tropical climate might be lost and a new "set-point" of comfort might be established that is adjusted to the "artificial" indoor air conditions. This might be a serious disadvantage in that every time the "artificially conditioned" person goes out from the air-conditioned space into the tropical climate he or she would then experience the air conditions outdoors as much too hot. By contrast, the person who has remained "naturally adjusted" to the tropical climate would experience the same air condition as comfortable, or, at most, as merely warm. The person living in an air-conditioned space would therefore be perpetually in the position of the newly arrived recruit as far as the adjustment of the sensation of comfort to the tropical climate is concerned. A continual reminder throughout the summer months every time one goes out of doors that the tropical climate is much too hot might very well have an adverse effect on the individual's morale.

The problem of air conditioning of bedrooms also requires careful consideration. Use of air movement reduces the number of uncomfortable nights. There is, however, an additional factor that should be borne in mind. Most of the uncomfortable nights follow days which are also above the comfort limit. The combined effect of day and night discomfort on morale, human productivity, etc., can be expected to be more severe than in situations where either day or night discomfort is experienced separately. Unfortunately there are no objective data on this important practical question. It is urged that a field study be undertaken in which the introduction of bedroom air conditioning can be tested for its effect on the morale of individuals in a community.

These problems comprise some of the substance of architectural biometeorology. They are emphasized because the buildings, especially the houses, now being constructed in tropical regions are most unsatisfactory from the physiological viewpoint. Building design must be studied so that places of habitation can be constructed securely against meteorological and geophysical extremes (hurricanes, tornadoes and earthquakes), but these structures must also be livable. Special attention is needed on the problem of designing homes and other buildings for regions where air conditioning by heating and cooling is not economically feasible. For example, attention might be given to the design of a simple, effective and trouble-free evaporative cooling system, especially for roofs. There is urgent need for codification of the thermal properties of construction material. Even where advance technological processes are available, however, buildings designed for architectural beauty are often unhabitable because physiological requirements have been overlooked or ignored.

Clothing. A number of problems were enumerated on the matter of appropriate clothing for hot regions. In Australia, for example, an exhaustive study of the physiological properties of textiles would be important both for the user and the producer. Other significant needs included: (a) establishment of the time course of changes in heat transfer following a change in clothing cover; (b) clarification of the physics of heat transfer through damp clothing; (c) establishment of quantitative expressions for the effect on heat transfer of perflation through large openings; (d) clarification of the relationship of porosity to water vapor transfer in fabrics made from synthetic fibres; (e) establishment of equations for total effect of clothing changes upon heat transfer, including interactions between effects on different channels; (f) establishment of cooling efficiency in relation to rate of air movement for various clothing systems and ambient conditions.

Mental health. There is a need to investigate the psychological aspects of the influence of hot and humid environments in tropical climates on man. There are many conflicting opinions in the medical field concerning the problems of alcoholism, the ability to perform physically and mentally, and the variations in capacity to work efficiently over long periods of time in tropical climates. These aspects have never been investigated adequately and need study. These general remarks can be most clearly emphasized in a brief consideration of the syndrome generally known as tropical neurasthenia.

The clinical features of tropical "fatigue" or "neurasthenia" are not specific to heat but also occur under other stress situations such as isolation from familiar surroundings, the individual being given more responsibility than he can carry, etc. In the tropics there are many new and unfamiliar factors which add to these stresses. Boredom, monotony, domestics and social stresses are all more common than in the home environ.

It might well be that the seed of discontent is well sown if the mental soil is weak; and a well-adjusted person might rise above the adverse circumstances of the tropics. It is not clear whether individuals of the former calibre form the major proportion of those who break down in tropical climates. Heat might, on the other hand, be a specific factor, for it has been suggested by experienced medical officers in the tropics that certain personality types do not "thrive" there whereas others do; the latter are, in turn, miserable and cold in temperate regions. On this clinical assessment it appears probable that certain personalities cannot stand up to air conditions which are near the limit of comfort. It is a challenge to the psychiatrist to define accurately this type of personality. Also the possibility should be examined of these individuals having a lower threshold of air conditions at which discomfort appears than the average for the population. Considerable costs in transport and frustration to the indiivdual might be saved if a test with a high predictive capacity could be developed which could be employed to prevent those persons with a high probability of manifesting psychic disturbances in tropical climates from going there.

In addition to the general sociological factors in the tropics which contribute to these psychic disturbances and the question of the individual's threshold, the part played by two additional factors needs to be considered. One is that these disturbances are rare in hot, dry climates but are more common in hot, humid conditions. This suggests that cool nights make bearable the heat of the desert day whereas the relentless discomfort by day and night, possibly with loss of sleep also, in the hot, humid tropics finally causes a breakdown of the psyche. The other is the effect of skin diseases. The impact on the individual's morale of continuous prickly heat, repeated furuncles, or chronic intertrigo is quite disproportionate to the extent and seriousness of the local lesions.

The syndrome variously identified as tropical fatigue, hot-climate fatigue, or tropical neurasthenia is really a mild psychoneurosis with certain specific and certain general contributory causes. There are two major problems which need investigation before a full evaluation of the importance of this syndrome can be settled. First, there are few reliable data on the incidence of the condition. In its very mild form, most individuals accept it as one of the unavoidable features of tropical life. Tropical neurasthenia is thus not regularly reported in military or civilian sickness returns. The syndrome is readily recognized by the trained observer who is a newcomer to a tropical community. Patients with these symptoms cannot generally be found among the clientele of a psychiatric clinic. The typical case, being neither psychotic nor neurotic, usually avoids the doctor if possible. Thus the only way to establish whether or not tropical neurasthenia is a really important problem is to make field surveys of tropical populations. The other major problem is the present difficulty of distinguishing unequivocally between the effects on the patients of meteorological elements and those of other contributory factors which can also cause these psychic disturbances and lead to a lowering of the individual's morale. One solution to this second problem would be to make an intensive study of individuals with the clinical condition. Another would be to examine the attitudes of communities in tropical regions by means of a survey on a random selection of inhabitants in order to give expression, in a quantitative way, to changes in morale at various seasons of the year. The following information might be sought in such a survey: (a) volume of complaints, (b) number of resignations, (c) number of applications for sick leave, (d) rate of wanton destruction of public property, (e) time taken for standard tasks, (f) accident rate, (g) quality of workmanship, (h) incidence of psychosomatic complaints and of neuroses, and (i) number and quality of spontaneously organized social events and the attendance at them. By suitable statistical analysis of this information it should be feasible to examine the possible correlation between this index of the community morale and the air conditions, expressed as effective temperature.

Results of a social-psychological study of this nature would need to be assessed with respect to a "base line" of morale of the community. This would not be simple. Social relations in a community are dynamic, and it can be conjectured that in an isolated, self-contained community they would be more delicately poised than in or near a town. Surveys of this nature need therefore to be carried out by experienced social-psychologists, possibly working in association with medical officers who have experience in tropical regions.

To make surveys of the types suggested here it is important that certain other problems be solved first. Adequate measures of mental performance, especially under natural conditions, must be developed. Techniques must be developed to measure the importance of psychological attitudes in acclimatization and performance under natural conditions.

The heat diseases. Knowledge of the causal mechanisms of some forms of heat illness, especially heat exhaustion, is in a most unsatisfactory state. The acute forms such as heat collapse, prickly heat leading to loss of heat regulation and hyperpyrexia, and heat stroke can seriously interfere with the operational efficiency of large groups of men moved suddenly to tropical areas without prior and adequate acclimatization. The more chronic forms, heat exhaustion, tropical anhidrotic asthenia, and mycotic and staphycoccal infections of the skin lead to a loss of initiative and lowering of morale in inhabitants of tropical regions. A state of chronic, mild, ill health is a common background factor in individuals showing the psychic disturbances characterized as tropical "fatigue." A serious intensive and concerted research effort is needed on this subject in any research program concerned with "the health and working capacity of tropical populations." The present inadequate state of knowledge in this field of research is probably best exemplified by the variety of schemes which have been suggested for the classification of heat illnesses.

Some of the specific issues upon which knowledge is needed are the following:

Skin disorders. Much is known of the pathophysiology and causal mechanisms of prickly heat. It leads to temporary, but severe, disablement in new arrivals in the tropics, especially if they expose themselves to large doses of ultraviolet radiation from the sun. Mycotic infections, furuncles and infected wounds all have a markedly higher incidence in the tropics than in temperate regions. Certain local factors have been implicated but their causal association has not been clearly established. These factors include a continuously moist skin, trauma to skin from wet clothes, the electrolyte content of sweat, etc. While these factors might play an important contributory part, the predominant clinical fact remains that individuals vary greatly in their susceptibility to these skin infections. Little is known of the reasons why certain skins have a specific sensitivity to skin disorders in the tropics. The development of test procedures for recognizing those individuals with a greater susceptibility than average of developing skin disorders in the tropics, as with the question of psychic disturbances, would prevent these potential casualties from being recruited for service in the tropics.

Circulatory disorders—heat syncope. Heat collapse is the commonest cause of incapacitation in unacclimatized individuals on first exposure to the hot, humid tropics. The adjustment of the circulation during acclimatization has as one of its most important results the resistance to syncope. The circulatory adjustments, heart rate, stroke volume, right heart filling pressure, blood volume, peripheral blood flow, venous tone, etc., have not been studied in the same detail that the vasovagal collapse in haemorrhage has and hence the circulatory mechanism which triggers off syncope in heat is not known precisely. There is need, therefore, for an intensive study of the circulatory system during exposure to heat up to the point at which syncope occurs. This might throw light on ways and means whereby syncope could be prevented. It might be that a drug which acts primarily on the venomotor system might prevent syncope without at the same time causing vasoconstriction of arterioles in skin which would interfere with tissue conductance of heat.

Disorders of water and electrolyte metabolism—heat exhaustion and tropical anhidrotic asthenia. There is urgent need for careful studies on heat exhaustion to evaluate the interrelationships between salt balance, water balance and changes in the intra- and extra-cellular spaces. Such studies would form the basis for preventative measures with regard to salt and water intake in subjects who are liable to heat exhaustion because of the nature of their work in tropical climates. It would also give guidance as to correct treatment. Even less appears to be known about the salt and water balances in tropical anhidrotic asthenia and this condition also therefore requires urgent study.

Heat stroke. There are three main areas of ignorance which are of both theoretical and practical importance. The first concerns the mechanism responsible for the depression of sweating which ultimately develops into total anhidrosis. This matter is most significant, for in the natural history of the disease, the anhidrosis usually precedes the appearance of hyperpyrexia. If the ambient conditions and physiological processes which cause the depression of sweating can be identified, a rational program of prevention should follow. The second problem is the length of time that the body temperature can be raised to various levels before irreversible changes occur in the body which lead to death. These changes are of two kinds. In one the circulatory system goes into profound shock and none of the present anti-shock measures restores the blood pressure to normal; the other is specific heat damage to cerebral tissue. Patients die with a good circulation but in deep coma or wild delirium. It might be that permanent damage occurs within 30 minutes at a rectal temperature of 110° F but only after 120 minutes at 107° F. Such knowledge would guide the urgency with which cooling must be started and the type of cooling that should be used. The third area of ignorance is the role of the circulatory system in the damage to vital tissues. Some heat stroke deaths are essentially circulatory in that blood pressure cannot be raised by known methods. Lesser degrees of circulatory collapse, for the period it takes to transport the case to a hospital, might be responsible for tissue damage. Evidence of this is seen in jaundice during recovery and in lower nephron nephrosis about a week after the accident which sometimes leads to renal failure and death. These subjects require intensive study both as a guide to immediate treatment of the case on recognition and subsequent hospital treatment.

Domestic animals. It has been recognized for many years that Zebu cattle are better adapted to the tropics than the European breeds. Yet comparatively little progress has been made in identifying those physiological characteristics which differ between the two types of animal. Recent work in Australia has shown that the difference may extend beyond heat regulation to adaptation in making the best use of the low nitrogen pastures of the tropics. Obviously more systematic studies on this finding are necessary. The differences in physiology between the various breeds of Zebu do not seem to have been studied at all. Of particular importance is the difference between the larger Zebu breeds and the small cattle of the wet tropics, such as West African Shorthorn and Sinhala which do not seem to be properly Zebus at all.

Perhaps the most important determinant of working efficiency is the availability of power. It is probable that for many years animal power may provide the chief source in the tropics. Even where internal combustion engines can be locally manufactured, there may still be exchange difficulties in importing sufficient petroleum to operate them. So far, there seem to be no investigations on the efficiency of work of animals in hot climates, analogous to the many studies which have been made on man. Yet even casual observation of the method of working animals in the tropics leads one to think that they are not efficient. For instance, cattle and buffaloes, whose heat regulation, even in heat adapted breeds, is not outstanding, may be seen working in the middle of the day exposed to solar radiation, when a comparatively primitive sunshade could improve their thermal environment. Likewise, donkeys may be seen in the subtropics carrying loads which must effectively prevent evaporation of sweat.

Other specific problems which need investigation are: (a) determination of the relationships between the properties of animal coats in relation to efficiency of cooling and (b) clarification of the physics of sweat distribution in animal coats in relation to efficiency of cooling. The present state of knowledge is particularly unsatisfactory in the following respects, some of which parallel those noted for human adaptations: (a) absence of quantitative indices of thermal effects permitting prediction of welfare, performance, and production under given conditions, (b) lack of clear indications of optimum production targets for given animals under various conditions, (c) insufficient data on the possible association between efficiency of food utilization and heat tolerance in a given species, breed or strain, (d) uncertainty as to optimum feeding practices for conservation of performance under conditions of periodic starvation, and (e) insufficient evidence on effects of chronic water deprivation.

Medical and human ecology. There is a need to investigate the influence of tropical climates upon the incidence of various diseases. The incidence of disease varies geographically and although the importance of geographic pathologic investigation is well recognized, this field has been and continues to be neglected. Research on medical ecology should not be limited to diseases peculiar to the tropics, but should include diseases found the world over, such as angina pectoris, arteriosclerosis, hypertension, cerebrovascular accidents, peptic ulcer and many others. The incidence of cardiovascular diseases among Negroes living in the tropics is quite different from that of the Negro and the white man living in the temperate zones; the role of tropical climate *per se* has never been adequately evaluated.

The incidence of renal lithiases is very high among young workers in the Sahara. This problem has been investigated among several thousand such workers but no good hypotheses to explain this problem have yet been forthcoming.

Of the many biometeorological problems that are in need of solution the consultants agree that more attention should be given to examining them in their total ecological context. From the viewpoint of human ecology it should be emphasized that no comprehensive survey has been made to determine the relative distribution of problems in human and animal adaptation under various types of tropical occupancy or economy, or of the relative importance of the various problems. Similarly, few estimates have been made of the changes that occur in the nature or distribution of problems following changes in the economy of a region. Furthermore, few estimates are available of the economic cost that would result from failing to solve various problems in human and animal ecology. Much more attention should be given to educating local inhabitants in the application of existing knowledge to important practical problems.

Field vs. laboratory investigations. Throughout this document we have emphasized many and various problems but have written relatively little regarding the methods by which these problems should be investigated. It is the considered opinion, both of the present consultants and of the scientists who comprised the group on biometeorology of the Task Force Conference on Atmospheric Sciences which met in the summer of 1961 under the direction of Dr. Sverre Petterssen (S. Petterssen: *Atmospheric Sciences, 1961-1971.* Nat. Acad. Sci.—Nat. Res. Council, Washington, 1962), that these problems can be most fruitfully investigated by research work in the field rather than in the laboratory. Laboratory work has thrown great light on mechanisms, physiological and psychological, of man and animals in heat, but the results are not always directly applicable to the practical problems which arise in the natural or actual tropical environment. Unfortunately, scientific status and prestige have been greater in laboratory work than in research in the field and as a consequence relatively little work in the latter has been done in the area of tropical biometeorology since World War II. Few of the major problems concerning the health and working capacity of tropical populations are going to be answered by further laboratory research. There are populations of indigenous and immigrant Caucasians living in tropical areas. The challenge to the human environmental biologist is to develop new field techniques for studying these populations so as to provide answers to the problems of the health and working capacity of the peoples of these areas.

While the field studies are certainly of utmost importance, they should be coordinated with research in environmental laboratories where theoretical knowledge can be augmented in studies under more precisely controlled conditions than are possible in the field. The fact that the basic processes of reaction to work in hot atmospheres, insofar as they have been studied, are independent of biotype suggests that, as far as laboratory work is concerned, the health and working capacity of tropical populations, whether indigenous or transitory, can be promoted by laboratory studies in temperate latitudes if the facilities for doing this type of work are available there but not available in the tropical community. Appropriate field teams should be established in the tropics to live with and to define the problems and to apply or confirm in the natural living or working environments the techniques or lessons learnt in the base laboratory. The laboratory would also serve as a place to work out and test new techniques for use in the field surveys. To paraphrase Surgeon Captain Ellis' comment, the objective of future investigation in tropical biometeorology should be "the peak of Everest, not the world's treadmill records."

Substantive recommendation to National Research Council. To implement these various ideas we propose that an *ad hoc* committee of scientists experienced in tropical biometeorology be constituted with the following terms of reference:

(a) to discuss the various recommended research problems on health and work capacity of tropical populations and allocate some order of priority to them;

(b) to consider the possibility of organizing this research on an international basis by asking certain laboratories to undertake projects and aid them financially and also to constitute teams of research workers from different laboratories for field research in the tropics;

(c) to examine the question of the finance needed and from what sources it could be obtained.

In planning its program of research this committee should give priority to field studies. Once funds have become available, it should organize a field team to make a survey of the feasibility of carrying out the research in the tropics. The field team should be comprised of physiologists, sociologists, and experienced tropical medical officers.

General Summary and Conclusions

GENERAL SUMMARY AND CONCLUSIONS

Chapter 1. INTRODUCTION

The main objective of the present survey was "to determine the role to be played by the United States in future research and development on problems related to human and veterinary medicine, hygiene, nutrition and climatic influences in the tropics." Within this framework, the following specific lines of inquiry were proposed:

"Collect the best factual information on the present status of diseases of human beings and animals of foremost economic importance in various tropical regions.

"List the most important human and animal diseases which at present cannot be controlled.

"Analyze the hygienic, climatic and nutritional problems which are responsible for low productivity of peoples currently inhabiting various tropical regions, as well as those which would constitute the greatest hindrance to the movement of new populations into those areas.

"Evaluate research and development work on these problems at present in progress in (a) research institutes of governmental and private agencies of other nations, and (b) various private and public institutions sponsored by the United States.

"Gather information on the specific problems of interest to American industry, commerce and government in various tropical regions."

For the purposes of the survey, the tropics were defined as including five major regions, viz., the Caribbean, Central and South America, Africa, Southwest Asia, South Central and Southeast Asia and tropical Oceania. The disease coverage was confined to the infectious and nutritional maladies. Within this category, a selection was made by the Advisory Committee of the diseases which were thought to constitute the most important public health problems in the tropics. A similar selection was made of diseases of domestic animals. The original plan provided for the collection of data over the five-year period 1954-1958, but in certain instances it was not possible to follow this procedure.

PART I

Chapters 2-7. SIGNIFICANT HUMAN DISEASES IN TROPICAL AND SUBTROPICAL AREAS

Available data for the five-year period 1953-1957 are presented with regard to population, general mortality, neonatal mortality, infant mortality and natural increase. Considerable lack of reporting was noted. Considering only the countries for which complete data on population were obtainable, a population increase of 32,291,000 was noted between 1953 and 1957. The greatest increase was recorded from South Central and Southeast Asia. Data on general mortality were obtainable only from 32 per cent of 169 countries and territories of the survey area. The average mortality rate was 9.38 per 1,000; when extrapolations were made for better coverage, the rate was 8.30. A mean annual infant mortality rate of 95.6 per 1,000 births and an average annual neonatal mortality rate of 4.68 per 1,000 births were recorded for the five-year period. In this vast area, only two countries had an infant mortality lower than that of 26.3 for the United States. On the basis of available reports, the relative rank of the first ten of the diseases of greatest public health importance in the entire area of the survey was, as follows: Tuberculosis, malaria, influenza, nutritional deficiencies excluding kwashiorkor, cholera, bacillary dysentery, pneumonia, measles, whooping cough and amoebic dysentery. Of the diseases considered in this report, the following are not amenable to control at this writing: Schistosomiasis, measles, leptospirosis and certain of the arthropod-borne viroses.

PART II

Chapter 8. SIGNIFICANT DISEASES OF DOMESTIC ANIMALS IN TROPICAL AND SUBTROPICAL AREAS

Effort was made to evaluate the relation of diseases of domestic animals to health problems in the tropics. Difficulty was encountered because the reporting of animal diseases is far less efficient than that of human diseases, which admittedly are inadequately reported. The ratio of veterinarians to the livestock population in the Caribbean, Central and South America was 1:118,272, with ratios of 1:160,315 for Africa, 1:106,035 for Southwest Asia and 1:51,256 for South Central and Southeast Asia. The comparable figure for the United States was

1:11,419. A survey of veterinary educational facilities indicated that such facilities were pitifully inadequate in Africa and Southwest Asia. A total of 19 countries furnished estimates on the annual economic losses from animal diseases; other data with regard to the extent of losses were assembled. An analysis was attempted of the distribution and relative importance of 23 diseases or disease categories of domestic animals in the tropics. There is only one of these diseases (sweating sickness of cattle) for which preventive and control measures are not known at present. Data were collected on personnel and per annum budgetary expenditures of national veterinary services. A total of 95 of 130 countries having such services reported a total of 5,336 professional personnel and 17,320 other personnel. For the Caribbean, Central and South America, veterinary budgets constituted 0.151 per cent of the total national budgets of the countries represented. The like figures in other regions were as follows: Africa 0.779, Southwest Asia 0.643, South Central and Southeast Asia 0.152 and Oceania 0.162. The ratios of expenditures to the livestock population of countries included, in terms of the number of animals per U.S. $1.00 of expenditure, were as follows: Caribbean, Central and South America 39.48, Africa 13.53, Southwest Asia 15.63, South Central and Southeast Asia 52.64 and Oceania 0.57. The comparable figure for North America was 3.32. As might be expected, the per cent of the total budget devoted to veterinary services was considerably less than that appropriated for health services. In spite of the relatively modest national budgets for veterinary services in relation to the needs in many parts of the tropics, it was the impression that gratifying advances have been made during recent years in curbing animal diseases.

PART III

Chapter 9. RESOURCES FOR HEALTH AND MEDICAL CARE

General Medical Resources in the Tropics

In a survey of the availability of certain medical resources in the areas included in this report, the number of medical and paramedical personnel, government expenditures for health services, the number and types of hospitals, clinics and outpatient facilities, and an analysis of preventive medicine programs were considered.

It was estimated that the areas included in the survey utilized the services of approximately 227,800 physicians and 160,200 qualified nurses in 1956. The number of persons per physician in the Caribbean, Central and South America was estimated to be 1,900; in Africa, 9,000; in Southwest Asia, 5,000; in South Central and Southeast Asia, 7,000; and in Oceania, 5,100. A perspective of the need which these figures represent may be conveyed by the analogous figure of 756 persons per physician in the United States in 1957. In like manner the numbers of nurses and other paramedical personnel were found to be exceedingly small in the survey areas, the deficiencies being aggravated by the concentration of medical services in the larger urban areas.

Total government operating expenditures for health in the survey areas amounted to the equivalent in United States currency of 5 billion dollars during the period 1954-1957. But, in individual terms, the per capita expenditures for one year (1957) were as follows: in Oceania, $4.51; Caribbean, Central and South America, $2.68; Southwest Asia, $1.66; Africa, $1.17; and South Central and Southeast Asia, $0.83. A comparison by political and geographical areas indicated that the ratio between figures for population and health expenditures in independent countries and mainland colonies was virtually unity, but there was a disparity in these figures in the case of island colonies, as the cost of maintaining an adequate medical establishment cannot fall below a certain level, no matter how geography limits the population served. Island administrations tend to benefit from this. In most areas of the survey, health expenditures comprised approximately 5 or 6 per cent of the total budget, the notable exception being Oceania, comprised of island colonies, where the ratio was 13.2 per cent.

In 1955-1957 there were 3.2 hospital beds per 1,000 population in the Caribbean, Central and South America. In Africa the comparable figure was 1.9; Southwest Asia, 1.1; South Central and Southeast Asia, 1.64; and Oceania, 4.8. The figure may be compared with that for the United States in 1957, which was 9.01 per 1,000. Data were also compiled on the numbers and types of hospitals, clinics and outpatient facilities, the distribution of facilities by directional authority and the amount of annual patient loads. Since the figures are relatively incomplete, only the most general of conclusions can be drawn from them. Indeed, data from the Caribbean, Central and South America are so sparse as to preclude comparisons with other regions. The data indicate that hospital bed space is not adequate to the need in Africa, Southwest Asia and South Central and Southeast Asia. Needs are greatest in South Central and Southeast Asia. In Southwest Asia, low annual patient loads may reflect a low degree of exposure to or utilization of Western concepts of medical care.

An analysis of preventive medicine programs for the period 1954-1958, as exemplified by immunizations against certain diseases, indicated that the major programs were directed against smallpox, tuberculosis, cholera and yellow fever. The magnitude of these and other immunization procedures varied with the geographical region. For instance, the largest number of yellow fever inoculations were carried out in Africa; Southwest Asia listed the greatest number of T.A.B. vaccinations, while the highest proportion of diphtheria inoculations was given in South Central and Southeast Asia. Undoubtedly, many factors controlled the utilization of such procedures, although to a certain extent the distribution of vaccinations indicated the degree of importance of the disease in a given region.

Taken in their entirety, the data contained in Chapter 9 would be of limited value if viewed as ends in themselves. The variety of sources from which they were drawn indicates rather clearly the unlikeliness that they are basically comparable. Thus, it would serve no useful purpose to offer them in any perspective other than that of the present report; but here they suggest a degree of relative technical poverty in certain tropical regions with which proposed research programs will have to cope.

Medical Mission Installations by United States and Foreign Mission Boards

A survey of medical mission facilities resulted in information concerning 1,280 mission hospitals and 1,897 inpatient and outpatient clinics with respective annual patient loads of 1,902,837 and 15,100,823. The mission facilities had 82,807 beds and were staffed by 2,696 physicians, 31 dentists, 5,738 nurses and 15,442 other personnel. Total operating funds available for the above-mentioned installations were $28,365,688. The largest number of medical missions was reported from Africa, followed by South Central and Southeast Asia. In Africa, however, installations were comparatively understaffed and underfinanced. A considerably smaller number of installations was reported from the remainder of the geographical regions included in the survey. In spite of incompleteness of data, which precludes an evaluation of the relative extent of the missions' contribution, there is no doubt that these organizations have contributed materially to health in the tropics. Moreover, from the viewpoint of United States interests, they have provided many American physicians with an opportunity to practice medicine in the tropics.

Industrial Medical Installations in the Tropics (American Firms)

Effort was made to secure data concerning medical programs of American corporations operating in the tropics. Questionnaires were sent to 83 such firms. Of these, 37 did not respond, 22 were unable to furnish any information, and 24 replied in whole or in part. The 24 firms operated 49 medical programs in 27 tropical countries; the total medical expenditures by 20 companies for 40 programs was $26,842,228.48. Of this amount, $1,138,618.72 (4.2 per cent) was spent for projects in preventive medicine.

Environmental Sanitation

The inadequacy in many areas of the tropical world of supplies of piped safe water is widely recognized by public health authorities as contributing in a major fashion to the transmission of many enteric infections. Thus it was disappointing that efforts to secure information on the distribution of potable water supplies and sewage systems in the survey area were generally unrewarding. The only careful study concerned piped water supplies in Latin America, where 39 per cent of 74 million urban residents lack such facilities. This number represented about 40 per cent of the total population at the time of the study. Partially complete data on piped water supplies in the countries of the eastern Mediterranean region convey the impression that, with few exceptions, urban communities here are also deficient in supplies of this commodity.

PART IV

Chapter 10. TROPICAL HEALTH AND THE ECONOMY OF THE UNITED STATES

Attempts were made to analyze, insofar as data were available, the impact of low health standards in the tropics on the internal economy of the United States. This country has many material interests in the tropics and is dependent on many tropical areas for a large share of its important strategic materials. Foreign trade with tropical countries constitutes a substantial portion of our total imports and exports. The underdeveloped countries offer huge market potentials for United States goods, and it is anticipated that trade with these areas will materially increase during the next ten years. United States investment abroad is increasing from year to year. At the end of 1960, it was $32,744 million, of which 38.5 per cent was in Latin America, Africa, Asia and Oceania.

Effort was made to assemble data on the cost of tropical diseases. Reliable information is meager. Available material consisted mostly of estimates unsubstantiated by economic surveys. The relationship of health to the economy of tropical areas is a complex subject involving many factors. Yet it cannot be entirely accidental that a low per capita income coincides with high morbidity and mortality and a low life expectancy. In only one of the 169 national health jurisdictions represented in this survey is the per capita income more than $700 per annum. In most of the countries, it is much lower. Some analysis has been attempted of the perennial question concerning the economic threats which will allegedly ensue from the saving of lives with a resulting lower morbidity and mortality and a longer expectancy of life. Examples are cited of India, Puerto Rico, Mexico and Ceylon, countries in which remarkable health advances have been made, advances which have been accompanied by economic improvement and increased agricultural production. Undoubtedly, however, a continued high rate of natural increase will be of concern unless the economy keeps pace with such increase. There is no doubt, however, that a reduction in debilitating infectious diseases and improvements in diet will increase the capacity of tropical populations for work and represent an economic contribution to the welfare of the nation. Difficulty has been encountered, however, in attempting to measure the impact of inadequate diets and debilitating infections on work output. It is quite apparent that authoritative studies are needed on the influence of low health standards on individual and group productivity.

Chapter 11. THE IMPACT OF TRAVEL AND MIGRATION ON TROPICAL DISEASE PROBLEMS

Travel and migration as used herein are broadly inclusive terms intended to encompass every possible kind of human movement or displacement with a resulting significance to public health. Historically, the travels of individuals or of whole populations have frequently been discovered, in retrospect, to have been associated with the spread of disease. In this perspective, the tropical diseases stand out. For example, the Spaniards undoubtedly brought smallpox to the Western Hemisphere, and the slave trade introduced to it a large array of infections such as schistosomiasis, filariasis, dracontiasis, yellow fever and onchocerciasis. In Southwest Asia, the annual pilgrimages to Mecca have, until recently, been attended with the threat of cholera, malaria and trachoma. The frequent religious fairs of India have been the birthplaces of some of the most severe epidemics of cholera in recorded history.

In modern times, the process has continued, whether it is exemplified by the accidental introduction of a single infected mosquito into Brazil, subsequently resulting in epidemics that cost more than 13,000 lives, or by the unfortunate forced mass relocation of riverine villages in Uganda to escape the scourge of sleeping sickness at a time when the role of the tsetse fly was imperfectly appreciated. An example is also provided by the relocation of Okinawans to the rain forest of Bolivia in 1954, a program which met with initial failure due to an unexpected epidemic of "jungle fever." In another example, the final word has yet to be said with regard to the rapidly increasing rates of schistosomiasis in Portuguese settlers in the Mozambique.

It is probably adventurous to claim that such undesirable results are theoretically avoidable in all instances. Yet, adequate health planning where large movements of non-immune persons are involved has been attempted with gratifying results, as in the construction of the Kariba Dam in Northern Rhodesia.

Certain of the oldest health problems associated with population movements cannot be settled by planning. Thus, nomadism and uncontrolled cyclical migrations have so far escaped efforts at medical control. In Africa, this has mitigated against the success of malaria eradication in many areas.

In addition to the mass movements of civilian populations, military movements, especially those as recent as World War II and the Korean War, succeeded in exposing large numbers of non-immune persons to exotic infections.

With regard to the interests of the United States, the greatest number of persons traveling from our boundaries to tropical areas disembark within the area of the Caribben, Central and South America (92.8 per cent of the total in 1956-1960). In the future, this ratio may fall in favor of tropical areas outside of the Western Hemisphere.

The almost universal adoption and implementation of the International Sanitary Regulations have caused a marked diminution in cases of the quarantinable diseases (plague, cholera, yellow fever, smallpox, typhus and relapsing fever) in ports of entry. However, these regulations are not designed to protect against import and export of many tropical diseases. The present foreign policy of the United States with regard to the so-called underdeveloped countries, most of which are in the tropics, is such as to present the field of American tropical medicine with a challenge which will grow stronger in the years ahead.

PART V

Chapter 12. RESEARCH PROGRAMS IN THE UNITED STATES IN MEDICAL AND HYGIENIC PROBLEMS OF THE TROPICS

Federal Agencies

Domestic coverage included research in federal agencies for the period 1954-1958, medical schools and schools of public health as of 1 July 1959, the pharmaceutical industry for 1958, and private research laboratories as of the latest available date. The amount expended by government agencies for intramural research in tropical medicine over the five-year period was $13,472,000. Of a total of $18,746,000 for intramural and extramural or contract research by federal agencies, 71.9 per cent represented intramural expenditures and 28.1 per cent represented extramural expenditures. The total amount during the five-year period constituted 2.4 per cent of the total of $773 million expended for all bio-medical research by the Federal Government during this period. In the federal agencies at the end of 1958 there were 211 professional and 415 subprofessional workers in tropical medicine; these individuals accounted for 11.6 per cent of the 5,400 Federal Government personnel engaged in all intramural medical and health-related research in 1958.

Medical Schools and Schools of Public Health

An inquiry into tropical medicine research in medical schools resulted in securing information from 78, or 95.1 per cent, of 82 schools, as well as 2 schools of public health. A total of 46 institutions reported 144 research projects, of which 46 were in tropical medicine and 98 in parasitology; of the 46 tropical medicine projects, 26 involved clinical studies. Of the 144 projects, 70 concerned 18 of the diseases regarded as those constituting the most important public health problems in the tropics. A comparison is made with 26 foreign medical schools which were engaged in 105 projects concerned with 29 of these diseases. A total of 123 staff members were engaged in the reported research, of which 21 were listed as full-time research personnel. Of the total personnel involved in tropical medicine research, 28.5 per cent were physicians and 71.5 per cent non-medical professional faculty members. The total amount expended for research in tropical medicine and parasitology for the fiscal year 1958-59 was $1,403,077, of which 71.3 per cent represented support from the Federal Government. The total amount was 1.3 per cent of the total research expenditures in the medical schools for the previous fiscal year (1957-58). As indicated by the proportion of expenditure, tropical medicine and parasitological research was receiving less attention in the medical schools of the country than in departments of the Federal Government.

Expenditures for Research by American Pharmaceutical Manufacturers in Calendar Year 1958

Data on tropical medicine research in the pharmaceutical industry in the United States were received from 53 firms, including all of the larger pharmaceutical houses. Only 16 companies reported any expenditure in this field. The total amount expended for this purpose in the calendar year 1958 was $5,105,000, of which $4,900,000 was spent on research in human diseases and $205,000 on research in diseases of domestic animals in the tropics. The above-mentioned amount represented only 3 per cent of the total expenditures for research in the drug industry for the year in question.

Research in Private Institutions

Four privately administered United States institutions are engaged in research in tropical medicine. All enjoy the use of working facilities located outside the continental United States and in areas defined as within the coverage of the survey. Two (the Leonard Wood Memorial and the Virus Research Program of the Rockefeller Foundation) pursue programs which are carefully delimited in terms of goals, being concerned, respectively, only with leprosy and with the arthropod-borne viroses. Conversely, the research programs of the Gorgas Memorial Laboratory in Panama and the Liberian Institute are broader in terms of diseases studied, but their facilities are entirely centralized, limiting their research programs to conditions characteristic of their respective locations. With the exception of the budgets of the Rockefeller Foundation, the annual budgets for the private programs are relatively modest. In 1960, the combined expenditures amounted to $1,971,483, of which 60.6 per cent represented expenditures of the Rockefeller Foundation. Of the remainder, 11 per cent was utilized by the Leonard Wood Memorial, 15.4 per cent by the Gorgas Memorial Laboratory, and 13 per cent by the Liberian Institute. Historically and financially, however, these institutions have little in common and it would be imprudent to pursue the matter of comparisons too strongly.

Chapter 13. FOREIGN RESEARCH IN MEDICAL AND HYGIENIC PROBLEMS OF THE TROPICS

In an effort to secure an idea concerning the extent of tropical medicine research in foreign institutions, queries were made of 207 medical research institutes, 65 veterinary research institutes, 86 medical schools and 63 veterinary schools located for the most part within the geographic areas of the survey. Useful data were provided by 116 medical research institutes, 33 veterinary research institutes, 38 medical schools and 23 veterinary schools. Seventy-five per cent of the institutions were government operated. Of the 210 which replied, 145, or 70 per cent, carried on research in this field. Of 72 research institutes which supplied financial data, the average expenditure per institute for such research was $187,000. The average annual allotment for tropical medicine research in 21 medical and veterinary schools was $17,000. The number of professional personnel employed by 91 medical and veterinary research institutions and 28 medical and veterinary schools was, respectively, 1,608 and 345. A total of 39.7 per cent of publications of the research institutes were devoted to tropical medicine, as were 44.2 per cent of those of the medical and veterinary schools. There was a tendency to devote more attention to tropical medicine research than was the case in institutions in the United States; there was also a closer relationship of the research to the disease problems of the tropics. The data conveyed the impression that foreign workers in tropical medicine and tropical veterinary medicine work with smaller expenditure allotments, and presumably less equipment, than is customary in this country. The number of resulting publications suggests that this relative deprivation does not prevent the performance of a large amount of research which constitutes almost half of the total medical and veterinary research in the areas represented.

PART VI

Chapter 14. RESEARCH GRANT PROGRAMS IN TROPICAL HEALTH

Domestic Grant Programs for Calendar Years 1954 through 1958

Grant programs in tropical medicine in the United States for the five-year period totaled 164, a relatively small number compared to total grants in medicine and the medical sciences. One hundred and thirty-seven of the grants were made by government agencies and 27 by private foundations. The total funds involved amounted to $5,733,191. Over the five-year period, there was a gradual increase both in the number of grants and the amount of funds. Ninety-six grants were awarded to personnel in professional schools, 45 to research institutes and 23 to academic institutions. The majority of the grants (91 of 164) went to investigators holding the M.D. degree; 61 recipients had Ph.D. degrees, 4 Sc.D. degrees and 2 the degree of D.V.M. Most of the research represented basic laboratory research; only 12 grants concerned clinical research, although an additional 38 fell within the classification of mixed laboratory and clinical research. There were some notable studies of a well-integrated and progressive nature, but the impression remained that the majority dealt with isolated projects which had little relationship to health needs in the tropics.

Foreign Grant Programs for Calendar Years 1954 through 1958

A study of foreign research grant programs was approached largely through national research councils or equivalent in 28 countries. No reply was received from eight countries and one was unable to furnish the desired information. In six countries no grants had been made for research in tropical medicine over the five-year period represented, 1954-1958. Of the 13 countries from which data were available, a total of 969 tropical medicine grants were made during the period, of which the great majority (854) were from government funds. Seventeen grants were financed by private industry, 62 by private foundations and 36 by other organizations, mainly international health agencies. During the last three years of the period, the number of grants increased significantly. Expanded tropical medicine research characterized programs in India, Indonesia, the Philippines and South Africa. In terms of U. S. dollars, the monies expended during the period totaled $10,166,235, of which 71.4 per cent was supplied by governments, 0.64 by private industry, 8.59 by private foundations and 19.37 by other organizations. The amount of the average foreign grant was $10,535, as compared with $34,958 for the average U. S. grant for the same period. A total of 150 institutions benefited from the grants; of these, 7 were academic institutions, 69 professional schools and 74 other types of institutions, the most of which were devoted to research. Of the 170 principal investigators, 111, or 65.3 per cent, held doctorate degrees. This figure may be compared with 97.5 per cent in the same category in the U. S. grants for the same period. In general, the results of the survey indicated a considerable interest and activity in supporting tropical medicine research in many countries having national research councils or equivalent organizations.

Grants to Foreign Institutions by American Foundations for Calendar Years 1954 through 1958

Most of the grants in medicine and public health in the survey area were not designed specifically for research but were made for a variety of purposes. They were divided into two categories, viz: Grants contributing directly to research, designated as R grants; and grants promoting public health and medicine in the tropics, designated as MPH grants. During the period in question, 281 R grants were made for the total sum of $11,814,624 and 61 MPH grants for a total of $3,027,511. With the exception of 1955, the yearly number showed a uniform consistency. A well-defined pattern of distribution was exhibited by both types of grants. The majority went to institutions in tropical America and South Central and Southeast Asia. Africa with its greater needs received only four grants or 2.1 per cent of the total amount allocated. In general, there was little relationship geographically between health needs and the grant coverage. The single exception concerned South Central and Southeast Asia. It is evident that American foundations have contributed materially to the promotion of medicine and public health in needy areas by grants to medical institutions and have thus supplemented generously public aid to these areas.

Chapter 15. FELLOWSHIP PROGRAMS IN TROPICAL MEDICINE

An inquiry was conducted into the amount of support available for fellowships in tropical medicine with the view of determining whether such support was adequate and in keeping with demands for training in this field. The inquiry included both domestic and foreign sources of fellowship funds for the five-year period 1954-1958. The total number of fellowships available in the United States programs surveyed was 30,282, of which 2,521 were in medicine and the medical sciences. Only 172, representing a total expenditure of $600,193, were granted in the field of tropical medicine. Fellowships in tropical medicine for non-United States citizens greatly exceeded those for U. S. citizens. Over 9,000 fellowships for foreign workers were reviewed in 11 different programs. During the five-year period, tropical medicine fellowships in these programs totaled 5,340 involving a total subsidy of $13,064,203. Nearly every country within the geographical coverage of this survey was represented among these fellowships. The relatively small number of tropical medicine fellowships granted to workers in this country would seem to reflect a definite lack of interest in the field.

Chapter 16. TEACHING OF TROPICAL MEDICINE AND HYGIENE

Domestic Teaching Programs in United States Medical Schools for 1959

Tropical medicine and parasitology lost much of their identity as discrete disciplines during the five years preceding 1959. Only one school had a separate department of tropical medicine and only two accorded a departmental status to parasitology. The number of teaching personnel in these subjects decreased slightly over a five-year period. Over one-third of the teachers had had no tropical experience and 56 per cent of them were not members of the American Society of Tropical Medicine and Hygiene or the American Society of Parasitologists. The survey points to the desirability of curriculum study groups re-evaluating the importance of tropical medicine and medical parasitology.

Teaching of Tropical Medicine and Hygiene in Foreign Institutions

The most influential institutions of tropical medicine teaching are located in Europe and were undoubtedly the outgrowth of health needs in tropical colonies. While European responsibility has diminished in accordance with political independence of many former colonies, tropical medicine teaching continues strong because interest has not diminished to the same extent as have the responsibilities. Most of the teachers of tropical medicine abroad have had extensive experience in the tropics and many of them have world-wide reputations in the field. In general, salary scales are low and it is necessary in many cases to supplement income by private practice of medicine or other devices.

Chapter 17. TRAINING FACILITIES IN THE FIELD OF TROPICAL MEDICINE AND HYGIENE

Information is summarized on institutions providing training programs and the nature of such programs. Opportunities in the United States for training in tropical medicine have been exceedingly meager in the past. The training programs at Columbia University and the Louisiana State University have for a number of years provided worth-while opportunities for medical students and faculty members. More recently, the institution by the National Institutes of Health of the program for International Centers for Medical Research and Training has represented a long step forward in providing additional facilities for badly needed expansion in this field.

Chapter 18. CAREER OPPORTUNITIES AND INCENTIVES

Strong incentives to select the field of tropical medicine as a career are lacking at present. With declining recognition of tropical medicine in the medical schools, opportunities here are unpromising. Industry offers few openings. American firms operating abroad formerly employed many American medical personnel but during recent years the tendency has been to engage local staffs. The former International Cooperation Administration offered many overseas positions in the health field but as a career service there was no assurance of continued employment. In many instances, salaries and allowances were inadequate in the face of difficulties encountered in hardship posts. If such programs are to continue, it is obvious that they should be staffed by career people who have tenure of office with suitable emoluments. In the Federal Government, today, the most promising career opportunities in tropical medicine and international health for both medical and paramedical personnel are in the uniformed services.

Chapter 19. FUTURE MANPOWER NEEDS IN THE FIELD OF TROPICAL HEALTH

In recent years, the changing political nature of certain tropical areas has made it difficult to estimate manpower needs in the field of tropical medicine over the next decade. In this country, a substantial increase in personnel and research in the medical and biological sciences over the next decade has been forecast by several recent surveys on manpower needs. However, it cannot be anticipated that tropical medicine requirements will increase at the same rate.

Over the past ten years there has been little increase in the membership of the American Society of Tropical Medicine and Hygiene. On the basis of this trend, it is reasonable to assume that the number of people interested in tropical medicine has not increased nor has there been any expansion in activity in the disciplinary fields related to tropical medicine. At this time, it is not possible to predict an increased demand for professional American personnel engaged in medicine and public health in the tropics. With the newly independent countries emerging, the future of medical missions in certain areas would seem to be uncertain, and it is difficult to visualize the need for additional professional personnel for these facilities. American medical and paramedical personnel also serve in medical facilities operated by American business firms in the tropics. However, more recent policy of the American companies has been to employ the local professional citizenry. Thus at present no increase in demand for American personnel in these facilities can be anticipated. The future plans for health programs in the tropics formerly carried out by the International Cooperation Administration under the technical assistance programs, have not been announced by its successor organization, the Agency for International Development. Therefore, it is not possible to estimate the further need for health personnel in this area.

If new medical schools are completed within the next decade, it can be expected that a small number, possibly 75, of additional instructors in tropical medicine and related disciplines will be required.

American personnel conducting research in tropical medicine in this country and overseas represents only a minor fraction of the total scientific and professional manpower engaged in all medical and health-related research. On the basis of the increased requirements indicated by the survey groups for the total medical and and biological fields during the next decade, an increased support of tropical medicine to the extent of 20 to 25 per cent seems a reasonable estimate.

PART VII

Chapter 20. RESEARCH NEEDS IN MEDICAL AND HYGIENIC PROBLEMS OF THE TROPICS: AN ASSEMBLY OF INFORMED OPINION

An analysis of research needs in human and veterinary medicine in the tropics was attempted. In order to achieve this goal, opinions were solicited from a total of 140 authorities in the disease conditions selected by the Advisory Committee as constituting the major health and veterinary problems of the survey area. Of these individuals, 108, or 77.1 per cent, replied; and 89, or 63.6 per cent, furnished research suggestions. Others supplied documents which were helpful. The suggestions were summarized for the most part by Committee members; these summaries are included in the body of the report, while the documents themselves appear in Appendix 19.

Recommendations of the Advisory Committee

RECOMMENDATIONS OF THE ADVISORY COMMITTEE

The Advisory Committee has made a careful study of the substance of this report. On the basis of these studies, enlightened by the individual experiences of its members, the Committee has drafted and unanimously adopted a number of resolutions. These are set forth below, each being preceded by a short preamble summarizing the argument for the need for action.

For the better understanding of the intent of the Committee, the resolutions should be read in the light of the following definitions of terms.

The Committee has chosen to use the single word "Research" rather than the clumsier phrase "Research, Development and Training" to describe the scope of the programs that it is interested to promote. The Committee does, however, emphasize that an adequate National Program must include not only fundamental research but also investigations of the type that are often described as "developmental" and that these basic and developmental studies will involve both laboratory and field investigations determined, in each situation, by the need and by the opportunity. The Committee also affirms that a National Program must include means for the training, both at home and abroad, of the personnel that will be required to conduct the recommended investigations.

The phrase "Tropical Health" has been deliberately adopted in the report and in the recommendations to emphasize the view that a National Program must include not only research, development and training in those diseases that are traditionally described as "tropical diseases," but also in those other factors, such as nutritional, environmental, climatological, demographic, etc., that have an important influence on the health of those who live in tropical regions.

I. Recommendation on the Role of the United States in Research in Tropical Health

A number of departments of the Federal Government, notably the Departments of State, of Health, Education, and Welfare, of Defense, and of Agriculture, have a national responsibility for the promotion of research in tropical health. To the extent that these agencies cooperate in the work of the United Nations, the World Health Organization, the North Atlantic Treaty Organization, the Southeast Asia Treaty Organization, or the Alliance for Progress, their obligations are, indeed, international as well as national.

The Committee recognizes that each agency of government that engages in research or training in tropical health derives its authority to do so from legislation that defines its particular mission. The Department of Defense, for example, has the responsibility for the protection of the health of military personnel serving in tropical regions and of the indigenous populations with which the military are associated. The medical mission of the Department of Health, Education, and Welfare, on the other hand, is the advancement of the health status of the American people at home. The Department's justification for the support of research overseas is that, thereby, medical knowledge in general is advanced. The International Health Act of 1960 (P. L. 86-610) does, however, give to the President and to the Secretary of Health, Education, and Welfare direct authority to "advance the international status of the health sciences through cooperative enterprises in health research, research planning and research training." It has been under this authority that a step, very significant to the advancement of tropical health, has been taken in the setting up of five centers for research and training in widely separated tropical regions. Finally, the Department of State has a responsibility to medical research not only because the promotion of international cooperation in science is a part of national policy but, also, because the improvement of the physical and economic well-being of the emerging nations is an important element in its foreign aid program.

The Committee appreciates that each of these agencies, in the fulfillment of its mission, has the responsibility to identify and define its own particular problems and to seek their solution by research designed and conducted under its own authority. The fundamental challenge in the field of tropical health is, however, the achievement of control over the major hazards to the health of all who live in tropical areas whether their residence be permanent or temporary. Delimited programs of research, each in its own way, make valuable contributions to this end. The challenge is, however, only adequately met when there is a systematic integration of programs on the basis of a continuing evaluation of the major needs and opportunities. The survey described in this report has been an attempt to develop a pattern for such continuing evaluation.

It is an inescapable fact that history, having brought the United States to a position of leadership in the world, has imposed on it a responsibility to support the efforts of other peoples to improve their health and welfare. This derives not merely from the deep moral and humanitarian purposes of our nation but is also dictated by justifiable self-interest. The Committee finds, however, that the agencies of government that have the means to pursue these objectives in the field of tropical health are unnecessarily constrained by ambiguity of authority. If the United States is to make its proper contribution to the international effort in tropical health, these constraints should be removed. Specifically there is need to establish authority to support research on problems that are important as problems of the tropics and not because their solutions may contribute indirectly to the health of people residing in the United States.

Resolution

Be it resolved that progress in the promotion of health and the control of disease in the tropical regions may best be achieved by a systematic program of research and development that is directed toward the study of the diseases that are the important causes of ill health in the inhabitants of these regions. The United States, as an acknowledged world leader, has an obligation to contribute to this effort to the full extent of its ability through the promotion of programs of research and of training of health personnel. These programs should be based on judgments of health needs and of scientific and technological feasibility. They should not necessarily be constrained by considerations of national self-interest or of potential benefit to the health of the people of the United States. Should legislation to remove these constraints be necessary, appropriate legislation should be sought by the agencies of government that are responsible for health operations overseas.

II. Recommendation on the Need for a National Program for Research in Tropical Health

The current activities in the field of tropical health of the agencies of government, a number of the nation's universities, private foundations, voluntary health organizations, and industrial corporations are reviewed and analyzed in this report. They combine to reflect a considerable and expanding effort.

It is evident, however, from Chapter 20 of the report that they fall far short of meeting recognized needs and that the goals of the greater physical and economic wellbeing of the indigenous populations of tropical regions call for a great expansion of research activity. The Committee believes that the United States can make its due contribution to the international effort most effectively and economically by fostering more coordination of research activities and that this may best be accomplished by the establishment of what might be known as a "National Program for Research in Tropical Health."

In this context, the word "coordination" is not intended to convey any implication of central control or direction, but rather the provision of an instrument for the exchange of information, ideas, and advice with the object of facilitating planning and programing by those who are active, investigatively or administratively, in the field of tropical health. The proposed organization should not seek funds to support any research program of its own but, rather, should contribute to the strengthening of the programs of existing operating agencies through its information service and its evaluation of needs and opportunities. The objective should be to assure that the research problems set forth in the body of this report, and others that will be recognized from time to time, will be vigorously pursued wherever the best opportunities for their solution may exist.

An organization should be developed that will maintain surveillance of significant national and foreign research activities, will serve as a forum for the exchange of ideas and the ventilation of problems, will evaluate available resources in facilities and scientific talent, and will encourage the recruitment and training of personnel.

In so doing, the organization should serve to foster an increased interest in the problems of tropical health amongst the nation's scientists and to stimulate the training of personnel for research in this field both at home and abroad.

The Committee believes that the National Academy of Sciences—National Research Council is well qualified to organize and provide these services by reason of its unique national status derived from its charter, by its close association with the scientific and professional societies and with the medical institutions of the country, by its international affiliations, by its long record of national service, by its ability to assemble authoritative advisory groups in the pure and applied sciences and by the qualifications of its staff.

Resolution

Be it resolved that the Chairman, Division of Medical Sciences, National Academy of Sciences—National Research Council, be requested to explore, with the relevant agencies of government and other interested private organizations, ways and means of securing their cooperation in a National Program for Research in Tropical Health through the establishment and support of an appropriate advisory organization within the National Academy of Sciences—National Research Council.

III. Recommendation on the Support of Research and Training in Foreign Institutions

The Committee has noted with approbation the program that is now in process of development by the Public Health Service for the establishment overseas of five centers for research and training. Each of these centers is a cooperative enterprise between a foreign institution and a medical school in the United States and will be supported by funds granted to the American institution. This program is a significant step toward the expansion of facilities for research, development and training in tropical health in the field. As indicated in this report, there are, however, other foreign institutions in endemic areas of tropical diseases, staffed by highly qualified personnel and favorably situated to undertake, economically and effectively, expanded programs of research, development and training in the field. There is presently lacking authority to grant funds directly to such institutions in situations in which it is not feasible to establish working relations with an institution in the United States.

Resolution

Be it resolved that consideration be given by the appropriate agency of government to seeking authority to make direct grants to approved foreign institutions for the support of expanded programs of research, development or training in tropical health.

IV. Recommendation on the Teaching of Tropical Health

In Chapter 16 of this report will be found the results of a recent survey of the teaching of tropical medicine in the medical schools of the United States and Canada conducted by Thurber, Frye and Swartzwelder. The report is a disturbing one. In about one-third of the schools the teachers lacked any experience in the tropics and 56 per cent of them were not members of either the American Society of Tropical Medicine and Hygiene or the American Society of Parasitologists. It is not surprising that the medical graduate evinces little interest in the study of tropical diseases and that it is proving very difficult to recruit physicians for service with health programs in tropical regions.

Resolution

Be it resolved that if the United States is to make the increased contribution to the study of tropical health that this Committee believes it has the obligation to make, a significantly greater effort must be made by the medical schools to stimulate the interest of medical students in their undergraduate years and to encourage selected students to undertake comprehensive postgraduate training. The former might be accomplished by providing opportunities for selected students to work in health programs overseas for short periods. The latter requires a strengthening of postgraduate programs in tropical health. These should include not only instruction and research experience in tropical diseases but also instruction in the fundamental ecological and epidemiological principles basic to the prevention of disease at the community level. Postgraduate training should include field studies in tropical regions.

V. Recommendation on the Support of the Office of Health Statistics, World Health Organization

The inadequacy of available resources for the collection of information on the status of health in the tropics is abundantly illustrated by this report. Although the Committee has recommended the establishment of an organization in the National Academy of Sciences—National Research Council that would maintain an information exchange service on research in tropical health, it is not contemplated that this organization would attempt the assembly of primary data on the incidence of various diseases on a world-wide basis. For this statistical service it must rely on the World Health Organization.

Resolution

Be it resolved that the Surgeon General, U. S. Public Health Service, be urged to give consideration to the question of inviting the World Health Organization to intensify its efforts to make its statistical coverage of tropical health more adequate and to the question of offering increased support from the United States for such efforts.

VI. Recommendation on the Need for Studies of the Economic Aspects of Tropical Diseases

In Chapter 10 of this report the attempt has been made to define the impact of disease in underdeveloped countries in terms of potential economic loss. The result has been disappointing simply because data bearing on many of the cost factors are lacking, particularly those that would permit estimates of losses in human productivity. This is a matter of major social concern inasmuch as the medical contribution to broad social planning is unlikely to secure judicious consideration unless it can be supported by an argument that relates it to the over-all economy.

There are many diseases of major importance in tropical regions for which means of control are available. In some situations these methods may be feasible, in others they may not—the decision, in many cases, will be made on economic grounds. Many of the cost factors in the malaria eradication program are known and it is, therefore, encouraging to learn that the Pan American Sanitary Bureau, at the instigation of the U. S. Public Health Service, is contemplating a study of the economic effects of this program. Studies on other diseases are urgently needed.

Resolution

Be it resolved that studies should be encouraged, in representative geographic areas, of the potential economic loss of major diseases for which control methods are known and of the potential economic gains to be expected from the application of control methods.

VII. Recommendation on the Need for Expansion of Veterinary Education and Research in Tropical Health

There is a great need for strengthening veterinary educational and research facilities in tropical countries. This is especially true in Southwest and Southeast Asia where domestic animals constitute the greater part of the agricultural motive power. Widespread disease losses seriously impede agricultural activities and reduce food supplies. Many of the capable veterinary organizations in Africa were organized and staffed by Europeans; with increasing independence of African countries, it is reasonable to assume that veterinary education and research will suffer.

On the other hand, there does exist a limited number of competently staffed and active veterinary centers, such as the Pan American Zoonoses Center at Azul, Argentine Republic, the Foot-and-Mouth Disease Research Center in Brazil, the Inter-African Bureau for Animal Health under the aegis of the Commission for Technical Cooperation in Africa South of the Sahara at Muguga, Kenya, the Animal Health Branch of the Food and Agriculture Organization in Rome, the Office Internationale des Epizooties in Paris, and the Veterinary Public Health Section of the World Health Organization. These have slender resources and deserve more generous support.

In all areas of the survey, it is apparent that funds for research in the veterinary schools are exceedingly meager and in some there are no funds available for this purpose. Another urgent requirement concerns regional laboratories to serve as centers for diagnosis, identification of etiological agents and as repositories of standard agents and reagents.

Resolution

Be it resolved that, in the judgment of the Committee, the accomplishments of international veterinary organizations have been outstanding but that their resources are woefully inadequate to meet the needs. Public and private agencies interested in the promotion of tropical health are invited to consider the need for additional support of such well-established and competent institutions as now exist and, beyond this, the need for the development of new facilities, particularly in Africa and in Southeast Asia.

Appendixes

APPENDIX 1

Plan for a survey of needs in the field of tropical medicine

I. *GENERAL INTRODUCTION*

II. *SURVEY OF DISEASE PROBLEMS IN TROPICAL AND SUBTROPICAL AREAS OF SIGNIFICANT IMPORTANCE TO PUBLIC HEALTH*

A. Human diseases

1. Morbidity and mortality

a. Population by age according to sex

b. Vital statistics

General mortality
Infant and neonatal mortality
Natural increase
Causes of death according to age and sex
Cases of and deaths from notifiable diseases

c. Analysis of diseases which are of greatest public health importance

2. Health and medical care

a. Medical and health personnel

Total medical and health personnel

Ratio of physicians to population
Number of private medical personnel
Physicians
Registered and fully qualified with medical degree
Partially qualified with some formal training
Dentists
Nurses
Qualified and certified
Other or not specified
Midwives
Qualified and certified
Other or not specified
Pharmacists
Veterinarians

b. Government health services—budgetary expenditures

Total operating expenditures annually, 1954-1958, inclusive
Estimated operating expenditure per inhabitant, 1954-1958, inclusive
Per cent total budget annually, 1954-1958, inclusive
Capital expenditures annually, 1954-1958, inclusive

c. Hospitals and clinics (inpatient)

Government
Private
Mission

Industrial
General
Infectious disease
Tuberculosis
Leprosaria
Maternity
Mental
Pediatric
Other (designate)

Total beds

Number of beds per 1,000 inhabitants

d. Clinics and dispensaries (outpatient)

Government
Private
Mission
Industrial
General
Infectious disease
Tuberculosis
Leprosaria
Maternity
Mental
Pediatric
Other (designate)

Total beds

Total annual patient load

e. Medical mission installations by United States and foreign mission boards

Hospitals and clinics (inpatient)

Name of country
Number of establishments by country
Total beds by country
Total annual patient load by country

Number of personnel

Physicians
Dentists
Nurses
Nurses' helpers
Technicians
Other

Total operating funds by country

Clinics and dispensaries (outpatient)

Name of country
Number of establishments by country
Total annual patient load by country

Number of personnel

Physicians
Dentists
Nurses
Nurses' helpers
Technicians
Other

Total operating funds by country

f. Industrial medical installations in the tropics (American firms)

Expenditures for medical programs by country

Country
Amount expended for medical care
Amount expended for preventive medicine
Total expenditures by country
Average expenditure per employee

Hospitals and clinics (inpatient) by country

Country
Number of establishments
Total beds
Number of beds per 1,000 employees
Total annual patient load

Number of personnel

Physicians
Dentists
Nurses
Nurses' helpers
Technicians
Other

Clinics and dispensaries (outpatient) by country

Country
Number of establishments
Total beds
Total annual patient load

Number of personnel

Physicians
Dentists
Nurses
Nurses' helpers
Technicians
Other

Per cent reduction from man-days lost because of sickness during last five years

Estimated annual monetary savings attributable to corporation's medical program during the last five years

g. Prevention and control—number of vaccinations and inoculations

Total number of vaccinations and inoculations including revaccinations

Smallpox
Typhoid-paratyphoid
Diphtheria
Whooping cough
BCG
Yellow fever
Poliomyelitis
Influenza
Typhus
Plague
Cholera
Rabies
Tetanus

Combined vaccines

Smallpox-yellow fever
Cholera-typhoid
Diphtheria-tetanus
Diphtheria-tetanus-whooping cough
Typhoid-diphtheria-tetanus
Other combinations

3. Environmental sanitation

a. Number of water supply systems and estimated population connected to systems in urban and rural areas

b. Number of sewage disposal systems and estimated population served by these and other facilities for sewage disposal

B. Diseases of domestic animals

1. Morbidity and mortality

Livestock population by country
Occurrence of zoonoses and other animal diseases
Estimated losses from disease per annum (number of animals)
Estimated economic losses per annum
Analysis of the most important animal diseases

2. Veterinary services

a. Personnel

Number of private veterinary practitioners

Government veterinary services

Veterinarians
Sanitary or lay inspectors
Technicians
Other

b. Total budgetary expenditures for government veterinary services

Annual expenditures, 1954-1958, inclusive
Per cent total budget annually, 1954-1958, inclusive

c. Prevention and control—diseases for which control campaigns are in operation

Disease

Amount of operating funds

Personnel engaged

Professional
Other

Year campaign inaugurated

Per cent reduction in number of cases of disease since start of control campaign

III. *RESEARCH AND RESEARCH NEEDS IN MEDICAL AND HYGIENIC PROBLEMS OF THE TROPICS*

A. United States

1. Intramural laboratory and clinical research

a. Federal Government (Public Health Service, other Health, Education, and Welfare, International Cooperation Administration, Department of Defense, Department of Agriculture, other agencies)

b. Medical schools, colleges and universities

c. Industry

d. Private institutions

Amount and source of funds
Number of personnel engaged

B. Foreign

1. Research institutes, medical and veterinary schools

Amount of funds
Number of personnel engaged
Fields of research

C. Research needs

1. Summary of views of experts

IV. *RESEARCH GRANT PROGRAMS IN TROPICAL MEDICINE*

A. Domestic

B. Foreign

C. Grants to foreign institutions by American foundations

1. Source of funds

Government
Private industry
Foundations

2. Beneficiaries

   Academic institutions
   Professional schools

3. Status of investigators

   Bachelor
   Master
   Doctoral

4. Have funds been applied in best possible manner in respect to over-all needs and relative importance of problems?

5. Projection of future needs

V. *FELLOWSHIP PROGRAMS IN TROPICAL MEDICINE OVER PAST FIVE YEARS*

A. Domestic

B. Foreign

1. Source and amount of funds

   Government
   Private industry
   Foundations
   International agencies

2. Status of beneficiaries

   Bachelor
   Master
   Doctoral
   Post-doctoral

3. Fields of study

4. Places of study

   Domestic
   Foreign

5. Total costs

VI. *TEACHING OF TROPICAL MEDICINE*

A. Domestic

1. Type of institution

   Schools of tropical medicine
   Medical schools
   Schools of public health

2. Number in teaching staff

3. Position levels

   Instructors
   Assistant professors
   Associate professors
   Professors

4. Educational qualifications of faculty members

   Bachelor
   Master
   Doctoral (M.D., Ph.D., D.Sc., other)

5. Practical experience of faculty members

6. Membership in professional societies

7. Curriculum

8. Research performed by faculty members

B. Foreign

VII. *TRAINING FACILITIES IN THE FIELD OF TROPICAL MEDICINE*

A. Academic

   Presently available facilities (from VI)

B. Field training facilities available to the United States

   Presently available (domestic and foreign)

C. Foreign training facilities

   Presently available facilities (from VI)

VIII. *CAREER OPPORTUNITIES AND INCENTIVES*

A. United States Government

B. Private organizations

C. International organizations

IX. *IMPACT OF TRAVEL AND MIGRATION ON TROPICAL DISEASE PROBLEMS*

A. Historical data

1. Military

2. Civilian

   Slave trade
   Migratory labor
   Religious pilgrimages

B. Current problems

1. Migratory labor

   United States
   Foreign

2. International travel

   Threat of introduction of tropical diseases into the United States; economic impact

3. Religious pilgrimages

X. *TROPICAL MEDICINE AND THE ECONOMY OF THE UNITED STATES*

A. Foreign trade; imports and exports to tropical countries during past ten years

B. Position of strategic materials

C. American investment in tropics during past ten years

D. Projected trade and investment for years up to 1970 based on data from Pauley report, Business Week survey, Department of Commerce statistics, reports of the United Nations Economic Commission, etc.

E. Tropical population increase and economy

XI. *FUTURE MANPOWER NEEDS IN THE FIELD OF TROPICAL MEDICINE*

A. Government (PHS, ICA, Agriculture, Defense, et al.)

B. International agencies (PASD, WHO, etc.)

C. Private institutions

D. Colleges, universities, medical schools, schools of public health

E. Industrial firms

F. Scientific categories required

XII. *GENERAL SUMMARY AND CONCLUSIONS*

XIII. *RECOMMENDATIONS OF THE ADVISORY COMMITTEE*

APPENDIX 2

Major geographic areas of the survey and countries comprising them

I. CARIBBEAN, CENTRAL AND SOUTH AMERICA

Argentina

Bahamas
Barbados
Bermuda
Bolivia
Brazil
British Guiana
British Honduras

Canal Zone
Chile
Colombia
Costa Rica
Cuba

Dominica
Dominican Republic

Ecuador
El Salvador

French Guiana

Grenada
Guadeloupe
Guatemala

Haiti
Honduras

Jamaica

Leeward Islands
  Antigua
  Montserrat
  St. Kitts-Nevis-Anguilla
  Virgin Islands

Martinique
Mexico

Netherlands Antilles
  Aruba
  Bonaire
  Curaçao
  St. Martin-Saba-St. Eustatius

Nicaragua

Panama
Paraguay
Peru
Puerto Rico

St. Lucia
St. Vincent
Surinam

Trinidad and Tobago

Uruguay

Venezuela
Virgin Islands, U.S.A.

II. AFRICA

Algeria
Angola

Basutoland
Bechuanaland
Belgian Congo—Republic of the Congo
(British Cameroons—federated with Nigeria and Cameroun)
(British Somaliland—federated with Somalia)

Cape Verde
Comoro Archipelago

Egypt
Ethiopia-Eritrea

French Camerouns—Federal Republic of Cameroon

(French Equatorial Africa)
  Chad—Republic of Chad
  Gabon—Republic of Gabon
  Middle Congo—Republic of Congo
  Ubangi-Shari—Central African Republic

French Somaliland

Note: Parentheses indicate the disappearance of a political entity which existed at the time the data were being gathered.

II. AFRICA, Continued

(French West Africa)
- Dahomey—Republic of Dahomey
- Guinea—Republic of Guinea
- Ivory Coast—Republic of Ivory Coast
- Mauritania—Islamic Republic of Mauritania
- Niger—Republic of Niger
- Senegal—Republic of Senegal
- Soudan—Republic of Mali
- Upper Volta—Republic of Upper Volta

Gambia
Ghana

Kenya

Liberia
Libya

Madagascar—Malagasy Republic
Mauritius
Morocco
Mozambique

Nigeria

Portuguese Guinea

Reunion

Rhodesia and Nyasaland, Federation of
- Northern Rhodesia
- Nyasaland
- Southern Rhodesia

Ruanda-Urundi

St. Helena and dependencies
St. Thomas and Prince Islands
Seychelles
Sierra Leone
Somalia
South West Africa
Spanish Guinea
Spanish North Africa
Spanish West Africa
Sudan
Swaziland

Tanganyika
Togo—Togolese Republic
Tunisia

Uganda
Union of South Africa—Republic of South Africa

Zanzibar and Pemba

III. SOUTHWEST ASIA

Aden Colony
Aden Protectorate
Afghanistan

Bahrain

Cyprus

Iran
Iraq
Israel

Jordan

Kuwait

Lebanon

Muscat and Oman

Qatar

Saudi Arabia
Syria

Trucial Oman
Turkey

Yemen

IV. SOUTH CENTRAL AND SOUTHEAST ASIA

Bhutan
Brunei
Burma

Cambodia
Ceylon
China (Taiwan)

Hong Kong

India
Indonesia

Laos

Macao
Malaya
Maldive Islands

Nepal
North Borneo

IV. SOUTH CENTRAL AND SOUTHEAST ASIA, Continued

Pakistan
Philippines
Portuguese India

Sarawak
Singapore

Thailand
Timor

Vietnam

West (Netherlands) New Guinea

V. OCEANIA

American Samoa

Bonin Islands
British Solomon Islands

Cocos (Keeling) Islands
Cook Islands

Fiji Islands
French Polynesia

Gilbert and Ellice Islands
Guam

Nauru
New Caledonia and dependencies
New Guinea

New Hebrides
Niue
Norfolk

Papua
Pitcairn

Ryukyu Islands

Tokelau
Tonga

United States Trust Territory

Wallis and Futuna
Western Samoa

APPENDIX 3

Glossary for Part I on human diseases

Incidence — number of clinical cases of a specific disease in a group of examined persons

Infant mortality — number of deaths among children less than one year old in relation to total number of children in that age group without etiological reference

General morbidity — number of illness cases in relation to total population without reference to etiology of illness

General mortality — number of deaths in relation to total population without reference to etiology of deaths

Lethality — number of deaths due to a specific disease in relation to the number of cases of this disease

Morbidity — number of cases, clinical or not, reported of a specific disease

Natural increase — ratio between the number of deaths and the number of births in a population without age reference

Neonatal mortality — number of deaths among children less than 24 hours old in relation to total number of children in that age group without etiological reference

Mortality — number of deaths due to a specific disease in relation to total population of an area

Prevalence — number of individuals affected by a specific disease with or without clinical signs in relation to the total number of individuals examined.

APPENDIX 4

Questionnaire for Part II on diseases of domestic animals

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL

DIVISION OF MEDICAL SCIENCES
Tropical Disease Project
2101 Constitution Avenue, N.W.
Washington 25, D.C.

Category—II.B. Diseases of domesticated animals.

Country ....

Data for year:
Calendar ....
Other ....

Monetary figures expressed in:
Local currency ....
£ Sterling ....
$ United States ....

1. Prevalence of disease—No. of cases of disease occurring in the country.

Disease	Number of cases
Some Zoonoses	
Anthrax	....
Brucellosis	....
Cysticercosis	
Cysticercus bovis	....
Cysticercus cellulosae	....
Encephalitis, Arthropod-borne (Identified by type where possible)	....
Glanders	....
Hydatidosis	....
Leptospirosis	....
Listerellosis	....
Psittacosis (Ornithosis)	....
Q Fever	....
Rabies	....
Rift Valley fever	....
Tuberculosis—Bovine	....
Wesselsbron virus disease	....

Disease	Number of cases
Other Diseases	
Actinomycosis	....
African swine fever	....
Anaplasmosis	....
Aphthous fever	....
Babesiosis	....
Blackleg	....
Blue tongue	....
Bovine infectious petechial fever (Ondiri-Disease)	....
Contagious pleuropneumonia	....
Distomatosis hepatica	....
Enterotoxemia	....
Equine encephalomyelitis	....
Haemorrhagic septicaemia (*Pasteurella multocida* infection)	....
Heartwater fever	....
Hog cholera	....
Infectious equine anemia	....
Johne's disease	....
Louping ill	....
Lumpy skin disease	....
Nairobi sheep disease	....
Nutritional diseases	....

Parasitic gastroenteritis	....
Rinderpest	....
Sheep pox	....
Swine erysipelas	....
Theileriasis	....
Trypanosomiasis	
Nagana	....
Surra	....
Vibriosis	....
Vesicular exanthema	....
Vesicular stomatitis	....
2. Estimated annual economic losses from diseases of domesticated animals	....
3. Number of full-time private veterinary practitioners (not employed by governments).	
a. Registered and fully qualified with veterinary degree	....
b. Partially qualified with some formal training	....
4. Budgetary expenditures for government veterinary services.	
a. Total expenditures	....
b. Per cent total budget	....
5. Government veterinary services—number of personnel employed.	
a. Number of veterinarians	....
b. Number of sanitary or lay inspectors	....
c. Number of technicians	....
d. Other employees	....

6. Prevention and control programs—diseases for which control programs are in operation.

Disease	Amount of Operating Funds 1957	1958	Personnel Engaged Professional	Other	Year Campaign Inaugurated	Per cent reduction in number of cases since start of control effort
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....

7. Estimates of new operations or extensions planned over next few years.

	Estimated costs of new operations over 1958 budget 1959	1960	1961	1962	1963
General operating expense (total)	....	....	....	....	....
Disease control (total amounts)	....	....	....	....	....
Equipment	....	....	....	....	....
Personnel	....	....	....	....	....

APPENDIX 5

Medical mission facilities by country in the survey area—Number of hospitals and clinics (inpatient and outpatient), number of beds, annual patient loads and total operating funds

COUNTRY	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
CARIBBEAN, CENTRAL AND SOUTH AMERICA								
Argentina	1	100	2,742	2		12,433	$ 273,788	1
Bolivia	5	95	3,021	10	1	123,279	7,620	3
Brazil	10	386	16,534	16	7	23,261	430,429	6
British Guiana	2	257	1,132	1		16,934	798,000	2
Chile	3	14	380	12	6	32,508	100,460	4
Colombia	3	30	7,012	10		4,350	12,000	1
Costa Rica	1	32	1,940	1		12,280	132,016	2
Cuba				9			5,200	1
Dominican Republic				1			3,370	1
Ecuador	2			9		7,752	2,395	2
Guatemala	1	70	2,476	22	8	58,195	229,300	6
Haiti	3	149	2,294	2	18	30,100	91,290	4
Honduras	3	72	1,938	8		27,700	38,085	8
Jamaica	1	45	1,090	1		10,674	126,005	1
Mexico	6	320	6,621	19	39	25,753	217,937	5
Nicaragua	2	25	10,164	2		19,923	39,276	1
Paraguay	4	44	2,965	2		4,600	5,650	2
Peru	4	56	1,217	12	2	31,752	97,851	4
Puerto Rico	5	322	13,604	7		37,914	1,266,247	12
Surinam	3		1,313	2		21,218	55,348	4
Trinidad	1	25	1,075	1		6,586	523,326	1
Venezuela	2	227	7,359	4		94,025		
Totals	62	2,269	84,877	153	81	601,237	$4,455,593	71
AFRICA								
Algeria				5		4,870		
Angola	18	1,282	14,791	20	224	230,951	$ 60,963	9
Basutoland	1	56	986	5	30	29,131	18,144	1
Bechuanaland	3	144	3,494	12	28	78,228	38,180	3
Belgian Congo	190	8,072	218,865	238	320	1,706,862	1,731,167	126
British Cameroons	8	589	15,130	3		19,447	235,080	5
British Somaliland				2				
Egypt	10	1,267	28,166	6		291,390	351,051	5
Ethiopia-Eritrea	25	1,103	17,779	59		502,875	410,778	34
French Camerouns	18	1,488	20,019	32	133	219,969	318,327	11
French Equatorial Africa								
Chad	2		849					
Gabon	1	300		1			300	1
Middle Congo			854	1	40	25,000		
Ubangi-Shari				1			2,500	1
French West Africa	5	100	12,279	21		66,322	8,280	11
Gambia				1		2,166	105	1
Ghana	11	603	13,004	14		170,992	347,482	12
Kenya	19	1,124	87,349	32	26	146,076	51,498	7
Liberia	10	65	4,103	8	9	21,196	36,290	5

APPENDIX 5, Continued

COUNTRY	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
Libya	1	28	352	2		32,878	39,090	2
Madagascar	4	655	3,026	1		47,184	59,860	1
Morocco	1	40	542	2	1	36,685	23,259	3
Mozambique	8	258	12,811	6	111	52,605	37,428	7
Nigeria	68	3,397	119,528	300	119	1,566,806	1,281,089	47
Rhodesia and Nyasaland Federation								
Northern Rhodesia	34	3,713	54,461	35	742	515,024	354,934	29
Nyasaland	14	398	10,566	21	126	242,540	39,600	9
Southern Rhodesia	32	1,840	62,616	41	347	249,854	165,557	32
Sierra Leone	4	177	2,727	1	4	87,886	20,200	1
Somalia				1		3,746	1,744	1
South West Africa	9	16	12,473	24	48	154,225	31,306	31
Sudan	12	228	2,348	18		76,872	112,233	8
Tanganyika	57	3,417	43,381	89	864	666,552	288,277	49
Tunisia				1				
Uganda	8	528	16,686	10	100	85,211	157,577	5
Union of South Africa	47	3,697	123,249	55		460,115	1,226,974	49
Totals	620	34,585	902,434	1,068	3,272	7,793,658	$7,449,273	506
SOUTHWEST ASIA								
Aden Protectorate	1	86	1,000	1		7,000	$ 20,888	1
Bahrain	1	85	1,600			9,000	60,000	1
Iran	7	401	18,246	7		46,544	277,171	7
Iraq	2	40	1,800			14,575		
Israel	1	110	3,892			17,251	82,491	1
Jordan	3	64	2,013	1		10,009	75,747	3
Kuwait	1	70	2,431			26,055	23,600	1
Lebanon	2	322	389			2,196	258,185	1
Muscat and Oman	2	102	2,173			12,500	42,200	1
Syria	2	122	1,302			4,000	70,000	1
Turkey	1	49	1,500	1		9,621	9,250	1
Totals	23	1,451	36,346	10		158,701	$919,532	18
SOUTH CENTRAL AND SOUTHEAST ASIA								
Burma	13	1,781	64,337	27	32	146,750	$ 474,573	18
Ceylon	5	393	13,849	2		64,528	7,875	2
China (Taiwan)	10	390	6,319	20		128,869	490,965	15
Hong Kong	4	260	7,637	18		70,887	25,908	4
India	327	23,646	426,447	283	261	2,978,516	6,403,728	244
Indonesia	61	8,147	144,280	113	327	810,334	2,618,158	43
Malaya	1	94	1,596	8	2	46,754	180,854	3
Nepal	4	125	1,900	5		44,763	64,845	6
Pakistan	28	2,448	47,233	41	70	456,532	576,368	27
Philippines	23	1,476	56,563	29	89	460,669	2,405,892	26
Sarawak	2	32	1,960	3		3,054	26,667	1
Singapore	3	247	2,940	2		69,912	340,385	2
Thailand	15	594	23,223	17	10	203,746	1,522,658	12
Vietnam	4	380	930	3		35,430		
Totals	500	40,013	799,214	571	791	5,520,744	$15,138,876	403

APPENDIX 5, Continued

COUNTRY	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
OCEANIA								
Fiji	1	6	71	2		7,641	$ 1,203	2
Guam				1		5,000		
New Guinea	26	3,570	35,968	60	20	869,448	369,542	28
New Hebrides	6	167	2,828	5		5,434		
Papua	21	405	8,514	8		66,999		
Ryukyu Islands				2		8,261		
Solomon Islands	21	341	32,585	17		63,700	31,669	18
Totals	75	4,489	79,966	95	20	1,026,483	$402,414	48

APPENDIX 6

Medical mission facilities by country in survey area—Hospitals and clinics not listed in Directory of Protestant Medical Missions

COUNTRY	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
CARIBBEAN, CENTRAL AND SOUTH AMERICA								
Argentina				1		1,600		
Bolivia	1	20	805	7	1	106,069		
British Guiana	2	257	1,132	1		16,934	$ 798,000	1
Chile				4		11,412		
Ecuador				1		4,176		
Guatemala				20		50,576	8,500	4
Haiti	3	149	2,294	2	18	30,100	91,290	5
Honduras				3		4,950	1,650	2
Mexico				1		1,100		
Nicaragua	1		164	2		15,673	39,276	1
Peru				3		7,361		
Puerto Rico	1	99	4,336	4		6,096	309,963	5
Surinam	2	114	1,208	2		21,218	55,348	4
Venezuela	2	227	7,209	2		59,031		
Totals	12	866	17,148	53	19	336,290	$1,303,027	22
AFRICA								
Algeria				3		4,870		
Angola				8	70	61,503	$ 1,800	2
Bechuanaland	1	60	1,554	7		43,966	14,000	1
Belgian Congo	3	60	17,000	8		69,407	19,523	9
Egypt				2		84,000		
Ethiopia	3	79		33		186,960	95,780	25
French Camerouns	4	318	3,575	14		74,852	30,060	5
French Equatorial Africa				1			2,500	1
French West Africa	2	50	11,648	16		51,450	8,280	11
Ghana	6	368	6,565	6		91,564	93,878	6
Kenya	5	222		3	12	8,852	1,440	1
Liberia				1	9	5,300	1,343	1
Madagascar	4	655	3,026	3		47,184	59,860	1
Morocco	1	40	531	1		26,000	20,000	1
Mozambique	3	84	1,727	1		16,870	3,528	1
Nigeria	10	457	13,473	5	3	91,840	182,252	8
Rhodesia and Nyasaland Federation								
Northern Rhodesia	5	673	5,487	5		48,273	75,865	2
Nyasaland	9	266	2,563	14		71,059	33,600	8
Southern Rhodesia	7	98	3,707	14	8	104,497	30,017	13
South West Africa	9	16	12,363	23	44	142,798	31,306	16
Somalia				1		3,746	1,744	1
Sudan	1			2		18,000	2,500	2
Tanganyika	3	134	3,380	19	118	198,972	22,421	7
Uganda				1		7,500		
Union of South Africa	14	1,087	19,835	35		101,354	326,610	34
Totals	90	4,667	106,434	226	264	1,560,817	$1,058,307	156

APPENDIX 6, Continued

COUNTRY	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
SOUTHWEST ASIA								
Jordan	1	24	13	1		9	$1,747	2
Totals	1	24	13	1		9	$1,747	2
SOUTH CENTRAL AND SOUTHEAST ASIA								
Burma				4		3,120		
China (Taiwan)	2	80	89	10		41,239	$ 6,874	9
Hong Kong				4		68,009	25,908	3
India	13	1,328	15,801	38	2	274,013	115,150	20
Indonesia	4	865	1,211	7		69,616	139,370	6
Nepal				2		7,000	800	2
Pakistan	4	524	13,931	8	40	141,785	84	1
Philippines	3	130	8,248	4	20	198,308	20,000	1
Vietnam	3	360						
Totals	29	3,287	39,280	77	62	803,090	$308,186	42
OCEANIA								
Fiji	1	6	71	2		7,641	$ 1,203	3
Guam				1		5,000		
New Guinea	13	1,360	14,771	47		575,093	151,241	7
New Hebrides	2	12	60	3		1,434		
Ryukyu Islands				1		8,261		
Solomon Islands	11	130	18,884	12		46,400	23,405	23
Totals	27	1,508	33,786	66		643,829	$175,049	33

APPENDIX 7

Medical mission facilities by country in the survey area—Catholic hospitals and inpatient and outpatient clinics

COUNTRY	HOSPITALS			CLINICS			HOSPITALS AND CLINICS OPERATING FUNDS	
	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	NUMBER IN COUNTRY	NUMBER OF BEDS	ANNUAL PATIENT LOAD	TOTAL OPERATING FUNDS	NUMBER OF INSTITUTIONS REPORTING
CARIBBEAN, CENTRAL AND SOUTH AMERICA								
Bolivia	1	20	805	5		101,244		
British Guiana	1	240					$748,000	1
Chile				4		11,412		
Guatemala				16		30,877		
Honduras				1		1,500		
Nicaragua				1		12,327		
Peru				2		1,261		
Venezuela	2	227	7,209	2		158,621		
Totals	4	487	8,014	31		317,242	$748,000	1
AFRICA								
Ghana	3	278	4,393	3		73,547		
Tanganyika	1	12	240	10	13	165,478		
Totals	4	290	4,633	13	13	239,025		
SOUTH CENTRAL AND SOUTHEAST ASIA								
China (Taiwan)				2		40,463		
Hong Kong				1		16,630		
India	6	640	12,780	7		147,646		
Pakistan	4	524	13,931	4		136,621		
Philippines	1	100	4,448	2	20	193,802	$20,000	1
Vietnam	2	60						
Totals	13	1,324	31,159	16	20	535,162	$20,000	1
OCEANIA								
New Guinea	5						$118,050	5
Totals	5						$118,050	5

APPENDIX 8

Medical mission facilities by country in the survey area—Type of medical installation

COUNTRY	GENERAL HOSPITALS	MATERNITY HOSPITALS	TUBERCULOSIS SANATORIA	LEPROSARIA	OTHERS	TOTAL HOSPITALS
CARIBBEAN, CENTRAL AND SOUTH AMERICA						
Argentina	1					1
Bolivia	3			2		5
Brazil	10					10
British Guiana	1			1		2
Chile	3					3
Colombia	1			2		3
Costa Rica	1					1
Ecuador	2					2
Guatemala	1					1
Haiti	3					3
Honduras	3					3
Jamaica	1					1
Mexico	6					6
Nicaragua	2					2
Paraguay	2			2		4
Peru	3			1		4
Puerto Rico	5					5
Surinam	2			1		3
Trinidad	1					1
Venezuela	2					2
Totals	53			9		62
AFRICA						
Angola	10			8		18
Basutoland	1					1
Bechuanaland	2	1				3
Belgian Congo	149	2		39		190
British Cameroons	5			3		8
Egypt	9			1		10
Ethiopia-Eritrea	19			6		25
French Camerouns	16			2		18
French Equatorial Africa						
Chad	2					2
Gabon	1					1
French West Africa	5					5
Ghana	9	1	1			11
Kenya	18			1		19
Liberia	8			2		10
Libya	1					1
Madagascar	2			2		4
Morocco	1					1
Mozambique	7			1		8
Nigeria	35	4	1	26	2	68
Rhodesia and Nyasaland Federation						
Northern Rhodesia	27		1	6		34
Nyasaland	12			2		14
Southern Rhodesia	30	2				32
Sierra Leone	3			1		4
Southwest Africa	9					9
Sudan	7			5		12
Tanganyika	40	7	1	7	2	57

APPENDIX 8, Continued

COUNTRY	GENERAL HOSPITALS	MATERNITY HOSPITALS	TUBERCULOSIS SANATORIA	LEPROSARIA	OTHERS	TOTAL HOSPITALS
Uganda	5			3		8
Union of South Africa	47					47
Totals	480	17	5	114	4	620
			SOUTHWEST ASIA			
Aden Protectorate	1					1
Bahrain	1					1
Iran	7					7
Iraq	2					2
Israel	1					1
Jordan	2			1		3
Kuwait	1					1
Lebanon	2					2
Muscat and Oman	2					2
Syria	2					2
Turkey	1					1
Totals	22			1		23
			SOUTH CENTRAL AND SOUTHEAST ASIA			
Burma	10			3		13
Ceylon	4			1		5
China (Taiwan)	5			5		10
Hong Kong	1		2	1		4
India	244		10	71	2	327
Indonesia	35	15	1	9	1	61
Malaya	1					1
Nepal	3			1		4
Pakistan	26			2		28
Philippines	22			1		23
Sarawak	2					2
Singapore	1				2	3
Thailand	12			3		15
Vietnam	2			2		4
Totals	368	15	13	99	5	500
			OCEANIA			
Fiji	1					1
New Guinea	22			4		26
New Hebrides	5			1		6
Papua	20			1		21
Solomon Islands	14	4		3		21
Totals	62	4		9		75

APPENDIX 9

Medical mission facilities by country in the survey area—Personnel of hospitals and inpatient and outpatient clinics

COUNTRY	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
CARIBBEAN, CENTRAL AND SOUTH AMERICA						
Argentina	6		20			45
Bolivia	15		21	8	5	26
Brazil	32	1	63	21	1	110
British Guiana	2	1	14	3	3	131
Chile	5		7	8		6
Colombia	3		16	5		3
Costa Rica	66		25	12		46
Cuba	4		1	1		7
Dominican Republic	1		1	2		
Ecuador	6	2	7			2
Guatemala	5		28			4
Haiti	10		18	18		24
Honduras	8		13	6		8
Jamaica	2		13			30
Mexico	18		36	6	1	3
Nicaragua	2		7	15	1	10
Paraguay	12		7	7		15
Peru	14		22	8		53
Puerto Rico	31		41	49	4	186
Surinam	5		9	12	3	17
Trinidad	5		12			32
Venezuela	83	1	67	89	5	181
Totals	335	5	448	270	23	939
AFRICA						
Algeria				3		6
Angola	22		35	128	2	71
Basutoland	3		3			4
Bechuanaland	13		26	27		34
Belgian Congo	98	7	194	48	14	164
British Cameroons	7		11	59		10
British Somaliland	2					
Egypt	100		39	99	1	110
Ethiopia-Eritrea	36		104	151	1	249
French Camerouns	40	2	60	62	17	36
French Equatorial Africa						
Chad	1			1		4
Gabon	14		12	15		2
Middle Congo			2	2		
Ubangi-Shari			1	1		
French West Africa	2		36	11		13
Gambia			1			
Ghana	17		67	123	12	204
Kenya	26		54	34		101
Liberia	9		14	16	6	20
Libya	2		10			17
Madagascar	3		11	8	1	
Morocco	2		8		1	1
Mozambique	7		40	67		20
Nigeria	104	2	423	781	32	540

APPENDIX 9, Continued

COUNTRY	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
Rhodesia and Nyasaland Federation						
Northern Rhodesia	32		90	105	8	177
Nyasaland	12		28	31		215
Southern Rhodesia	23		99	158	49	64
Sierra Leone	8		11	20		3
Somalia			1			
South West Africa	2		21	36	1	1
Sudan	8		22	43		11
Tanganyika	47		149	307	42	66
Uganda	15		28	111	3	41
Union of South Africa	93	1	548	181	60	564
Totals	748	12	2,148	2,628	250	2,748
SOUTHWEST ASIA						
Aden Protectorate	4		4	15		1
Bahrain	5		2	16		2
Iran	16		77	5	6	7
Iraq	7		11			84
Israel	5		8			1
Jordan	7		4	9		5
Kuwait	6		2	16		8
Lebanon	6		1	14		3
Muscat and Oman	6		4	4		1
Syria	6		4	17		2
Turkey			2			
Totals	68		119	96	6	114
SOUTH CENTRAL AND SOUTHEAST ASIA						
Burma	26		98	49	4	95
Ceylon	1		4	12	2	3
China (Taiwan)	39	2	121	43	14	137
Hong Kong	31	1	20	22	3	16
India	965	6	1,439	1,998	155	1,805
Indonesia	96		450	786	24	828
Malaya	5		18	9		7
Nepal	9		39	17	6	19
Pakistan	99	1	198	222	19	618
Philippines	163	3	256	129	4	269
Sarawak	3		6		5	3
Singapore	11		53	17	5	172
Thailand	57		181	29	6	180
Vietnam	4		12	3		71
Totals	1,509	13	2,895	3,336	247	4,223
OCEANIA						
Fiji	2		1			53
Guam	1		1			1
New Guinea	19	1	71	217	3	167
New Hebrides	6		13	20		8
Papua	6		16	33		10
Ryukyu Islands	1		2			1
Solomon Islands	1		24	31		18
Totals	36	1	128	301	3	258

APPENDIX 10

Medical mission facilities by country in the survey area—Personnel of hospitals and clinics not listed in Directory of Protestant Medical Missions

COUNTRY	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
CARIBBEAN, CENTRAL AND SOUTH AMERICA						
Argentina	1					1
Bolivia	4		10	8	4	6
British Guiana	2	1	14	3	3	131
Chile	2		1	5		
Ecuador	1		3			
Guatemala			5			1
Haiti	10		18	18		20
Honduras	1		2	3		
Mexico			1			
Nicaragua	1		7		1	10
Peru	2		3	2		2
Puerto Rico	9		20	18		
Surinam	4		9	12	3	17
Venezuela	78		64	88	5	181
Totals	115	1	157	157	16	369
AFRICA						
Algeria						6
Angola			6			7
Bechuanaland	4		10	26		
Belgian Congo			12	12		
Egypt	1		3			
Ethiopia	3		34	47	1	7
French Camerouns	5	2	23	61	3	17
French Equatorial Africa			1	2		
French West Africa	1		27	8		13
Ghana	7		30	53	5	150
Kenya	3		1	2		1
Liberia			1			
Madagascar	3		11	8	1	
Morocco	2		6		1	
Mozambique	3		13	15		3
Nigeria	12	1	169	212	18	189
Rhodesia and Nyasaland Federation						
Northern Rhodesia	3		9	56		46
Nyasaland	1		9	31		67
Southern Rhodesia			11	9	3	5
South West Africa	2		20	36	1	1
Somalia			1			
Sudan			3			
Tanganyika	7		14	39	3	23
Union of South Africa	25		83	82	45	140
Totals	82	3	497	699	81	675
SOUTHWEST ASIA						
Jordan			2	1		1
Totals			2	1		1

APPENDIX 10, Continued

COUNTRY	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
SOUTH CENTRAL AND SOUTHEAST ASIA						
Burma			4		3	
China (Taiwan)	2	1	2		1	1
Hong Kong	16	1	13	12	3	8
India	51		116	30	11	586
Indonesia	5		21	44	5	57
Nepal	2		3	2	1	2
Pakistan	31	1	65	64	11	364
Philippines	2	3	3	2	1	2
Totals	128	6	250	177	44	1,024
OCEANIA						
Fiji	2		1			53
Guam	1		1			1
New Guinea	8	1	23	209	3	
New Hebrides			1			3
Ryukyu Islands	1		2			1
Solomon Islands			15	1		10
Totals	12	1	43	210	3	68

APPENDIX 11

Medical mission facilities by country in the survey area—Personnel of the Catholic hospitals and clinics represented

COUNTRY	PHYSICIANS	DENTISTS	NURSES	NURSES HELPERS	TECHNICIANS	OTHERS
CARIBBEAN, CENTRAL AND SOUTH AMERICA						
Bolivia	4		8	8	4	6
British Guiana	1	1	10	3	3	110
Chile	2		1	5		
Guatemala			1			
Honduras	1		1	1		
Nicaragua	1				1	
Peru	2		2	2		
Venezuela	78		64	88	5	181
Totals	89	1	87	107	13	297
AFRICA						
Ghana	4		14	23	3	119
Tanganyika	3		7	17	3	1
Totals	7		21	40	6	120
SOUTH CENTRAL AND SOUTHEAST ASIA						
China (Taiwan)	2		1	2		
Hong Kong	5		2			2
India	29		58	19	6	522
Pakistan	28	1	61	59	7	364
Philippines	11	3	16	21	4	
Totals	75	4	138	101	17	888

APPENDIX 12

Questionnaire for section on industrial medical installations in the tropics

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL
DIVISION OF MEDICAL SCIENCES
2101 Constitution Avenue
Washington 25, D. C.

SURVEY OF NEEDS IN THE FIELD OF TROPICAL MEDICINE

Industrial medical installations in the tropics (Caribbean, Central and South America, Africa, Southwest, South Central and Southeast Asia and Oceania)

Name of Corporation.. Data for calendar year 1958 or

Address.. ....

A. Expenditures for medical programs by country:

Country	Amount expended for medical care	Amount expended for preventive medicine	Total expenditures by country	Average expenditure per employee
....	$............	$............	$............	$............
....	$............	$............	$............	$............
....	$............	$............	$............	$............
....	$............	$............	$............	$............

B. Hospitals and clinics (inpatient) by country:

Country	No. establishments	Total beds	No. beds per 1,000 employees	Total patient load		No. of staff members (total by country)				
				American personnel	Indigenous patients	Physicians	Dentists	Nurses	Technicians	Other
......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......

C. Clinics and dispensaries (outpatient) by country:

Country	No. establishments	Total beds	No. beds per 1,000 employees	Total patient load		No. of staff members (total by country) (outpatient care only)				
				American personnel	Indigenous patients	Physicians	Dentists	Nurses	Technicians	Other
......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......

D. Projected expansion in overseas medical facilities:

Country	No. of new hospitals planned	Estimated cost	No. of new clinics or dispensaries planned	Estimated cost
....	....	$............	....	$............
....	....	$............	....	$............
....	....	$............	....	$............
....	....	$............	....	$............

E. Estimated percent reduction, if any, from man days lost because of sickness during last 5 years ....

F. Estimated annual monetary savings attributable to corporation's medical program during last 5 years .... $...............

Information on this form has been supplied by .... **Title**....................................
(Signature)

APPENDIX 13

Titles of research grants approved by the Tropical Medicine and Parasitology Study Section, National Institutes of Health, fiscal year 1958, but excluded from present study as not pertaining to the field of tropical medicine

1. Control of blood sucking ectoparasites
2. Etiology and pathology of a disease in *Achatina fulica*
3. Inorganic metabolism in trypanosomes
4. Tracer studies: field activity of Lone Star tick
5. Toxic effect of blue-green algae
6. Pathogen vector potentials of parasitic mites
7. Combination of insecticides with insect tissues
8. The dynamics of arthropod populations
9. Influence of microenvironments on insect activity
10. Infectious processes in insects
11. Host selection in Cimicidae
12. Host parasite relationships in *Toxocara canis* infection
13. Ecology of the rumen
14. Transmission of *Pasteurella pestis* by Triatominae
15. Relationships between cacti and desert arthropods
16. Life cycle of *Thelazia californiensis*
17. Cultivation of insect phase of avian plasmodia
18. Larval development of cestodes
19. Pyruvate metabolism in *Trichomonas vaginalis*
20. Nutrition of free living nematodes
21. Reproductivity of entomophthorous fungi
22. Incidence and treatment of allergy to flea bites
23. Growth and control of *E. histolytica*
24. Fungal parasitism in man and animals
25. Epidemiology and therapy of *T. vaginalis* vaginitis
26. Biology of avian schistosomiasis
27. The sterile culture of large rhizopods
28. Transmission of toxoplasma among reservoir hosts
29. Nutrition of the fresh-water ciliates
30. General biology and toxicology of nematocysts of *Physalia*
31. Dermatitis-producing cercariae
32. Immunological aspects of trichinosis
33. Tissue and immunological reactions to *Ascaris* eggs
34. Physiological factors of adaption in snails
35. Allergic inflammation in experimental trichinosis
36. Anaplasmosis in cattle
37. Rabies in bats
38. Host-parasite relationship of *Ancylostoma braziliense*
39. Trematode parasites encysted in Florida mullet
40. Biology of brackish-water larvivorous fish
41. Analysis of migratory behavior
42. Comparative analysis of gregarious behavior
43. Susceptibility to infection by malaria parasites
44. Amino acid requirements of *Trichomonas vaginalis*
45. Studies on epidemiology and immunology of schistosomes
46. Cytotaxonomic studies on schistosomes
47. Homo- and hetero-transplantation of *Schistosoma mansoni*
48. Behavior of adult mosquitoes
49. Schistosome cercariae in the Pacific Northwest
50. Artificially cultivated tapeworms for host transfer
51. Role of mite genetics in disease transmission
52. Studies on nature of *Endamoeba histolytica*
53. *In vivo* and *in vitro* approach to ascarid culture
54. Cultural studies on the small race of *E. histolytica*
55. Antigen-antibody reactions in parasite infections
56. General biology of a mite and its predators
57. Acarina in transmission of avian blood parasites
58. Microbial diseases of the housefly
59. Housefly resistance to insecticides
60. A survey of the bats of Southern Arizona
61. Bionomics of flood water mosquitoes
62. Functional microchemistry of trematodes
63. Survival of protozoa at freezing temperatures
64. Epizootiology of sylvan rabies
65. Nutritive requirements of *Paramecium multimicronucleatum*
66. Chemotherapy studies on *Toxoplasma gondii*
67. Plasmodium infections in pigeons
68. Trichiniasis in swine herds
69. Effect of diet on histochemistry of insect tissues
70. Relationship of *Trichinella spiralis* to its environment
71. Anthelmintic action of phenothiazine
72. Chick typhlitis: Etiology, prevention, transmission
73. Drug resistance in trypanosomiasis
74. Nutrition of host and parasitemia with *Trypanosoma cruzi*
75. Studies on host-parasite relations
76. Protein metabolism in parasitic helminths
77. Fat metabolism in *Hymenolepis diminuta*
78. Biology of medically important gamasid mites
79. Study of biology, parasites and migration of bats
80. Genetic properties of germ cells in *Hymenolepis*
81. Relations of viruses to protozoa, helminths, fungi
82. *Culex pipiens* complex in relation to encephalitis
83. Biochemistry of parasitic helminths
84. Effect of L. S. D. and related amines on the liver fluke

APPENDIX 13, Continued

85. Metabolic studies of *Strongyloides ratti*
86. Visceral larva migrans
87. A hemagglutination test in visceral larva migrans
88. Physiology of trichomonad protozoa
89. Host-parasite relations of intestinal helminths
90. Physiology of mosquito species—complexes
91. Epizootiology of parasites in arctic nesting birds
92. Punch card indices for acarina
93. Pathogenesis of ectoparasitic infections of fish
94. Fatty acid and steroid metabolism in trichomonads
95. Taxonomy of the *Plecoptera*
96. Study of toxins produced by trichomonads
97. Biology and ecology of lesser housefly
98. Insect digestive processes related to parasitism
99. Inter-relationship of host and parasite
100. Oxidative metabolism of insect metamorphosis
101. Revision of poisonous *Latrodectus* spiders
102. Physiology of insecticide resistance
103. Feeding habits in relationship to natural parasitism
104. Host cellular response to larval development
105. *Haemoproteus metchnikovi* in the turtle
106. Toxoplasma antibodies in well persons
107. Studies on the bionomics of *Culex tarsalis* Coq.
108. Ectoparasites of wild rodents
109. Intracellular bacteroids of cockroaches
110. Studies on *Echinococcus* in Mississippi
111. Mosquito ecology in irrigated pastures and hay fields
112. Enzymology of certain metazoan parasites
113. Adaptation of *Paramecium* to growth
114. Pathogenic secretions of gall-inducing nematodes
115. Selective chemical inhibitors of embryonation
116. Mechanisms of infections in the oyster
117. Studies on sparganosis and cestode biology
118. Growth in ciliates of the genus *Paramecium*
119. Physiology and biochemistry of growth
120. The use of fly larvae for biological control of snails
121. Nature of resistance to trichostrongyloidosis
122. The physiology of insect chemoreception
123. The biology of the mouse pinworms
124. Chromosomal heredity in *Chlamydomonas*
125. The toxoplasma parasite and toxoplasmosis
126. Protozoal screening methods for cancer chemotherapy
127. Nutrition of Trypanosomidae of insects
128. Hereditary characteristics in *Endamoeba histolytica*
129. Effects of viruses in tissues of arthropods
130. Biochemical role of oxygen in parasitic protozoa
131. Study of hamsters infected with *Trichinella spiralis*
132. Axenic cultivation of ciliated protozoa
133. Nutrition of thermophilic ciliated protozoa
134. *In vitro* cultivation of the avian plasmodia
135. Trematode life cycles and trematode diseases
136. Oxygen consumption of trematodes
137. Resistance to the nematode stomach-worm, *H. contortus*
138. Effects of diets and drugs upon enteric protozoa
139. Primate spleen in control of malaria
140. Digestive enzyme studies on blood-sucking insects
141. Diagnosis and pathogenesis of toxoplasmosis
142. Behavior of larval and adult mosquitoes
143. Rearing of *Cyclocoelum microstomum* in laboratory birds
144. Biology and public health importance of bats in Oklahoma
145. The physiology and nutrition of intestinal flagellates
146. Oxidative and synthetic enzyme systems in insects
147. Parasitism involving the snail
148. Ability of aphids to transmit viruses
149. Serology of schistosomiasis
150. Morphology of the species of the genus *Balantidium*
151. Chemical factors in insect behavior
152. Comparison of porcine and bovine trichomonads
153. Studies on virus and parasite relationships
154. Chagas' disease in the United States
155. Identification of larval mosquitoes
156. *In vitro* precipitate test for visceral larva migrans
157. Mechanism of immunity to filarial worms
158. Biology and chemotherapy of fungus infections
159. Enzyme activity of parasitic protozoa
160. Ticks of the genus *Ixodes* in Utah
161. Experimental trichinosis in hibernating hosts
162. Oxidative phosphorylation in insect muscle mitochondria
163. Studies of *Leucocytozoon* in the turkey
164. Effects of irrigation upon the spread of molluscan hosts
165. Studies on the biologic function of glyoxalase
166. Quantitative action of parasiticides
167. Reservoir of equine encephalomyelitis
168. Biology and chemistry of plant resistance to insects
169. Contact chemoreception in adult mosquitoes
170. To translate and publish Buchner's "Endosymbiose"
171. Nature of immunity in *Trypanosoma lewisi*
172. Reactions to insect bites: Causes and effects
173. Biochemistry and physiology of *Ascaris lumbricoides*
174. Studies on acquired taxoplasmosis
175. Vitamin B_{12} deficiency in tapeworm infestation
176. Fine structure of malaria parasites and host cells
177. Immunity in experimental schistosomiasis
178. Ectoparasite survey of rats

APPENDIX 14

Questionnaire for section on foreign grant programs in tropical medicine

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL
DIVISION OF MEDICAL SCIENCES
2101 Constitution Avenue
Washington 25, D. C., U. S. A.

SURVEY OF NEEDS IN THE FIELD OF TROPICAL MEDICINE

IV-B Research grant programs applicable to medical problems in the tropics (Caribbean, Central and South America, Africa, Southwest, South Central and Southeast Asia, and Oceania)

Name of organization ....

Address ....Name and title of official supplying information ....

A. Source and Number of Grants:

	Total Number of Individual Grants	Number Active per Year 1954	1955	1956	1957	1958
Government	....	....	....	....	....	....
Private Industry	....	....	....	....	....	....
Private Foundations	....	....	....	....	....	....

B. Source of Funds:

	Funds Spent per Year (Local Currency) 1954	1955	1956	1957	1958	Total Funds Spent
Government	....	....	....	....	....	....
Private Industry	....	....	....	....	....	....
Private Foundations	....	....	....	....	....	....

Are figures based on actual expenditures .... or estimates ....? Please check one.

C. Beneficiaries:

	Total Number
Academic Institutions	....
Professional Schools	....
Other	....

D. Status of Principal Investigator:

	Total Number
Bachelor of Science	....
Master of Science	....
Professional Degrees:	
Doctor of Medicine	....
Doctor of Philosophy	....
Doctor of Science	....

(Or equivalent degrees in your country)

E. Evaluation of Past and Current Needs:

In your opinion, have funds available for research in tropical medicine during the past 5 years been adequate in relation to the needs in preventive medicine and disease control in your country or in areas of the national interest?

F. Estimate of Future Needs:

If possible, please estimate below the amount of funds yearly for the next five years that could be adequately used for research on problems in tropical medicine of major importance to your country, taking into consideration availability of research facilities and research workers.

	1959	1960	1961	1962	1963
Projected Needs (Local Currency)	....	....	....	....	....

APPENDIX 15

Addresses of the major centers of tropical medicine teaching mentioned in the text

BRAZIL

Instituto de Medicina Tropical de São Paulo
Faculdade de Medicina
Universidade de São Paulo
Caixa Postal 2921
São Paulo
(Director: Prof. Carlos da Silva Lacaz in 1960)

MEXICO

Escuela e Instituto de Salubridad y Enfermedades Tropicales
Esq. Carpio y Plan de San Luis
Mexico 17, D. F.
(Director: Dr. Gerardo Varela in 1961)

CHILE

Departamento de Parasitología
Facultad de Medicina
Universidad de Chile
Casilla 9183
Santiago
(Director: Prof. Amador Neghme in 1961)

CANADA

Institute of Parasitology
Macdonald College
McGill University
Box 231—Macdonald College P. O.
Quebec
(Director: Dr. Thomas W. M. Cameron in 1961)

UNITED KINGDOM

London School of Hygiene and Tropical Medicine
Keppel Street (Gower Street)
London, W. C. 1, England
(Dean: Prof. E. T. C. Spooner in 1961)

The Incorporated Liverpool School of Tropical Medicine
University of Liverpool
Pembroke Place
Liverpool 3, England
(Dean: Prof. B. G. Maegraith in 1961)

Department of Tropical Medicine
University of Edinburgh
Surgeons' Hall
Edinburgh 8, Scotland
(Director: Dr. Frederick J. Wright in 1961)

FRANCE

Institut d'Hygiène Tropicale et de Médecine Sociale
Universite d'Aix-Marseille
Boulevard d'Alès
Marseille 5^e^
(Director: Prof. J. Sautet in 1960)

Institut de Médecine Tropicale
15, rue de l'Ecole de Médecine
Paris 6^e^
(Director: Prof. Georges Lavier in 1961)

SWITZERLAND

Schweizerisches Tropeninstitut
Basel
(Director: Prof. Rud. Geigy in 1961)

PORTUGAL

Instituto de Medicina Tropical
Rua da Junqueira
Lisbon 3
(Director: Dr. F. Cambournac in 1961)

THE NETHERLANDS

Koninklijk Institut voor de Tropen
Afdeling Tropische Hygiëne en Geographische Pathologie
Mauritskade 57
Amsterdam-0
(Director: Prof. J. W. Wolff in 1960)

Instituut voor Tropische Geneeskunde
Rijksuniversiteit te Leiden
Rapenburg 33
Leiden
(Director: Prof. J. E. Dinger in 1960)

BELGIUM

Institut de Médecine Tropicale Prince Leopold
155, rue Nationale
Antwerp
(Director: Prof. P. G. Janssens in 1959)

Laboratoire de Parasitologie Tropicale
Faculté de Médecine et de Pharmacie
Université Libre de Bruxelles
115, Boulevard de Waterloo
Brussels 1
(Director: Prof. R. Vanbreuseghem in 1960)

APPENDIX 15, Continued

FEDERAL REPUBLIC OF GERMANY

Bernhard-Nocht-Institut für Schiffs- und Tropenkrankheiten
Bernhard-Nocht-Strasse 74
Hamburg 4
(Director: Prof. E. G. Nauck in 1961)

Institut für Infektions- und Tropenmedizin der Universität München
Neudeck 1
Munich 9
(Director: Prof. A. Herrlich in 1960)

ITALY

Istituto di Clinica delle Malattie Tropicali e Subtropicali
Università di Roma
Città Universitaria
Rome

Istituto di Malariologia "Ettore Marchiafava"
Policlinico "Umberto I"
Rome
(Director: Prof. G. Raffaele in 1959)

INDIA

All-India Institute of Hygiene and Public Health
110, Chittaranjan Avenue
Calcutta 12

Calcutta School of Tropical Medicine
Chittaranjan Avenue
Calcutta 12
(Director: Dr. R. N. Chaudhuri in 1960)

AUSTRALIA

School of Public Health and Tropical Medicine
University of Sydney
Sydney, New South Wales
(Director: Prof. E. Ford in 1956)

APPENDIX 16

Overseas Pasteur Institutes with affiliation to the Pasteur Institute in Paris

	Year of Establishment
FRENCH OVERSEAS DEPARTMENTS	
Algeria (Algiers)	1894
Martinique (Fort de France)	1938
French Guiana (Cayenne)	1940
Guadeloupe (Pointe à Pitre)	1948
FRENCH OVERSEAS TERRITORIES	
New Caledonia (Noumea)	1955
REPUBLICS OF THE COMMUNITY	
Congo Republic (Brazzaville)	1908
Senegal (Dakar)	1924
Malagasy Republic (Tananarive)	1927
FOREIGN COUNTRIES	
Republic of South Vietnam (Saigon)	1891
Republic of South Vietnam (Nhatrang)	1893
Tunisia (Tunis)	1893
Morocco (Tangiers)	1913
Greece (Athens)	1920
Iran (Tehran)	1921
Republic of Guinea (Kindia)	1923
Morocco (Casablanca)	1928
Republic of South Vietnam (Dalat)	1936
Ethiopia (Addis Ababa)	1951
Cambodia (Phnom-Penh)	1953
Republic of Cameroon (Yaoundé)	1959

NOTE: The construction of a Pasteur Institute in Bangui (Central African Republic) was completed in 1961. Construction is planned for a Pasteur Institute in the Republic of the Ivory Coast.

APPENDIX 17

Tropical research laboratories employing ORSTOM personnel in 1960

Name of laboratory	*City*	*Country*	*Number employed*
Centre Muraz du Service des Grandes Endémies d'Afrique Occidentale	Bobo-Dioulasso	Republic of Upper Volta	4
Institut d'Enseignement et de Recherches Tropicales	Abidjan	Republic of the Ivory Coast	1
Centre de Brazzaville	Brazzaville	Congo Republic	4
Institut de Recherches Camerounaises	Yaoundé	Republic of Cameroon	2
Institut de Recherches Scientifiques de Madagascar	Tananarive	Malagasy Republic	4
Institut Français d'Océanie	Nouméa	New Caledonia	1
Institut de Recherches Médicales de la Polynésie Française	Papeete	Tahiti French Polynesia	1
World Health Organization	Lagos	Nigeria	1
Institut Pasteur	Tehran	Iran	1

APPENDIX 18

List of authorities requested to submit suggestions on specific problems

Diseases of high endemicity

Bacterial diseases

Bacillary dysentery

Prof. Patrick Collard, Department of Bacteriology, University College, Ibadan, Nigeria

Dr. Albert V. Hardy, Assistant State Health Officer, Florida State Board of Health, P. O. Box 210, Jacksonville, Florida

Dr. H. M. Penido, Superintendent, Fundação Serviço Especial de Saude Publica, Rio de Janeiro, Brazil

Prof. J. Sénécal, Institut des Haute Études, Dakar, Republic of Senegal

Leprosy

Dr. J. A. Kinnear Brown, Ministry of Health, Entebbe, Uganda

Dr. Orestes Diniz, Director, Serviço Nacional de Lepra, Ministério da Educacão e Saude, Rio de Janeiro, Brazil

Dr. R. V. Wardekar, Secretary, Gandhi Memorial Leprosy Foundation, Wardha, Maharashtra, India

Meningococcal infections

Dr. S. T. Achar, Director, Institute of Pediatrics, Madras Medical College, Madras, India

Prof. J. Sénécal, Institut des Haute Études, Dakar, Republic of Senegal

Dr. H. C. Trowell, Prebendal House, Stratford-sub-Castle, Salisbury, England

Dr. B. B. Waddy, Reader in Tropical Hygiene, Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1, England

Pneumonia (all forms)

Dr. J. R. Lauckner, Department of Medicine, University College, Ibadan, Nigeria

Prof. Ruy João Marques, Director, Instituto de Medicina Tropical, Universidade do Recife, Recife, Pernambuco, Brazil

Tuberculosis

Dr. Stig Anderson, National Tuberculosis Institute, Bangalore, India

Dr. E. Aujaleu, Directeur général de la Santé publique, Ministère de la Santé publique et de la Population, Paris, France

Prof. N. A. Schmelew, Director, Institute of Tuberculosis, Soviet Union Academy of Medical Sciences, Moscow, USSR

APPENDIX 18, Continued

Typhoid and paratyphoid fevers

Dr. Kho Lien Keng, Department of Pediatrics, Medical School, University of Indonesia, Djakarta, Indonesia

Dr. Gamal Nor-el-Din, Director, Abbassia Fever Hospital, Cairo, Egyptian Province, United Arab Republic

Whooping cough

Prof. Dr. Robert Debré, Président, Centre International de l'Enfance, Chateau de Longchamp, Bois de Boulogne, Paris 16^{e}, France

Dr. Margaret Pittman, Chief, Laboratory of Bacterial Products, Division of Biologics Standards, National Institutes of Health, Bethesda, Maryland

Spirochaetal diseases

Treponematoses (Syphilis and yaws)

Dr. F. Nery Guimarães, Instituto Oswaldo Cruz, Rio de Janeiro, Brazil

Dr. C. J. Hackett, Senior Medical Officer, Research Planning and Coordination, World Health Organization, Geneva, Switzerland

Dr. Thomas B. Turner, Dean of the Medical Faculty, The Johns Hopkins University School of Medicine, Baltimore, Maryland

Dr. R. Wasito, Director, Venereal Disease Research and Yaws Campaign Institute, Surabaya, Indonesia

Viral diseases

Influenza

Dr. C. H. Andrewes, National Institute for Medical Research, London. N. W. 7, England

Dr. Thomas Francis, Jr., Department of Epidemiology, The University of Michigan School of Public Health, Ann Arbor, Michigan

Dr. I. G. K. Menon, Deputy Director, Pasteur Institute, Government of India Influenza Center, Coonoor, India

Measles and mumps

Dr. K. McL. Cobban, University College Hospital, Ibadan, Nigeria

Dr. John Enders, Harvard University School of Public Health, 25 Shattuck Street, Boston 15, Massachusetts

Dr. D. B. Jelliffe, UNICEF Professor of Child Health, Makerere Medical School, Kampala, Uganda

Prof. Carlos da Silva Lacaz, Institudo de Medicina Tropical de São Paulo, Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil

Poliomyelitis

Dr. J. H. S. Gear, Director of Research, The Poliomyelitis Foundation Laboratories, South African Institute for Medical Research, Johannesburg, Republic of South Africa

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APPENDIX 18, Continued

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Trachoma

Prof. Dr. G. B. Bietti, Direttore, Clinica Oculistica, Universitaria di Roma, Rome, Italy

Dr. G. Sicault, Deputy Executive Director (Planning), United Nations Children's Fund, United Nations, New York

Dr. John C. Snyder, Dean, Harvard University School of Public Health, 25 Shattuck Street, Boston 15, Massachusetts

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Parasitic diseases

Ancylostomiasis

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Dr. Lie Kian Joe, Institute for Medical Research, Kuala Lumpur, Federation of Malaya

Prof. Dr. H. F. Nagaty, Chairman, Department of Endemic Diseases, Faculty of Medicine, Ein Shams University, Cairo, Egyptian Province, United Arab Republic

Filariasis

Dr. Frank Hawking, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N. W. 7, England

Dr. Émile Massal, Directeur, Institut de Recherches Médicales de la Polynésie Française, Papeete, Tahiti

Dr. R. G. Rachou, Departamento Nacional de Endemias Rurais, Belo Horizonte, Brazil

Dr. N. G. S. Raghavan, Deputy Director, Malaria Institute of India, Delhi, India

Malaria

Dr. C. A. Alvarado, Director, Division of Malaria Eradication, World Health Organization, Geneva, Switzerland

Dr. F. J. C. Cambournac, Regional Director, World Health Organization, Brazzaville, Republic of the Congo

Dr. G. Robert Coatney, Chief, Laboratory of Parasite Chemotherapy, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland

Sir Gordon Covell, Director, Malaria Reference Laboratory, Horton Hospital, Epsom, Surrey, England

Dr. F. J. Dy, Director of Health Services, Regional Office for the Western Pacific, World Health Organization, Manila, Republic of the Philippines

Dr. Arnoldo Gabaldon, Ministro de Sanidad y Asistencia Social, Caracas, Venezuela

APPENDIX 18, Continued

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Schistosomiasis

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Dr. J. Gillet, Institut de Médecine Tropicale, Antwerp, Belgium

Dr. Y. Komiya, Chief, Department of Parasitology, National Institute of Health, Tokyo, Japan

Dr. T. P. Pesigan, Chief, Division of Schistosomiasis, Department of Health, Republic of the Philippines, Manila, Republic of the Philippines

Prof. Hans Vogel, Tropeninstitut, Bernhard-Nocht-Strasse 74, Hamburg 4, Federal Republic of Germany

Amoebiasis

Dr. R. Elsdon-Dew, Director, Amoebiasis Research Unit, Institute for Parasitology, Durban, Natal, Republic of South Africa

Dr. Henry E. Meleney, The J. Hillis Miller Health Center, University of Florida, Gainesville, Florida

Nutritional diseases

Kwashiorkor and other nutritional disorders

Dr. J. F. Brock, Head, Department of Medicine, University of Cape Town, Cape Town, Republic of South Africa

Dr. William J. Darby, Director, Division of Nutrition, Vanderbilt University School of Medicine, Nashville, Tennessee

Prof. B. S. Platt, Director, Human Nutrition Research Unit, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N. W. 7, England

Prof. V. Ramalingaswami, All-India Institute of Medical Sciences, New Delhi, India

Dr. Nevin S. Scrimshaw, Head, Department of Nutrition, Food Science and Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts

Diseases of relatively low endemicity at present but potentially great because of epidemic character in past and present unprotected populations

Bacterial diseases

Cholera

Dr. A. H. Abou-Gareeb, High Institute of Public Health, Alexandria, Egyptian Province, United Arab Republic

APPENDIX 18, Continued

Dr. R. N. Chaudhuri, Director, School of Tropical Medicine, Calcutta, India

Dr. R. Pollitzer, 1426 M Street, N. W., Washington, D. C.

Dr. Joseph E. Smadel, Chief, Laboratory of Virology and Rickettsiology, Division of Biologics Standards, National Institutes of Health, Bethesda, Maryland

Plague

Dr. R. B. Heisch, Division of Insect-Borne Diseases, Medical Research Laboratory, Nairobi, Kenya

Dr. Atilio Macchiavello, Department of Advisory Services, World Health Organization, Geneva, Switzerland

Dr. Karl F. Meyer, Director Emeritus, George Williams Hooper Foundation for Medical Research, University of California Medical Center, San Francisco 22, California

Dr. R. Pollitzer, 1426 M Street, N. W., Washington, D. C.

Spirochaetal diseases

Relapsing fever (all forms)

Dr. M. Baltazard, Directeur, Institut Pasteur de l'Iran, Teheran, Iran

Dr. Hélène Sparrow, Institut Pasteur de Tunis, Tunis, Tunisia

Leptospirosis

Lieut. Col. William S. Gochenour, Jr., U. S. Army Medical Unit, Walter Reed Army Medical Center, Fort Detrick, Maryland

Dr. Ricardo Veronesi, Hospital das Clinicas, Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil

Dr. J. W. Wolff, Director, Institute of Tropical Hygiene and Geographical Pathology, Department of the Royal Tropical Institute, Amsterdam, Netherlands

Rickettsial diseases

Typhus fever (all forms)

Dr. Alfred L. Craddock, Apry, Furzefield Road, Reigate, Surrey, England

Dr. Paul Giroud, Chef du Service des Rickettsioses, Institut Pasteur, Paris^{xv}, France

Dr. Octavio de Magalhães, Instituto Oswaldo Cruz, Rio de Janeiro, Brazil

Viral diseases

Dengue

Dr. W. McD. Hammon, Head, Department of Epidemiology and Microbiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh 13, Pennsylvania

Smallpox

Dr. C. Henry Kempe, Head, Department of Pediatrics, University of Colorado Medical Center, Denver 20, Colorado

Dr. C. Purananda, Director, Queen Saovabha Memorial Institute, Bangkok, Thailand

Dr. R. Sanjiva Rao, Assistant Director, Virus Research Center, Poona, India

Yellow fever

Dr. Augusto Gast-Galvis, Director, Instituto de Estudios Especiales "Carlos Finlay", Bogotá, Colombia

Dr. J. Austin Kerr, Pan American Health Organization, Washington, D. C.

Dr. Kenneth C. Smithburn, 3339 West 42nd St., Indianapolis 8, Indiana

Dr. Fred L. Soper, Director, Pakistan-SEATO Cholera Research Laboratory, Mohakhali (Tejgaon), Dacca 5, East Pakistan

Dr. Max Theiler, Director, The Rockefeller Foundation Virus Laboratories, York Avenue and 66th St., New York 22, New York

Parasitic diseases

Leishmaniasis

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Dr. P.C. Sen Gupta, Calcutta School of Tropical Medicine, Calcutta, India

Dr. Marshall Hertig, Gorgas Memorial Laboratory, Panama, Republic of Panama

Dr. P.E.C. Manson-Bahr, Physician Specialist, Department of Health, Nairobi, Kenya

Diseases of relatively low endemicity but high mortality or serious complications

Viral diseases

Rabies

Dr. Karl Habel, Chief, Laboratory of Biology of Viruses, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland

Dr. P. Lépine, Chef du Service des Virus, Institut Pasteur, Paris[xv], France

Dr. N. Veeraghavan, Director, Pasteur Institute of Southern India, Coonoor, India

Parasitic diseases

Hydatid disease

Dr. A. R. Neghme, Director, Department of Parasitology, School of Medicine, University of Chile, Santiago, Chile

Dr. Calvin W. Schwabe, Chairman, Department of Tropical Health, Schools of Public Health and Medicine, American University of Beirut, Beirut, Lebanon

Dr. R. V. Talice, Professor of Parasitology, Facultad de Medicina, Instituto de Higiene, Montevideo, Uruguay

APPENDIX 18, Continued

Onchocerciasis

Médecin Général P. M. Bernard, Secrétariat d'État aux Relations avec les États de la Communauté, Premier Ministre, Paris, France

Dr. Thomas A. Burch, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland

Dr. R. W. Crosskey, Ministry of Health, Kaduna, Northern Nigeria

Dr. M. Giaquinto, Endemo-epidemic Diseases, Division of Communicable Diseases, World Health Organization, Geneva, Switzerland

Dr. F. C. Rodger, Consultant Ophthamologist, Princess Margaret Hospital, Swindon, Wiltshire, England

Dr. Luis Vargas, Laboratorio de Entomología, Instituto de Salubridad y Enfermedades Tropicales, México 17, D. F. (Mail address: Apartado Postal 19205, México 4, D. F.)

Chagas' disease

Dr. Emmanuel Dias, Instituto Oswaldo Cruz, Manguinhos, GB, Rio de Janeiro, Brazil, and Instituto Oswaldo Cruz, Bambui, R.M.V., Minas Gerais, Brazil

Dr. J. L. Pedreira de Freitas, Departamento de Higiene e Medicina Preventiva, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, São Paulo, Brazil

Dr. Cecilio F. Romaña, Malabia 2515, Buenos Aires, Argentina

African trypanosomiasis

Dr. Mário A. de Andrade Silva, Inspecção Superior de Saúde, Instituto de Medicina Tropical, Ministério do Ultramar, Lisbon, Portugal

Dr. T. A. M. Nash, School of Veterinary Science, University of Bristol, Langford, Bristol, England

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Dr. M. Vaucel, Directeur général des Instituts Pasteur hors-métropole, Paris^{xv}, France

Dr. K. C. Willett, Director, West African Institute for Trypanosomiasis Research, Kaduna, Northern Nigeria

Dr. S. G. Wilson, Veterinary School, Utrecht University, The Netherlands

New diseases concerning which present knowledge is limited, but which appear to be of considerable health importance

Arthropod-borne viral infections

Dr. Charles R. Anderson, Virus Research Centre, Poona, India

Dr. Ottis R. Causey, Director, Belém Virus Laboratory, Belém, Brazil

APPENDIX 18, Continued

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Dr. Telford H. Work, Chief, Virus and Rickettsia Section, Communicable Disease Center, U. S. Public Health Service, Atlanta, Georgia

Diseases of domestic animals

Dr. R. A. Alexander, Director of Veterinary Services, Department of Agriculture, Onderstepoort, via Pretoria, Republic of South Africa

Dr. W. G. Beaton, Director, Interafrican Bureau for Animal Health, C. C. T. A., Muguga, Kikuyu, Kenya

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Dr. A. B. Coronel, Director, Bureau of Animal Industry, Department of Agriculture and Natural Resources, Manila, Republic of the Philippines

Dr. P. J. du Toit, Chairman, South African Council for Scientific and Industrial Research, Pretoria, Republic of South Africa

Dr. Ervin A. Eichhorn, Chief, Animal Health Branch, Animal Production and Health Division, Food and Agriculture Organization of the United Nations, Rome, Italy

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Research needs in human and animal tropical biometeorology

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APPENDIX 18, Continued

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Dr. Bernard Metz, Laboratory of Applied Physiology, Faculty of Medicine, University of Strasbourg, Strasbourg, France

Dr. Frederick Sargent, II, Department of Physiology, University of Illinois, 524 Burrill Hall, Urbana, Illinois

Dr. Joseph S. Weiner, M. R. C. Unit for Climate and Working Efficiency, Oxford University, Oxford, England

Dr. C. H. Wyndham, Applied Physiology Laboratory, Transvaal and Orange Free State Chamber of Mines, P. O. Box 809, Johannesburg, South Africa

APPENDIX 19

Research needs in medical and hygienic problems of the tropics; suggestions submitted by authorities in various fields

BACILLARY DYSENTERY

Research Problems in Bacillary Dysentery—Excerpt from a letter dated 1 March 1961 from **Dr. Patrick Collard,** University College, Ibadan, Nigeria.

The following are the most important research problems in connection with bacillary dysentery in Nigeria at the present moment:

1. Epidemiology in the "Extended Family."
2. Reason for prevalence of Flexneri II and rarity of *Shigella sonnei* and *S. dysenteriae.*
3. The nature of the barriers which prevent epidemic spread.
4. Modes of transmission.

Investigation of Acute Diarrhoeal Diseases—Submitted 6 April 1962 by **Dr. Albert V. Hardy,** Acting State Health Officer, Florida State Board of Health, Jacksonville, Florida.

The diseases and disorders in which diarrhoea is the outstanding manifestation continue to be a leading hazard to the life and health of infants and children in many of the less developed countries. On a world-wide basis it is estimated that they account for about 5 million deaths of infants and children each year. As a common disease of adults in underdeveloped areas they are an important cause of economic loss. These diseases have not received the study which their relative importance indicates, in part due to difficulties of investigation where the disorders are prevalent. Moreover, since the nature of the problem undoubtedly varies from area to area the findings in the more developed countries cannot be applied to conditions in the less developed areas. There is therefore an urgent need for investigations designed to provide more effective means of control.

The investigations indicated are of four broad types. The more basic studies as of etiology, epidemiology and nutritional status will be designed to provide the information required for the evolution of effective control. These investigations will require intensive studies of comparatively small population groups selected to be widely representative and located with ready access to the laboratory facilities required. The second type of study is to evaluate the effectiveness of specific control procedures. This calls for limited observations on comparatively large population groups. These investigations will need to be located where specific control procedures are to be applied and where there is access to a comparable region in which that control measure will not be used. Observations to determine differences in morbidity or mortality from diarrhoeal diseases, or variations in the incidence of enteric infections, will be obtained in the test and the control areas. Thirdly, a number of limited and specialized studies of specific aspects of the problem are indicated. The fourth type of study has high practical significance. It involves the development of "pilot" or demonstration control programs which will transform the knowledge acquired in research to life saving and disease preventing programs. The study activity here is the measurement of the efficacy of the preventive measures as they can be applied in practice.

The first type of study requires a special research team which ordinarily functions as an independent unit. The second and the fourth must be related to an operating program; the cost of these studies will usually be small as compared to the budget required for the control activity. The limited special studies require specialized skills of ordinarily one, two or three persons for each study. These four types of study will be considered separately.

A. COMPREHENSIVE STUDIES

A major problem here is to determine the relative roles of various enteric pathogens (or "facultative pathogens"), and of nutritional deficiencies in the etiology of diarrhoeal diseases. The hypothesis is that this varies widely ranging from conditions in which virtually all diarrhoeal disease is an acute enteric infection in previously well nourished individuals, to those in which the diarrhoeal diseases are predominantly caused by or related to preceding nutritional deficiencies. The interrelationship of these conditions as well as the independent roles of each need to be determined. Equally important the environmental conditions which permit the spread of enteric infections must be evaluated. All factors related to the cause of the diseases need to be considered.

The facilities required for these studies will limit the possible locations for the investigations. Adequate laboratory facilities both for microbiological and chemical studies are essential. The population to be studied should be as widely representative as possible. The indicated size of the population group will vary with the incidence of disease, but it will be relatively small as in the order of 2,000 to 5,000. Selected villages or small towns provide isolated and easily defined study areas, but segments of cities or urban families selected on a random basis may be used. Whatever the area, the laboratory facilities, which will be the focus of the investigation, will need to be within easy reach. INCAP in Guatemala is illustrative of the type of location from which such studies may be conducted admirably. There an Institute, initially concerned with studies of foods and human nutrition, expanded its activities through the addition of a microbiological section. Contrarywise, other institutions primarily concerned with microbiology and infectious diseases might expand their activities through adding facilities for the study of related problems in nutrition.

Observations indicated are as follows:

(i) A complete community survey and census is first required. This can be accomplished by local non-professional personnel working under close direction or by selected auxiliaries where these are available. Family rosters and general data on the family and home environment are obtained on the initial visit. The interviewers must be able to foster an attitude of willingness to cooperate in a prolonged survey from which the family will derive little or no immediate benefit. In underdeveloped areas the diarrhoeal diseases will be known to be an important health problem, and interest and cooperation in the study of these will be more readily elicited. The families will be followed through regular visits of the interviewers at intervals of two to four weeks to determine whether there is or has been any diarrhoeal disease in any member of the family (or other condition on which information is being collected concurrently) or any change in the family roster. Also the interviewers must be regularly available to receive reports of the onset of any diarrhoeal disorder. Data assembled in this way and the related studies described below will provide a full picture of diarrhoeal diseases in the community.

(ii) The occurrence of subclinical as well as clinical enteric infections will be determined by monthly laboratory examinations of a sample of the population. These repeated cultures may be limited to children of specified age where it is impractical to collect fecal samples from adolescents and adults. Samples for bacteriological examination may be obtained by rectal swabs for immediate plating; passed samples are satisfactory when they are transmitted promptly to the laboratory. Bacteriological studies for *Shigella* and *Salmonella* and in so far as is practicable for enteropathogenic *E. coli* will be done. Parasitological examinations may be included or omitted according to local conditions. These studies will provide the needed data on the distribution of clinical and subclinical enteric infections in the population group.

(iii) Those developing diarrhoeal disorders will have additional fecal examinations according to a pre-arranged schedule. Early and repeated examinations are needed.

(iv) Special clinical and epidemiological case records on each illness will be completed.

(v) In order to assess the nutritional situation of the population as a whole the following will be needed: (a) information on the kind and amount of various food stuffs produced and available for consumption in the community; (b) dietary intake studies of the families selected, and in a small sub-sample of individual children, consisting of 7-day diet records taken several times during different seasons; (c) clinical examinations of all members of the families selected with particular attention to signs of nutritional deficiencies; (d) selected laboratory tests to supplement the clinical examinations such as haemoglobin, total proteins, etc.

(vi) Environmental factors contributing to the occurrence of diarrhoeal diseases will be evaluated and findings will be correlated with incidence of disease and prevalence of infection to determine their relative significance. The observations will include collection of data on (1) potability and accessibility of water supplies, (2) disposal of human excrement, (3) contamination of soil and pollution of water supplies, (4) ecology of flies and their seasonal prevalence, (5) practices relating to production, processing, storage and consumption of milk and food, (6) presence of domestic animals and rodents, and (7) characteristics of housing including measurements of crowding.

(vii) Social and anthropological observations as to attitudes concerning the diarrhoeal diseases, and as to habits or customs which may be related to the occurrence of these will be obtained. Prevailing practices in the care of infants and children with these disorders will be determined.

Through these comprehensive studies there will be obtained a record of nutritional status, the distribution of enteric infections in cases and carriers, a full picture of physical and social environmental factors, and information as to the occurrence of diarrhoeal diseases of all degrees of severity. Through this slow and detailed process of observation, evidence will gradually accumulate which should establish the relative roles and the interrelationship of malnutrition and enteric infections in diarrhoeal diseases, and provide the detailed epidemiological picture including modes of transmission of the prevailing enteric infections.

Two problems in the conduct of such studies are recognized. It is not easy to maintain the cooperation of a study population over a period of from one to five years. Provision of some desired service unrelated to the study would be helpful. Also it is difficult to avoid modifying the population through the contacts involved in the study. The degree of success will depend largely on those who have the repeated contacts with the families.

The personnel and budgetary requirements for comprehensive studies will vary with the size of the study population. The director appropriately would be a physician epidemiologist. For field studies he would require the assistance of a public health nurse, a non-medical nutritionist, a clinician and a sanitary engineer together with indicated interviewers. According to need these could devote either full-time or part-time to the study. The laboratory work would require the leadership of a microbiologist who would need the assistance of persons competent in parasitology and chemistry together with experienced laboratory helpers. Consultation by a statistician, particularly during planning, would be indicated, and a health educator and social scientist would be helpful. Adequate clerical and statistical assistance is essential. The cost of the study would be predominantly for the salaries of the required personnel. An adequate budget would be relatively large. The site of such studies would need to be selected with the greatest of care. Information of world-wide significance would be provided by even one such comprehensive study in a strategically located area.

B. STUDIES OF CONTROL PROCEDURES

A variety of environmental conditions are acknowledged to have some influence on the prevalence of diarrhoeal diseases. The provision of safe water supplies and sanitary disposal of human excrement are the most pressing environmental problems in newly developing areas where diarrhoeal diseases represent major health problems. It is widely believed that the provision of such facilities, together with control of flies, are of primary importance in the control of diarrhoeal diseases. Since previous studies have established conclusively that fly control is effective in lowering the prevalence of shigellosis, additional studies of this control procedure are not considered indicated at this time. Thus fly control may be used at present with adequate knowledge of its value and limitations.

Though the importance of potable water supplies and sanitary disposal of human waste is acknowledged by health officials, their relative value in control of diarrhoeal diseases is not known. There is a need, therefore, to conduct investigations to determine precisely their role in the prevention of the enteric diseases. Such knowledge, if significant positive correlations were obtained, would provide additional stimulus to the development of water supplies and excreta disposal facilities in newly developing areas and hasten the control of diarrhoeal diseases.

The importance of other environmental controls, such as hygiene of housing and protection of milk and food products, is acknowledged. However, on the basis of current evidence and needs in newly developing areas they are not considered to be of the same general importance. Present research is needed for major problems. Hence attention will be directed to the evaluation of water and excreta disposal and to the medical control procedures which, on the basis of present knowledge, warrant primary consideration.

(1) *Investigation of Effect of Environmental Changes.* The provision of potable water in adequate quantities and convenient accessibility to population groups is a paramount sanitational need in the developing areas. Within such areas the enteric diseases constitute the major cause of mortality and morbidity. Studies to date have shown presumptively that increased availability of water with its attendant increased use for personal hygiene resulted in significant reductions of diarrhoeal diseases. In view of such observations there is an urgent need for well designed studies to determine conclusively the significance of increased availability of water in the control of enteric infections.

Currently various plans are under consideration by national governments to improve community water supplies. These range from simple protection from contamination of existing sources, such as wells or surface supplies with no distribution system, to development of comprehensive plans for construction of complete water supply and distribution systems. Because of the extent of the problem and complete range in programme that may be considered feasible economically, it will be necessary to conduct in differing localities studies to evaluate the effect of the various programmes under consideration. Evaluation of the effect of the following is indicated: (1) Improved water quality in absence of change in distribution system; (2) Distribution of water to central locations in a community; (3) Distribution of water to individual premises with source outside the dwelling; and (4) Distribution of water to sanitary facilities inside dwellings.

There are wide variations in excreta disposal practices throughout the world depending on economic development and varying customs and habits of populations. Facilities for disposal vary from highly sanitary measures to total absence of appurtenances. In many small communities, villages and rural areas in newly developing areas, facilities are being installed for the sanitary disposal of human excrement to prevent contamination of water supplies, soil, vectors of disease and other animate or inanimate objects. The precise effectiveness of the various procedures used to dispose of human wastes in a sanitary manner on reduction of enteric diseases requires evaluation. In addition, studies are required to determine the most practical design and construction of facilities which will be economically attainable and acceptable to the people.

Selection of communities for study will require careful consideration. Test areas should be selected in which well defined changes will be made in a comparatively short time and in a uniform manner throughout the test area. For each test area there must be a comparable control community in which the environmental factor being evaluated remains unchanged.

Evaluation of the effect of each environmental change on prevalence of disease and infection will be conducted in the test and control areas according to procedures for collecting data on incidence of disease and prevalence of enteric infection as outlined previously under the comprehensive studies. The observations in both the test and control area should begin one year before the change in supplies and continue thereafter for an average period of about 3 years (or until sufficient data is obtained to determine effects of the change on prevalence of enteric disease).

The personnel required for this study are essentially similar to those described for the comprehensive studies, though here the sanitary engineer would necessarily be full time and have a place of high importance in the planning and conduct of the study. He would appropriately serve as co-director with an epidemiologist director. The possibility of including these investigations as part of the comprehensive studies described above warrant consideration.

(2) *Hydration and Rehydration in the Prevention of Mortality.* The high importance of dehydration as a cause of death from diarrhoeal disorders is generally acknowledged. As an immediate method of preventing deaths from these diseases, programmes of rehydration or designed to prevent dehydration are of high significance. Though varying procedures have been suggested or employed, there are no data on the mass significance of these various programmes for the prevention of mortality from these diseases. The following studies are suggested to provide needed evidence concerning their relative efficacy. It is emphasized that there will need to be detailed planning of studies in relation to local conditions. In this the participation of pediatricians and MCH personnel would be essential.

As in the evaluation of other control procedures this investigation requires simultaneous observation of test and control populations, each clearly defined. These trials would lend themselves to the use of the "factorial design" which has been effectively employed in drug therapy studies. It must be assured that in the test populations the control methods are readily available and it must be known to what extent they are, or are not, being employed.

In this investigation the test of the efficacy of the measure(s) under observation will be the reports of mortality. In both the tests and control area suitable procedures will be required to assure reliability in reporting and comparability in the reported findings. In the less developed countries usually this will require the collection of supplementary data from the family of a child dying from known or possible diarrhoeal disease or from the medical attendant if available. For this appropriately trained interviewers will be required.

It is accepted that under favourable conditions deaths from diarrhoea resulting in severe dehydration do not occur. The concern in this study is to determine the relative effectiveness of methods which may be employed where hospitals and well-trained physicians are not accessible. Comparable communities will be observed simultaneously. The control will be one with only the resources to meet grave medical emergencies, the situation commonly existing in underdeveloped areas. In the test communities medical and health measures at varying levels and of differing types will be made available. There will be in one the MCH services commonly provided. In other test communities the more specialized services will be added. Comparable communities in multiples of four or five (depending on the number of differing procedures to be examined) will need to be studied simultaneously. For dependability in findings, observations will need to be repeated in different countries under differing conditions.

In the selection of study areas it will need to be known that the prevailing mortality from the diarrhoeal diseases are essentially the same, and the social, cultural and economic conditions similar. Since the measure of efficacy will be differences in mortality from these enteric diseases, the communities observed will need to be cities or areas with populations of some 20,000 depending on the level of mortality.

In the planning of the different levels of service, it is recognized that variations from the proposed steps may be dictated by local conditions. Hence the precise nature of services provided will need to be specified precisely. The different level of services proposed for the comparable communities are as follows:

(a) A "control" community without added health services. It may have dispensaries where emergencies are given attention.

(b) A comparable community with a well operated Maternal and Child Health Center and related general MCH services, including emphasis on health education.

(c) A similar community in which there is established special rehydration centers with emphasis on oral rehydration and where indicated parenteral rehydration is done.

(d) In the fourth community the service would include in addition to the above special and aggressive programs for rehydration in the home and for special education designed for the prevention of dehydration. In connection with this, sugar-electrolyte solutions would be made freely available.

(e) In the fifth there would be all of the above, together with adequate and accessible hospital services for children.

The recognized problem will be to apply only the test procedure(s) without other influences which would modify the mortality in the test community.

In these studies the measurement of results will be simple as compared with the application of the control program. If possible, communities for study should be selected in which other than the research agency would assume the cost for the application of the control program. In the absence of this, the research agency could both apply the program and evaluate the results.

The personnel needs are for the joint action of consulting pediatricians, MCH personnel, and public health administrators interested in research. An adequate supporting staff will be essential. These studies could be handled entirely by such operating personnel with only general guidance in organization and in the accumulation and analysis of the mortality data. This consultive assistance could be provided appropriately by a medical epidemiologist.

If the operating agency assumes responsibility, the research cost would be small. If the control program has to be applied by the research agency, the cost would be relatively high.

C. SPECIAL STUDIES

Through cooperative planning the following special studies need to be arranged:

(1) *Nutrition and the diarrhoeal diseases.* The comprehensive community studies outlined should provide substantial evidence as to the respective roles of malnutrition and infection in the cause of diarrhoeal diseases. To obtain conclusive data, however, an "experimental" approach through observation of the response to supplementary feeding programs in community groups will be required. It may be assumed that the earlier community investigations will point to some major dietary deficiency which could be presumed to be related to the cause of diarrhoeal disease. This hypothesis then will need to be tested precisely. Lacking any promising procedures to examine the nutritional cause of diarrhoeal disease of humans through animal feeding tests, the one approach available is the observation of the response to appropriate supplementary feeding in community groups. Again this investigation will demand the simultaneous study of test and control communities. Each will need to be observed as outlined for the comprehensive studies. In one the indicated food supplements

will be provided and the extent to which these are actually used will need to be determined. Observations on the occurrence of specific diarrhoeal diseases over a period of two or more years could be required to evaluate the response.

The conduct of this study will demand detailed planning and particularly exacting management. As in any experimental approach it cannot be assured that the findings will be as conclusive as expected.

(2) *Pathology.* The gross and microscopic tissue examination in a consecutive series of deaths from diarrhoeal diseases will provide specific data not otherwise attainable. This has been initiated through the cooperation of the Commission on Enteric Infections of the Armed Forces Epidemiological Board and INCAP. A series of 100 cases from Guatemala are being studied, including full bacteriological and virological examinations. A similar plan could provide for studies in other areas. The objective of this proposed special study would be to have series of cases from five or more study areas in widely scattered regions of the world examined similarly.

(3) *Virological studies.* The significance as a cause of diarrhoeal disease and the world-wide distribution of enteric viruses is quite unknown. Here the requirement is for the collection of dependable specimens from a series of clinical cases and from comparable individuals without diarrhoeal disease or intimate exposure to it. Such specimens may be shipped readily and examined over a period of time in appropriately designated laboratories. There would need to be an exact documentation on each case or individual providing a specimen. These costly examinations should be done only in selected laboratories using similar techniques.

The cost of this investigation would be relatively high. In timing, the study should not have high priority.

(4) *Special bacteriological studies.* The WHO and the related national Shigella and Salmonella Centers are established and essential units for the investigation of diarrhoeal diseases. Currently they serve predominantly for the identification of problem organisms. Their function desirably could be expanded so that they would serve as centers for the assembling of data on Shigella and Salmonella infections. To this end a more adequate documentation on all cases from which agents are obtained and submitted for study is recommended. Likewise the submission of comparable data on all isolations of Shigella and Salmonella from areas in which these infections are being studied is to be encouraged. The added cost of assembling these significant data would be small.

The standardization of laboratory procedures warrants attention. Periodic meetings of directors of WHO and the National Shigella and Salmonella Centers, together with microbiologists serving field research units, would aid in attaining this objective.

Special attention to the entero-pathogenic *E. coli* is needed. Whether these are of clinical significance in the less developed countries in which diarrhoeal diseases are prevalent is not known. The use of standard procedures for isolation in study areas, the assembling of isolates in one or more central laboratories with appropriate data as to source of organisms would provide much useful data. The need for examination of "normals" as well as those with diarrhoea requires repeated emphasis.

Other suspect organisms will demand special consideration also. Present information does not warrant the statement of special study plans. The needs should become apparent with the progress of the investigation.

Special laboratory studies are needed on the resistance of Shigella to antibiotics. Though results to date have not been promising, the search for a useful diagnostic serological test, including a consideration of copra antibodies must not be overlooked. The possible usefulness of the fluorescent antibody technique warrants examination also.

(5) *Clinical studies.* The clinical features of shigellosis, salmonellosis, and other commonly occurring diarrhoeal disorders have been studied adequately. However, there occur in some countries particularly severe and rapidly fatal diseases in which diarrhoea is a prominent symptom. "Toxicosis" as a cause of death in Latin America is an illustrative example. Detailed studies of severe but poorly understood clinical entities must be encouraged. Hence the epidemiologist may serve effectively in assembling data from different areas of the world which will aid in relating and classifying such problem cases.

D. DIARRHOEAL DISEASE CONTROL DEMONSTRATIONS

The development of diarrhoeal disease control programs on a demonstration basis is needed to determine the practicability and acceptability of control programs indicated by the research findings. The demonstration unit would be the pilot program which transforms the information provided by research into life saving and health promoting applied programs. Demonstrations necessarily must be established within a superior operating public health organization. The public health administrator would be the indicated director. He would need to be assisted by competent investigators and field assistants, notably an epidemiologist and public health nursing personnel. The exact nature of the demonstration program will be indicated by the nature of research findings. The cost might be drawn either from operating or from research funds. The development of such demonstrations of the control of diarrhoeal diseases warrants high priority.

LEPROSY

Research Problems on Leprosy—Excerpts from a letter dated 15 April 1961 from **Dr. J. A. Kinnear Brown,** Senior Specialist Leprologist, Ministry of Health, Entebbe, Uganda.

My own leprosy research has been in the fields of epidemiology and immunology, although 30 years ago in Southern Nigeria I carried out investigations into the influence of diet, particularly Avitaminosis B, on the course of the disease.

In a series of papers culminating in a review of "The factors influencing the Transmission of Leprosy" (published in the Transactions of the Royal Society of Tropical Medicine and Hygiene Vol. 53.2, March 1959), I tried to evaluate the significance of those views which have held the field for a long time and to some extent have been taught as being almost axiomatic. I was led to this evaluation by the fact that the pattern of the disease in Uganda in 1950 was very different from what I had seen in Nigeria in 1930, in which country everything appeared to correspond with traditional experience. Sulphones had been scarcely introduced, and only 2 per cent of the leper population in Uganda was within reach of any kind of treatment. Reduced to their simplest form, the alternatives were that the disease was different or the epidemiology needed to be reconsidered. Clinically the disease exhibited the same manifestations and followed the same course in the two countries.

I have concluded that leprosy is a disease of a race within the race, that contact may include and even obscure relationship. It would help our understanding of leprosy if the disease pattern could be studied elsewhere where it is hyperendemic by those who can take time to absorb the social background and who have the necessary clinical and statistical experience.

In the sphere of immunology, I am impressed with the possibility that there may be more than a superficial relationship with tuberculosis. Stone and I have produced a new lepromin test (described in The Lancet of 20th June 1959, pp. 1260-1262), with which we have shown that, as far as this test is concerned, any lepromin conversion after B.C.G. vaccination is due to the vaccination and not due to any tissue elements in the antigen. This subject needs further investigation. I am at present conducting a long-term trial of B.C.G. in the prophylaxis of leprosy sponsored and financed by the Medical Research Council of Great Britain. Concentration, because of the genetic influences believed to follow from our epidemiological work, is on children under 15 years who are blood relations of patients. This should give a cross section of the child population particularly at risk and that has a sufficiently vested interest in avoiding the disease to make co-operation through the years more likely. Alternative tuberculin negatives are being vaccinated but half of all the children are also being depot lepromin tested as well. This should give us six comparable groups.

The intriguing group consists of those who are persistently lepromin negative despite their positive tuberculin; natural, or acquired after vaccination. Whilst I think more trials should be conducted among the blood relations of patients, I should be interested in the effects of a vaccine which included B.C.G. and either *M. leprae murium* or *M. leprae hominis* or even some other acid fast bacilli.

The work will naturally be made easier if the bacillus can be prepared in pure culture and some method discovered of infecting an experimental animal. Such investigations would be better conducted where liaison with a hyperendemic area is simple, to make it easy to get fresh supplies of infected tissues and if need be, of lepromatous serum.

The urgency appears to have gone out of the search for new drugs as the majority of leprosy is curable even if at a slower rate than tuberculosis. The curing of the majority is reducing considerably the risk to which the general population is exposed, and early treatment will reduce the need for remedial surgery in the not too distant future. This is a miraculous achievement. Nevertheless, one would like to see a drug that would accelerate the cure of the lepromatous patient for even if taken early, he may be left with stigmata, and my experience is that he really needs to keep on with his sulphones for the rest of his life. This being so, and there being countries where the proportion of lepromatous patients is high, one wonders which line of research will hold out the most hope either of possible achievement or probable value, vaccination or new therapy.

Research Problems on Leprosy—Excerpts from a letter dated 4 March 1961 from **Dr. R. V. Wardekar,** Secretary, Gandhi Memorial Leprosy Foundation, Wardha, Maharashtra State, India.

There are numerous unsolved problems in leprosy. For the time being I am suggesting the following few problems which I am quoting verbatim from a note I had prepared for some other purpose:

(1) *Epidemiology*

(a) *Infectivity.* The infectivity of bacteriologically positive cases (slit and scrape method) is accepted universally, but bacteriologically negative cases are not yet accepted as non-infectious by all. There are workers, who from circumstantial evidences believe that some of these negative cases are infectious. In a chronic disease like leprosy with a long latent period and low pathogenicity, it is extremely difficult to prove infectivity by direct methods. However, because of the importance of the matter it should be made the subject of further careful investigations.

(b) *Role of casual contact.* The general belief is that leprosy spreads only by a prolonged and close contact. In a country like India, with its tropical climate, so many insects and agricultural occupations, it is not uncommon to have abrasions on the body, which, after all, seem to be the point of entry for *M. leprae.* In the presence of so many abrasions, it does not seem quite unlikely, that even casual contact may be sufficient to transmit infection if the bacilli manage to reach a suitable place in the tissues. If casual contact is not enough it will have to be assumed that repeated doses of bacilli are necessary for producing disease. This will incidentally introduce the question of the size of the dose and the fate of bacilli introduced repeatedly in small doses in the body.

(c) *Difference in incidence in the two sexes.* The findings of the sex-incidence of the disease in childhood period seems to be conflicting. Some report an equal incidence in the two sexes during childhood; while others report a higher proportion in males than in females, the ratio diminishing with age till it reaches almost equal proportions at the age of 20 years and above. This greater susceptibility of the male child is said to be peculiar only in the lepromatous type. In the later adult-age, the incidence in males seems to be higher than in females. In a recently pubished observation on a small population from Nigeria, however, the incidence in the females is equal or even higher than in males, though in the general population the females preponderate only slightly over the males.

It seems necessary, therefore, to carry on further studies to find out whether there is any difference in the sex ratio in childhood and adult leprosy, whether the conditions of life play any role in creating differences and whether there are other factors responsible for this difference.

(2) *Pathology and Pathogenesis*

(a) *Involvement of nerves.* Anaesthesia, paralysis of muscles and trophic changes are some of the problems which have to be investigated further. A study of this nature has to be taken up by persons who are primarily neuro-anatomists and neuro-physiologists. Along with the study of minute anatomy it is also necessary to study the gross anatomy of the nerves which are very commonly affected in leprosy. Recent studies about the mechanism and movements of the feet and of transmission of body weight through the feet show that a better understanding of these will go a long way in prevention and treatment of trophic ulcers of the feet.

(b) *Involvement of other tissues.* There is a fair amount of information about the involvement of various tissues in different types of leprosy but it cannot be said that our knowledge in this respect is complete. More has yet to be known in the way not only of tissues involved but also of the mode of involvement. Careful clinical, histological and post-mortem studies by persons well trained in such techniques have, therefore, to be carried out.

Many of the signs and symptoms of the disease have to be correlated with the pathological changes in the various tissues. Bacteriological studies have to be associated with such pathological studies.

(c) *Pathogenesis.* The enquiry to understand the evolution of disease from the stage of contact to the development of full fledged lesions has to be intensified. Mode of spread of the bacilli in the body has yet to be understood satisfactorily.

(3) *Clinical*

(a) *Lepra reaction.* The different varieties and the nature of lepra reaction is little understood at present. There is a great need for investigation in this matter. The investigations will naturally include clinical, immunological, histological and biochemical studies.

(b) *Problem cases of leprosy.* While typical cases of leprosy can be easily classified into the main types of the disease, there are a percentage of cases which offer great difficulties in this respect. Such cases require complete and long-term studies.

(4) *Treatment*

The greatest single advance in the whole field of leprosy in the last several years is the discovery of sulphones. Sulphones have now been accepted to have a definite, though slow bacteriostatic action against *M. leprae.* The clinical improvement however is not paralleled by the disappearance of bacilli, especially from the nerves. An intensive search, therefore, for more potent, specific and rapidly acting chemotherapeutic agents has necessarily to continue.

The treatment of reactions, neuritis, etc., is still largely empirical. Cortisone raised great hopes at the beginning, but in practice it has been found to be of limited value. These studies have to be continued.

A significant advance has however been made in treatment in direction of physiotherapy and reconstructive surgery for the hands and feet. Further research in this direction is likely to be of great help.

(5) *Control*

(a) *Chemotherapy in control.* Experiments to find out whether a planned use of chemotherapeutic drugs can control leprosy are being carried out, but if possible, such experiments should be undertaken at a few more places with a view to assess the results.

(b) *Prophylactic chemotherapy in control.* Some work is in progress to find out if the treatment of healthy contacts with sulphone will prevent the development of leprosy in such contacts. The prophylactic role of chemotherapy needs to be more extensively investigated.

(c) *Role of B.C.G. vaccination in control.* As lepromin positivity is supposed to indicate a certain resistance to leprosy and because B.C.G. induces lepromin positivity in a considerable proportion of individuals, B.C.G. has been recommended by some workers as a useful means in the control of leprosy. Some other workers, however, doubt if there is any appreciable degree of cross immunity between leprosy and tuberculosis. A controlled field trial to assess the role of B.C.G. in decreasing the incidence of leprosy is, therefore, needed.

(d) *Role of combined B.C.G. and chemotherapy in control.* If, as is likely, chemotherapy and B.C.G. both are separately proved to play a significant role in control, it would be logical to assume that the two may be complementary in a combined experiment on control. Simultaneous reduction in the proportion of infectivity and susceptibility in a community may bring control of leprosy into sight much earlier than either of them alone. Such field trials are, therefore, essential to arrive at a final scheme for control for the whole country.

MENINGOCOCCAL INFECTIONS

Research Problems on Meningococcal Meningitis—Excerpts from a letter dated 8 March 1961 from **Dr. Donough O'Brien,** Visiting Professor of Pediatrics, Institute of Pediatrics, Madras Medical College, Madras, India, for **Dr. S. T. Achar,** Director of the Institute.

In this area meningococcal meningitis is not a particularly pressing clinical problem, nor indeed is it at present the commonest form of pyogenic meningitis. This topic does not at the moment warrant any special priority for investigation in this area.

The conditions in this part of the world in most pressing need of investigation are the encephalitides, Indian childhood cirrhosis, and perhaps Vitamin A deficiency. More important clinically are protein malnutrition, enteric infections, and the more expeditious management of gastro-enteritis; but here there is already a clearer understanding of what has to be done.

Research Problems in Connection with Meningococcal Infections—Submitted 1 February 1962 by **Dr. B. B. Waddy,** London School of Hygiene and Tropical Medicine, London, England.

Epidemics of cerebrospinal meningitis occur from time to time in all parts of the world. In countries with temperate climates they are often associated with war conditions; collections of young adults, such as army recruits, are particularly liable to suffer.

In countries in geographical relation to the Sahara (the African Soudan), cerebrospinal meningitis occurs on a scale not approached in any other region. For example, the total incidence in the 1940 and 1941 epidemics in England and Wales amounted to approximately 1 case in 10,000 population. The greatest epidemic traced by Ordman (1932) in South Africa and elsewhere amounted to 3 cases per 1,000 population. However, in a typical savannah area in West Africa (northwest Ghana) at least a sixth of the population died of cerebrospinal meningitis in 1906-1908. Much the same mortality occurred in 1919-1920 and in a cycle of epidemics between 1943 and 1950 the incidence was 81.9 per 1,000. Similar figures could be quoted for all the savannah areas of the African Soudan.

There is evidence that in between the cycles of epidemics, at least in the past, cerebrospinal meningitis actually became extinct in most of its epidemic foci. The next cycle would then occur when it was reintroduced from what appears to be an endemo-epidemic focus in the extreme southeast of the Republic of the Sudan.

The seasonal incidence of the epidemics is very clear: they occur during the dry season, in dry areas only, and end when humidity rises—at almost exactly the same moment each year, regardless of early rain falling or not falling. The usual sequence of events in any one area is for a first season's epidemic to start slowly, six to eight weeks after the onset of the dry season. In the next dry season the epidemic starts earlier and builds up to an incidence exceeding 30 cases per 1,000. Subsequently that area is free except for sporadic cases (which are seldom investigated bacteriologically and in some of which the diagnosis is dubious).

Pneumococcal meningitis is always epidemic at the same time, though no exact investigation of the proportion of pneumococcal cases has ever been carried out.

It has been noted repeatedly that in the last month of the epidemic season, April, the case mortality rate is very low, regardless of treatment, and even if a fresh area is invaded at this period.

The largest epidemics (at least in Ghana) have always occurred in areas where the type of house in use is very large, mud-roofed as well as mud-walled, and destitute of light and ventilation inside.

In temperate climates cerebrospinal meningitis is a winter disease with incidence closely related to the coldest months.

Most of the above information is given by Waddy (1957).

There are many problems in connection with cerebrospinal meningitis that have not yet been investigated.

1. *The scale of epidemics in the African Soudan.* The writer believes that the explanation lies in the extreme contrast of climatic conditions between wet and dry seasons, and in the extreme lack of light and ventilation in the mud-roofed houses. However, this cannot be taken as a final and satisfactory answer.

2. *Seasonal incidence.* The association with atmospheric dryness is so clear that there must be a close connection. In temperate climates, it must be noted that the *absolute* humidity of the atmosphere is dependent on temperature. Outdoor absolute humidity is lowest in the coldest months, and indoors—due to condensation on walls and particularly windows—relative humidity is low.

(a) The writer believes that the survival of the meningococcus, in infective form, in the atmosphere is closely dependent on low atmospheric humidity. Relative humidity is the more likely factor.

It is believed also that a lack of ultraviolet light is important for the survival of the meningococcus outside the human body. (This would account for the part apparently played by the mud-roofed house; it would fit in with the winter incidence in temperate climates, and an apparent tendency for meningitis to be associated with occupations such as coal mining.)

As far as is known to the writer, the only bacteriological research so far done on the atmospheric and other conditions associated with the survival of the meningococcus was that of Miller and Schad (1944) and of Hemmes (1959).

(b) Physiological research on the drying and cooling of the upper respiratory mucosa, and its relation to respiratory infections, is far from advanced. It is known that ciliary action is slowed by cooling.

3. *Carrier rates.*

(a) Only a very few small-scale investigations of the meningococcal carrier rate have been made in the Soudan. Nothing is known of the trends in the rate before, during and after an epidemic cycle. Bearing in mind the extreme clarity of the general epidemiological picture in these conditions, if a long-term investigation of carrier rates could be undertaken in a typical area, it would be possible to correlate the results very closely with the actual occurrence of cases. This might have an important practical bearing on preventive measures.

(b) The apparent true endemic home of cerebrospinal meningitis, the Mongalla area of the Republic of the Sudan, might be investigated to discover why conditions there favour continuous transmission, and conceivably whether preventive measures there might prevent epidemics in other areas.

4. *Virulence of the organism.* Do changes in virulence take place? Why should mortality rates in the last month of an epidemic tend to be so low? What determines whether an individual becomes a short- or long-term carrier, or suffers from meningitis?

5. *Other causes of meningitis.* There have been one or two investigations of the aetiology of sporadic meningitis in the Soudan, e.g., Sénécal *et al.* (1957). The proportion of cases not meningococcal, in large epidemics, is not known. There appear usually to be coincident epidemics of lobar pneumonia and pneumococcal meningitis, the treatment and prognosis of which are not identical with those of meningococcal meningitis. Nothing but research done during actual epidemics can elucidate this important matter.

6. *Treatment.* Treatment, with sulphonamides sometimes reinforced with penicillin, has given very satisfactory results in very difficult conditions. Nevertheless, refinements might be introduced to lower case mortality rates. Sénécal *et al.* (1957) used cortisone drugs with considerable success in late cases.

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TYPHOID AND PARATYPHOID FEVERS

Research Problems on Typhoid and Paratyphoid Fevers—Excerpts from a letter dated 11 April 1961 from **Dr. Kho Lien Keng,** Head, Hematology Laboratory, Pediatric Department, University of Indonesia, Djakarta, Indonesia.

As stated before in the Journal of the Indonesian Medical Association,[1] the Journal of Tropical Pediatrics,[2] and in the Annales of Paediatrici,[3] the main problem, especially in places without adequate laboratory facilities, is a diagnosis of typhoid and paratyphoid fever with simple methods available by the general practitioner or specialist.

In an attempt to make the diagnosis of salmonellosis typhi or paratyphi in children who were admitted in our pediatric department with fever of unknown origin, 78 per cent of the cases could be diagnosed correctly by means of peripheral blood examination and bone marrow punctures alone before the results of bacteriologic and serologic examination were known. This diagnosis was confirmed by means of the findings of *Salmonella* in the blood, urine or faeces and by positive agglutination reactions. In 8 cases the diagnosis was wrong and in 3 cases the diagnosis was doubtful because of the negative bacteriologic and serologic examination. The main criteria for the diagnosis of typhoid or paratyphoid fever are:

(1) the findings of hyperphagocytosis of granulocytes, red blood cells or platelets by bone marrow macrophages,
(2) depression of erythropoietic activity in the bone marrow,
(3) decreased number of eosinophils in the bone marrow,
(4) leukopenia of the blood,
(5) aneosinophilia of the blood, in spite of the findings of many worm ova in the stool.

The bone marrow examination could be mastered by the doctors or technicians within a short period (one or two weeks). This simple method is already used by some doctors in Indonesia in places where the laboratory facilities are insufficient.

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WHOOPING COUGH

Research Problems in Connection with Whooping Cough—Excerpts from a letter dated 28 February 1961 from **Dr. Margaret Pittman,** Chief, Laboratory of Bacterial Products, Division of Biologics Standards, National Institutes of Health, Bethesda, Maryland.

Concerning the most important research problems in connection with whooping cough, I have tried to think of the problems as they relate specifically to those countries that have a high incidence of the disease. From the standpoint of control of whooping cough it seems to me that application of present knowledge should be of greater concern than research.

It has been established that pertussis vaccine containing 12-15 units per total human immunizing dose is capable of affording protection to children against whooping cough. This is the only bacterial vaccine with which it has been shown that laboratory-measured potency is directly correlated with protection in the child. The immediate problems are (1) the production of vaccines in adequate quantities, and with good protective potency and (2) a public health plan for effective administration of the vaccine.

Although there is sufficient knowledge to produce effective vaccine there is still need for basic research from the viewpoint of more efficient production, of preparation of vaccines free from reactive substances and of knowledge on what is the protective antigen. I am discussing below some of the areas where additional information in the preparation of the vaccine and in the vaccination of children would be helpful.

1. *Production of pertussis vaccine:* Problems encountered are selection of media and detoxification of the vaccine.

a. *Media.* Pertussis vaccine with adequate protective activity is being produced in many countries. There is not, however, any generally accepted method of preparation. Classically, strains of *Bordetella pertussis* of known antigenicity are grown on Bordet-Gengou media, and the bacterial suspension to which Merthiolate has been added is allowed to age at 4° C until relatively free from toxicity. Bordet-Gengou medium contains 20 per cent blood. With the use of this large amount of blood, contamination becomes a troublesome factor. Both liquid media and solid media containing charcoal are being used. A formula used in one laboratory may not be satisfactory in another. Each laboratory usually has to adjust the formula to meet the conditions in their laboratory. Although many studies have been made, the exact growth requirements correlated with the volume of medium, aeration, etc., are not known.

b. *Detoxification.* The ideal vaccine is one with adequate protective activity but relatively free from untoward reactive substances. The pertussis bacteria contain in addition to all of the reactive substances present in gram negative bacteria, a thermolabile dermonecrotic toxin, a sensitizing factor and perhaps other reactive substances. In children the reactions induced may be locally erythema and soreness and systemically fever, general malaise and rarely convulsions and fatal encephalopathy.

The greatest need here is an adequately controlled clinical study to determine if the present laboratory freedom-from-toxicity test is capable of measuring the reactive substance in a vaccine for children or vice versa to determine if a lot of vaccine that is toxic for mice is necessarily undesirably reactive for children.

2. *The protective antigen.* The protective antigen of pertussis vaccine cannot be defined at this time. The only known means to detect it in the laboratory is the mouse protection test. An *in vitro* method for identification would be materially helpful in the separation of the protective antigen from the undesirable reactive substances.

3. *Immunization Program.*

a. *Selection of children for immunization.* In the setting up of an immunization program in a country where there is high incidence of infection it is desirable to provide the maximum amount of protection with the least expenditure of man hours and money. Information of age incidence of the disease is important. In the case of whooping cough, there is danger of confusing the very high mortality rate in the young infant with incidence of the disease at this age, with the result that undue emphasis is placed on vaccination of the child 1 to 2 months of age. If, as in the United States, the percentage of cases in the young infant is relatively low, then the number prevented from having the disease will be very small in relation to number immunized. On the other hand, if emphasis is placed on vaccinating children of the age in which the highest incidence occurs, the greatest number will be protected with the least expenditure of effort and money. With control of the disease at the age of highest incidence, the chances for the young infant to be exposed are reduced. The immunization should be fitted to the conditions in the particular country.

b. *The booster dose.* Several booster doses usually are recommended in immunization schedules. Information is needed to determine if smaller doses would not be adequate for recall of immunity instead of the single primary immunizing dose now generally being used. In children three years or more in age the reactions are usually more intense than in the infant.

c. *Tests for evaluation of immunity.* There is need for the development of a simple laboratory test that would give a satisfactory evaluation of the immune response of the child following vaccination.

TREPONEMATOSES (SYPHILIS AND YAWS)

Research on the Treponematoses—Submitted 27 February 1962 by **Dr. C. J. Hackett,** Senior Medical Officer, Research Planning and Coordination (formerly Medical Officer, Venereal Disease and Treponematoses) and **Dr. T. Guthe,** Chief Medical Officer, Venereal Disease and Treponematoses, World Health Organization, Geneva, Switzerland.

The treponematoses comprise four clinical entities: venereal syphilis, non-venereal syphilis of children, yaws and pinta. In these notes no reference has been made to pinta, prevalent only in the Americas and about which there is little clear understanding; however, many of the suggestions offered are equally applicable to this disease, and the need for a susceptible experimental animal is particularly great.

The more immediate and important avenues for research may be briefly summarized under the following headings:

I. CULTIVATION OF TREPONEMES IN NON-LIVING MEDIA OF WHICH THE COMPOSITION IS ACCURATELY KNOWN

An approach to this problem is being made by the study of the biochemistry, growth or survival requirements of *non-pathogenic* treponemal or allied organisms which can at present be cultivated, such as the Kazan strains 2 - 9, the Reiter and Zuelzer organisms, the non-pathogenic variant of the Nichols strain of *T. pallidum*, or the Borrelia and related organisms.

Such knowledge might bring out patterns of great value in the approach to the cultivation of *pathogenic* treponemes, which in turn would open the way for investigations into: (i) antigenic structure, mutational aspects, as well as strain and type stability of treponemes; (ii) classification of pathogenic treponemes, and possibly the relation between different clinical syndromes, which would be of value in the eventual eradication of the treponematoses; (iii) improvement and simplification of specific diagnostic methods, and development of differential laboratory methods; (iv) metabolism of the treponemes as a basis for chemotherapeutic investigations, based on precise knowledge rather than trial and error; (v) determination of sensitivity of treponemes to therapeutic agents; (vi) survival of treponemes on the skin surface and away from the body.

II. EPIDEMIOLOGY

(a) *Venereal syphilis*

(i) increased accuracy of morbidity data;

(ii) better methods for case-finding, and representative survey designs making use of modern statistical sampling techniques;

(iii) serological screening with specific testing of primiparae;

(iv) study of that part of the population in which venereal syphilis tends to be highly prevalent and which may serve as a reservoir of infection.

These studies have significance in developed and newly independent countries.

(b) *Endemic treponematoses*

(i) intensive study of endemic foci untouched by improved standards of living or by penicillin therapy, to learn their natural history and endemic pattern, which might serve as a basis for the assessment of the endemic status of these infections elsewhere;

(ii) definition of the essential social, hygienic, climatic, economic and other factors in "standards of living" that favour transmission, high prevalence and recession;

(iii) the origin of the "last yaws cases" and the period following the eradication of yaws, as determined by the absence of autochthonous cases for three years or on the basis of other criteria, after which the risk of the widespread introduction of venereal syphilis may become important.

Such studies—in addition to the intrinsic value of their findings—would have great practical value in prevention.

III. IMMUNOPATHOLOGY

(i) the nature, extent, role and pattern of antibodies, particularly the protective ones, at different stages of the treponematoses, using new methods, i.e., immuno-electrophoresis; use of substances inhibiting antibody transport or antibody formation by specific cells;

(ii) differences between early and late stages, their lesions and duration; the part that humoral and tissular immunity play in pathogenesis; possible distortion of immune reactions and reproducibility of these in primates;

(iii) understanding of latency and relapses; location of treponemes in the body in all stages, especially in latency. Survival time and possible modification of treponemes in primates, including man;

(iv) differences between venereal syphilis and the endemic treponematoses, and the factors apart from treponeme specificity influencing them; experimental infections and the nature and extent of cross-immunity in animals and man; immunological immaturity in neo-natal animals in relation to antibody formation, including possible defence mechanisms;

(v) studies of certain lesions that occur in endemic treponematoses areas (hyperkeratosis, goundou, dyspigmentation, contractures of the lateral digits, etc.); role of temperature in the production and localization of lesions in the experimental animal, i.e., intratesticular infection, late visceral lesions, etc.

IV. DIAGNOSIS

(i) clinical diagnostic criteria for early and late endemic treponematoses lesions;

(ii) improved simple treponemal-specific tests (see also I iii);

(iii) criteria for false reactions in reagin tests and their study by treponeme antigen tests and prolonged periodical observation of patients; their importance in mass campaigns and in individual medicine.

V. THERAPY

(i) assessment of results at regular intervals for many years following the most frequently used therapeutic agents and schedules in venereal syphilis, yaws and endemic syphilis;

(ii) laboratory tests for assessing the value of new drugs in treponematoses;

(iii) continued periodical observation of the susceptibility of treponemes to penicillin; reasons for the absence of resistance in treponemes after twenty years of penicillin;

(iv) inexpensive, new, long-acting, effective drugs with no allergic or toxic hazards;

(v) nature and extent of sensitization of patients to penicillin, and its early detection, prevention and treatment.

VI. PREVENTION

(a) *Venereal syphilis*

(i) evaluation of factors in addition to penicillin therapy that have hastened recession in certain countries;

(ii) factors responsible for the significant recent increased incidence in many countries, particularly in young adults;

(iii) chemoprophylaxis and immunization in specially exposed groups and in "reservoir" groups;

(iv) prevention of extension of venereal syphilis into populations from which endemic treponematoses have been eradicated.

(b) *Endemic treponematoses*

(i) minimal public health activities needed at various levels of endemicity to ensure eradication;

(ii) measurement of results of mass campaigns by clinical observation and specific treponemal tests;

(iii) prevalence, clinical and serological, in relation to social, hygienic and other conditions, below which no further action may be required for eradication;

(iv) immunoprophylaxis;

(v) effective, practical and economical measures to stop transmission;

(vi) combination of measures against endemic treponematoses with other diseases (i.e., leprosy, smallpox);

(vii) present endemic status of the treponematoses throughout the world, the important factors that have reduced their prevalence and the further changes needed to ensure their eradication.

Excerpts from the Fifth Report of the Expert Committee on Venereal Infections and Treponematoses, World Health Organization, Geneva, 1960—Submitted at the suggestion of Dr. C. J. Hackett, World Health Organization, Geneva.

8. *Research.* The Committee welcomed the plans for an intensified medical research programme in many fields studied by the Twelfth World Health Assembly, and expressed its satisfaction that it was the intention of WHO during the initial year of this programme to study the means by which its existing programme in venereal disease and treponematoses might be most productively extended. Furthermore, it noted that a Scientific Group on Treponematoses would, for this purpose, be convened in 1959 to advise on specific plans.

In its review of the *gonorrhoea* problem, the Committee had already made certain suggestions for research. As regards *treponematoses*, many suggestions for research, including serology and laboratory aspects, have been made by previous expert committees. The first International Symposium on Yaws Control held in Thailand in 1952, the second International Conference on the Control of Yaws held in Africa in 1955, and other meetings which WHO has convened—or in the organization of which it has participated or was represented—have made several research proposals. The members of the WHO Expert Panel on Venereal Infections and Treponematoses and other leading workers have also been widely consulted on research problems in 1958-59, as a preliminary to the envisaged research programme. Important study material was thus available to the Committee, and is summarized in Annex 2.

Microbiological studies and experimental animal infections must be based upon suitable laboratories, while epidemiological, clinical and preventive studies, including experimental human infections, would be carried out mainly in the field. Some of the knowledge obtained through further research would have immediate application in the control and eradication of the treponematoses; some may open up other aspects of practical value; most of it may have wider application also with regard to other communicable diseases.

The Committee considered that in regard to *studies of the treponeme*, continued research work on the culturing of pathogenic treponemes and the study of their antigenic structure is of paramount importance, as well as serological identification of active components in the treponemal body and capsular material for differentiation between different groups and types of this microorganism. Studies on survival of treponemes away from the body under different environmental conditions should also be given a high priority in the research programme. In the *epidemiology of the endemic treponematoses*, studies on modes of transmission and factors favouring them, as well as on the extension of venereal syphilis into areas cleared of yaws and endemic syphilis (immunity) are important. In *venereal syphilis*, search for factors other than antibiotics which have brought about a decline in prevalence of syphilis, and the reasons for the recent increase in early syphilis in some areas, should be undertaken. In the *pathology* of the treponematoses the survival of treponemes in the body and their localization in latency should receive attention in the research programme.

On the *clinical* side it was considered that the importance of cardiovascular and neurological involvement, as well as congenital transmission in all of the treponematoses in relation to the duration of infection and age of the patient in treated and untreated diseases should be studied.

The growing use of surgical methods in the treatment of aneurisms and valvular deformation was mentioned, and the importance of correct serology and adequate preliminary penicillin therapy in these cases was stressed. In the *diagnostic field* continued work to evolve a simple, specific, sensitive, reproducible and inexpensive serum test employing treponemal antigens should be given the highest priority, and it was felt that the need for study of the nature and extent of biological false positive reactions in mass and other venereal disease and treponematoses campaigns in developing areas is becoming increasingly urgent. In the field of *therapy*, the Committee had already pointed out the need for the development and assessment of other antibiotics than penicillin, effective in all stages and manifestations of the treponematoses. The need for research into the nature and extent of penicillin sensitization and the significance of humoral penicillin antibodies has also been referred to elsewhere in this report. In the *prevention* of endemic treponematoses evaluation by clinical and serological surveys of results of campaigns against the treponematoses after 5-10 years would be of great importance. In regard to venereal syphilis, sex-behaviour and other studies are desirable in the younger age-groups, where the attack-rates of the infection are the highest.

Research Problems on Syphilis and Yaws—Submitted 1 February 1961 by **Dr. Thomas B. Turner,** Professor of Microbiology and Dean of the Medical Faculty, The Johns Hopkins University School of Medicine, Baltimore, Maryland.

The discovery and development of penicillin created a powerful weapon against syphilis and yaws, which together constitute one of the major diseases of the tropics. Much has been accomplished in the control of these diseases; much remains to be accomplished.

In dealing with such a formidable adversary as the *Treponema*, aided and abetted by ignorance and the frailties of human nature, it is well to adopt a healthy scientific skepticism, and question whether in fact we possess all the tools necessary to accomplish and maintain effective control of the treponematoses.

Taking the long view, therefore, and mindful of the usual slow pace of discovery, I would strongly urge that both fundamental and applied research on the treponematoses be sponsored. While it is often difficult to distinguish between basic and applied research and the two frequently merge, it is to the more fundamental aspects of the problem that the following comments will be directed.

A. *Study of the Antigenic Structure of Treponema*

There are interesting antigenic interrelations between the cultivable non-pathogenic treponemes and the non-cultivable pathogenic varieties. Important and perhaps critical differences also exist. While investigation of the pathogenic organisms will be handicapped until cultivation on artificial media is achieved, much can nevertheless be accomplished by the application of modern immunologic and chemical techniques to presently available material.

Possible practical results relate to development of a simple laboratory test the results of which would parallel the complicated but highly valuable TPI test; to the identification of immunogenically active fractions; and to illumination of the biological basis of the older serological tests employing tissue-lipid antigens. This last problem impinges directly on the vast and growing complex of diseases that appear to have an immunologic basis, of which lupus erythematosis, myasthenia gravis, and rheumatoid arthritis are but a few examples.

B. *Effectiveness of New Antibiotics*

There is no evidence that the *Treponema* has developed enhanced resistance to penicillin during the fifteen years in which this antibiotic has been widely used. This theoretical possibility exists, however. Of more alarming import is the rapid rise in the rate of hypersensitivity to penicillin among populations everywhere. For this reason it is an open question how long penicillin can continue to be the mainstay of treponematosis control.

There should be a continuing exploration of antibiotics other than penicillin from the standpoint of their treponemicidal activity.

C. *Study of Syphilis and Yaws as a Chronic Infectious Process*

Few infectious diseases achieve a more exquisite balance between host and parasite than do syphilis and yaws, the infected human being or animal being largely resistant to extraneous *Treponema*, while the infecting organisms remain fully virulent for new hosts. Study of this phenomenon by newer experimental methods such as fluorescent antibody technique might yield basic biologic information of great interest, although its practical value is not readily foreseen.

D. *Cultivation of Pathogenic Treponemes*

Cultivation of treponemes on artificial media would be a scientific contribution of inestimable value, and one which potentially could revolutionize the approach to these diseases. As a practical problem it is mentioned last simply because there are few new ideas or approaches that appear promising. Sponsoring agents should be alert, however, to encourage any reasonable proposal in this area.

INFLUENZA

Research Problems on Influenza—Excerpts from a letter dated 1 February 1961 from **Dr. C. H. Andrewes,** National Institute for Medical Research, Medical Research Council, London, England.

Research problems in the field of influenza are not very different in tropical and temperate countries. There is one difference: epidemics in the tropics occur less frequently than in temperate climes, but when they do occur there is less relation to season. Thus Asian influenza spread rapidly through the tropics in 1957, while the epidemic took longer to build up after it first hit Europe and North America—waiting apparently for cooler weather. Differing social conditions such as overcrowding may have caused this difference rather than climatic conditions themselves.

Four major problems common to tropical and temperate climes are:

1. whereabouts of influenza between outbreaks. Does it ever disappear from a community?
2. origin of "new" strains. Are these always derived from preceding ones, or could they come, as is suggested, for Asian flu, from an undetected animal reservoir?
3. possible improvement in present-day vaccines. The present time 70 per cent protection is not good enough to lead to high acceptance of vaccine.
4. possibilities of attenuated vaccines.

Research Problems on Influenza—Excerpts from a letter dated 31 January 1961 from **Dr. Thomas Francis, Jr.,** Department of Epidemiology, The University of Michigan School of Public Health, Ann Arbor, Michigan.

In general, one can say that influenza in the tropics has been less thoroughly studied than in the temperate zones although one certainly knows it does occur.

In making the following comments I should refer to problems which might be of special emphasis in the tropics but others also which relate to influenza as a whole. I would list, then, the following areas:

1. Origin of epidemics, particularly pandemic
2. Search for possible reservoirs in ill-explored areas of the world
3. Final compounding of a vaccine which can meet the gamut of significant strain variations
4. (This might be high on the list)—The application of vaccines which are now effective
5. Further investigation of the composition of influenza virus and its essential functional units
6. Search for effective chemotherapeutic and prophylatic compounds or preparations
7. Better understanding of the mechanisms of bacteria-viral interplay
8. Still greater knowledge of the pathogenesis of the disease, especially in inexperienced populations
9. Studies in cardio-pulmonary physiology relating to the severe form of disease
10. Improved vaccine preparations, including application of adjuvants, for more durable immunity

11. Factors responsible for viral virulence

It is not intended to assign any particular priority in this list although I think the preventive measures are those highest in our minds. Of course, there is much work going on in this area. The origin of epidemics and basis of strain variation are of import.

Several of the suggestions clearly may extend to tropics and also might include serological surveys of some of these areas where knowledge of the experience is doubtful.

MEASLES AND MUMPS

Research Problems on Measles and Mumps—Excerpt from a letter dated 3 February 1961 from **Dr. K. McL. Cobban,** University College Hospital, Ibadan, Nigeria.

Both measles and mumps occur in Nigeria. The latter is not a problem of importance. The former, from my records over the past four years, appears to occur in epidemics with approximately a two-year interval of sporadic cases. It can be a serious disease in small children—apparently more so than in England. The problem here is to discover an effective and cheap means of prevention by active immunisation.

Addendum 20 January 1962: I would add for your information that during the past few months we have had a further epidemic, the third in five years. In confirmation of the seriousness of the disease in African children, I recently followed 30 consecutive cases in children and 11 of these developed bronchitis or broncho-pneumonia. Twenty-seven of these children were under three years of age.

Research Problems on Measles and Mumps—Excerpts from a letter dated 6 February 1961 from **Dr. D. B. Jelliffe,** Department of Paediatrics and Child Health, Makerere Medical School, Kampala, Uganda.

(1) *Mumps.* I do not believe (based, of course, on limited experience in different parts of the world) that any form of research into mumps is even a second-grade priority in the tropics.
(2) *Measles.* By contrast, measles is a formidable disease in poorly nourished and parasitically debilitated tropical children. (This was especially so in West Africa.) I would, therefore, suggest that practically oriented research in connection with measles might be: (i) a study of factors responsible for the apparent greater severity of disease (and complications) in children in some tropical regions (i.e., whether virulence of virus and/or host factors, such as malnutrition, anaemia, parasite burden); (ii) continued and intensified laboratory investigation and field trials of would-be protective vaccines (such as avirulent and formalin-fixed measles virus, or egg adapted distemper virus).

No. 2 (ii) is a real priority, as measles kills many tropical children and appears to have a high incidence of severe complications.

POLIOMYELITIS

Research Problems on Poliomyelitis—Excerpts from a letter dated 1 March 1961 from **Dr. Isamu Tagaya,** Chief, Department of Enteroviruses, National Institute of Health, Tokyo, Japan, for **Dr. Masami Kitaoka.**

In Japan we consider the most important research problems in connection with poliomyelitis as follows:

1. Change in the epidemiology and ecology of poliomyelitis virus in connection with a large-scale Salk vaccine administration
2. Ecology and epidemiology of enteroviruses other than poliovirus
3. A systematic virological survey of aseptic meningitis or encephalitis cases in summer season in connection with non-paralytic poliomyelitis and other enterovirus diseases

Recently we have come to observe polio epidemics during summer season, paralytic cases being observed chiefly in infants under three years old. Last year we had a large type-1 polio epidemic in Hokkaido, the northernmost part of Japan and in Kyushu, the southern part of Japan. From this winter on, Salk vaccine will be supplied for a large-scale vaccination of infants under three years old, and a decrease in paralytic cases is expected. Change in epidemiology and ecology of poliovirus by Salk vaccine is a problem to be investigated urgently. The problem of live oral poliovaccine has been discussed much in Japan and a small-scale field trial is to be carried out in many places under the sponsorship of the Ministry of Health and Welfare, employing Sabin vaccine donated by Pfizer Ltd., in order to evaluate its immunogenic effect, the possibility of reversion of neurovirulence and interference by other enteroviruses.

Last summer we had a considerable epidemic of Coxsackie B 5 in Shikoku and near Osaka, central part of Japan. Coxsackie B 1, 3 and 5 viruses have been isolated also from feces of the patients suspected to be polio in Hokkaido. Any large-scale survey of enteroviruses other than polio has not been carried out in Japan and it is urgently requested from the view point of epidemiological control and of live oral poliovaccine programme. At the same time a systematic virological survey of aseptic meningitis or encephalitis in summer season is one of the most important research problems in Japan, as we have many cases suspected to be caused by other viral agents than poliovirus.

Addendum: In July 1961 the Japanese Government administered 13 million doses of Sabin's trivalent vaccine to the infants from 3 months to 6 years, and in some areas where polio incidence was increasing, the age of infants to be vaccinated was extended to 10 years. It appeared that the mass vaccination had stopped further increase of paralytic poliomyelitis incidence. During winter and early spring in 1962 the second mass vaccination with live oral poliovaccine will be carried out to the infants from 3 months to 12 years (total 17 million doses). As a consequence the main research project of the most important problems in connection with poliomyelitis in Japan in 1962 is a nation-wide surveillance after mass vaccination. Work will be carried out by the cooperation of clinicians, epidemiologists and virologists under the Committee of Live Oral Poliovaccine, being sponsored by the Ministry of Health and Welfare. Research work on other enteroviruses is to be promoted, too.

Research Problems on Poliomyelitis—Excerpts from a letter dated 31 January 1961 from **Dr. John R. Paul,** Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, Connecticut.

In reviewing this subject, I go back to observations by Dr. James H. S. Gear of Johannesburg, South Africa, who began to point out the significance of poliomyelitis as a tropical disease over a decade ago.[1] He was well ahead of his time. In 1955, Dr. Gear wrote for the World Health Organization as follows: "Great changes in the way of life of millions of persons in Africa and in Asia and in Tropical America are taking place and impending. For the first time, large sections of the population are being provided with purified water. It may be asked what will happen when Africans and other individuals from primitive surroundings drink pure water and eat safe food not exposed to flies . . . The infant mortality rates so appallingly high at present will fall in parallel. There also seems to be little doubt that the incidence of poliomyelitis will rise, and this trend will continue until some means of prevention is found."[2] This I believe to be a cogent statement and points the way to the kind of research that is needed.

I had the occasion to discuss this concept and to agree with Dr. Gear in a general way, before the Third Conference of the Industrial Council for Tropical Health, sponsored by the Harvard School of Public Health, April 1957.[3] These comments are merely mentioned as background material.

More specifically, one could point to special fields of research:

1. The use of the *oral poliovirus vaccine* in tropical countries. The effectiveness of this new prophylactic agent has been studied by Dr. Sabin in Mexico, Dr. Fox and his colleagues in Louisiana, by our group in Costa Rica and by others elsewhere. Dr. Sabin

in particular has shown that the effectiveness of this vaccine may be especially influenced in tropical environments because of the phenomenon of interference not only with wild polioviruses but with other wild enteroviruses. The problem here is the frequency of infections due to enteroviruses other than polioviruses, which may inhibit the effectiveness of the oral poliovirus vaccine. By increasing the vaccine dose one may overcome this difficulty. However, here is a matter calling loudly for more research, both in the field, in the experimental infection in primates and also in *in vitro* studies in tissue cultures.

2. *Serological surveys.* These may serve as a base line for a program leading to the use of any vaccine. The promotion of serologic surveys designed to measure the prevalence of antibodies in various populations is in line with recommendations and discussions made by the W.H.O. Expert Committee on Poliomyelitis at their meeting in Washington in June 1960.[4]

I would like to point out the value of doing such surveys in areas where there are different ecologic regions and where population groups can be sampled from several adjacent areas such as, for instance, in Peru, where there are three ecologic parallel zones —coastal, mountain and jungle. As another example, a survey was made at the request of the Ministry of Health of Guatemala in 1957.[5] It was carried out as a project of the Regional W.H.O. Poliomyelitis Laboratory of the Americas to guide that country in its vaccination plans. Another area would be a country such as Chile, where extremely high infant mortality exists and a high rate of typhoid fever still persists.

3. *Poliovirus infections in infancy.* A problem which deserves particular attention here is the relation of *infant mortality* to the *poliomyelitis rates* in countries where the former is going down, and the latter, if the juvenile population is unvaccinated, are going up. What are the public health procedures which influence these apparently paradoxical trends? This problem is discussed in a report.[6]

4. One might proceed to list a number of other projects, such as the role of insects and the dissemination of polioviruses, particularly flies and cockroaches which are known to be mechanical vectors of this virus. Recent work has shown that poliovirus may actually multiply inside the fly.[7] This carries with it the idea that poliovirus variant production could occur within the fly and this in turn might bring some new thoughts to bear on the effect of temperature in the mechanical vector in view of the fact that temperature has been shown to have considerable bearing on variant production in polioviruses in tissue culture.

5. *Enteroviruses other than poliovirus.* The study of these agents parallels closely that of poliovirus. There are many relationships here. In the W.H.O. Technical Report No. 203, it is recommended (on p. 53, item 3) that research be pursued in this field.

The next point might be how to get the work done. I am not in a position to mention specific laboratories in tropical and semi-tropical regions which are well equipped to carry on research on polioviruses. Others are better able to do this than can I. Mention should be made of Dr. Gear in South Africa, the Middle America Research Unit of the National Institutes of Health in Panama, NAMRU #2 and NAMRU #3, as well as that of Dr. Contreras in Santiago, Chile, although Chile is not exactly a tropical country.

It might be good to consult with the P.A.H.O. with regard to poliomyelitis research in Central and South America. The World Health Organization in 1954 in conjunction with P.A.H.O., established a Regional Laboratory for Poliomyelitis for the Americas to provide advice, to help to train workers and to promote research in the areas south of the Rio Grande. This laboratory, now under the direction of Dr. D. M. Horstmann, is located in the Department of Epidemiology and Public Health in the Yale University School of Medicine, New Haven, Connecticut.

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[3] Paul, J.R., 1957. Industry and Tropical Health III, Boston, pp. 81-89.

[4] 3rd Report on Poliomyelitis, 1960. Tech. Rep. Series No. 203, pp. 41-43 and p. 53.

[5] Horstmann, D. M., Saenz, A. C. and Opton, E. M., 1960. Immunity to poliomyelitis in Guatemala: a serological and virological survey. Bull. Wld. Hlth. Org., *22*:255-262.

[6] cf. figure 2, infant mortality rates and poliomyelitis case rates in various countries on page 751 in Paul, J. R., 1958: Endemic and epidemic trends of poliomyelitis in Central and South America. Bull. Wld. Hlth. Org. *19*:747-758.

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TRACHOMA

Research Problems on Trachoma—Excerpts from a letter dated 1 February 1961 from **Prof. Dr. Giambattista Bietti,** Direttore Della Clinica Oculistica, Universitaria di Roma, Rome, Italy.

In my opinion the most important point in the research on trachoma is at the moment represented by the aim to obtain the virus in large amounts in culture, in order to assess the possibilities of a vaccination in the field.

Another point, which deserves the attention of the researchers, is the relationship between the virus of trachoma and the inclusion conjunctivitis.

I would like finally to stress the importance of continuing the research on the value of chemotherapy in the treatment of the disease especially as a mass therapy in underdeveloped areas.

Research on Trachoma—Submitted by **Dr. Phillips Thygeson,** Director, Francis I. Proctor Foundation for Research in Ophthalmology, University of California Medical Center, San Francisco, California.

Trachoma is still the eye disease of greatest world-wide importance and according to W.H.O. estimates at least four hundred million persons are affected. Until the introduction of the sulfonamides in 1938 no treatment of value was known. Although individual cases can now be treated successfully with either sulfonamides or broad or medium spectrum antibiotics the treatment time is too prolonged for mass campaigns in underdeveloped countries. Of prime importance, therefore, is the development of a method of treatment by which the disease can be eradicated in days instead of weeks or months. Some studies using depot penicillin have been encouraging but penicillin is much less active than the broad spectrum antibiotics and as a result the relapse rate has been high.

The agent of trachoma, a member of the psittacosis-lymphogranuloma group of atypical viruses, has now been cultivated in quantity in the yolk sac of the developing chick embryo so that extensive studies in the biology of trachoma virus are now being made. A conference on the biology of trachoma virus was held in May 1961 by the New York Academy of Sciences; the proceedings are being published.

There are a number of clinical problems on trachoma requiring further research. They may be listed as follows:

1. Differentiation of trachoma at onset from various types of follicular conjunctivitis.
2. Criteria of cure in trachoma.
3. Role of secondary bacterial infection in the disease.
4. Role of age at onset in severity of the disease.
5. Question of racial susceptibility.
6. Are there inapparent or subclinical infections and does a carrier state exist.
7. Does transmission by flies or other arthropods occur?
8. Conditions promoting relapse or reinfection.
9. Reliability of the cortisone provocative test as a test of healing.

10. Question of trachomatous involvement of tissues, such as the lacrimal sac, other than the conjunctiva and cornea.

11. Relationship, clinical and epidemiologic, to inclusion conjunctivitis, with particular reference to the possibility of so-called genital trachoma.

In regard to laboratory studies, in addition to those dealing with the biology of the virus the following can be listed:

1. Improved methods of cytologic diagnosis.

2. Improved methods of diagnosis by culture.

3. Exploration of serologic methods of diagnosis, with particular reference to the complement fixation test with principal antigens and to the fluorescence antibody test.

4. Exploration of possible methods of inducing active immunity by means of vaccines.

ANCYLOSTOMIASIS

Research Needs in the Control of Ancylostomiasis and Other Soil Transmitted Helminthic Infections',—Submitted 31 January 1961 by **Dr. Paul C. Beaver,** Professor of Tropical Diseases and Hygiene, Tulane University, New Orleans, Louisiana.

In a discussion of the control of soil-transmitted intestinal nematodes, two general aspects may be stressed: 1) remedial measures based on accurate detection and successful treatment of *disease*, and 2) effective interruption of transmission of *infection* by means of environmental conditioning which simultaneously would be advantageous to the people and disadvantageous to the parasites.

Remedial Aspects

To sort out and treat the diseases produced by parasites new information is needed on the following:

Factors which produce high prevalence of light infections. It is obvious that the parasite burden in most of the individuals in areas of extremely high prevalence does not represent the total inoculum. Exposure to infection presumably is frequent and heavy. If light infections are due to humoral immunity or to premunition or to crowding interference, what are the abnormal conditions which permit the establishment of heavy infections?

Disease in relation to light infections. The particular conditions, if any, under which a few hookworms or ascarids can produce disease is a matter of considerable interest. Although there is no known basis for their doing so in well nourished individuals, there are reports of anaemia being produced by hookworm burdens which ordinarily have no detectable effect. Ascaris in small numbers are said to have toxic or allergic effects in certain individuals; the latter has understandable basis, the former does not.

Nutrition and host resistance. Nothing has been done with Trichuris in this regard. Some reports indicate that malnutrition favours the establishment and development of ascaris and hookworms, others indicate the opposite. The duration of heavy hookworm infections in either poorly or well nourished individuals has not been adequately studied. "Crisis" and "self-cure" seen in dogs and other animals with heavy hookworm burdens may or may not occur in humans. The hookworms of man are very different from those of dogs; observations made on the hookworms of dogs therefore cannot be applied to those of man.

Improvement of anthelmintics. Better anthelmintics are needed for hookworms and Trichuris. The best ones available are either toxic or relatively inefficient, or both.

Survey methods. Methods of making reliable selective surveys need to be reviewed and tested. Perhaps new techniques can be developed. The reliability of direct smear counts needs to be tested further. Thus far comparisons have been made between direct smear and dilution counts, showing that in general they agree in the variability of estimates. They have not been compared adequately with respect to variability from day to day, i.e., the reliability of daily counts on a single individual has not been tested. The feasibility of using direct smear counts needs further testing. Further testing is perhaps not necessary to prove this fact, but it is needed to popularize the method.

Interruption of transmission. Available facts encourage the view that environmental management to the disadvantage of soil-transmitted helminths is a feasible approach to control. To provide greater choice of methods and to encourage greater interest in the use of that approach, the following studies possibly would be helpful:

Location of infective sites. The relative amount of transmission that occurs in the dooryard as compared with other locations is in general evident in the age-sex prevalence statistics, but actual soil studies in situations where dooryard transmission is doubted are needed to provide firm basis for conclusions.

Unexplained low endemicity. Identification and evaluation of natural adverse conditions should be attempted in areas where worm infections apparently should, but do not, occur. A good example of this situation is the Fort Rosebery area of Northern Rhodesia where Ascaris and Trichuris are essentially lacking among people who have moderate to high rates of hookworm infections and could easily acquire "inoculations" from neighboring districts where Ascaris rates are extremely high. Trichuris is present but occurs only rarely in any of the communities of the region. Until the absence as well as the presence of infections can be fully explained, it must be assumed that important control possibilities are being overlooked. Investigations of this problem, carried out by workers who have thorough understanding of the soil and the worms doubtless would be fruitful. In this connection, the positive and negative influences of coprophagous insects with reference to different species of worms should not be overlooked.

Alteration of soil. Conditioning of the soil by means of adding materials and chemicals to change its physical properties should be investigated from the standpoints of control values and feasibility. This is a "high priority" problem in connection with construction of new housing and model villages. For heavily contaminated soil in old villages and other long-established situations, the possibility of using chemical disinfection, residual or otherwise, should also be investigated. Substances used on kennels (calcium cyanamid, sodium borates) and poultry farms (pentachlorophenate) might prove useful.

Population relocation. With knowledge already available, natural control methods should be applied and evaluated as a part of any experimentation with population relocation and village construction.

Night-soil and sewage irrigation. Night-soil fertilization poses four problems which could profitably be studied:

Disinfection methods. How best to disinfect the night soil by composting or other forms of heat sterilization and by storage with and without the addition of substances to accelerate killing of eggs and organisms. There is special need for methods adaptable to small farm units.

Natural decontamination. There is need for an objective evaluation of the relative importance of night-soil fertilization as compared with other factors in transmission. Dooryard contamination, direct (by young children) and by handling of night soil, is possibly accountable for most of the infection attributed to field contamination of vegetables.

Crop relations. It would be interesting and possibly helpful to investigate the validity of the view that raising certain crops (such as coffee, sugar cane, rice) encourages direct contamination of soil and infection-transmission. It may only be that the soils are especially suitable for the worms as well as the crop, and that the people employed in the cultivation of such crops are especially prone to contaminate the "dooryard" soil and are particularly susceptible to disease from worm infections (because of malnutrition?).

Food disinfection. Disinfection of uncooked fruits and vegetables by means of aqueous iodine appears to be feasible under certain circumstances. Field trials at military or civilian establishments in areas where night soil is commonly used would be highly worthwhile.

Reference

[1] Beaver, P. C., 1961. Control of soil-transmitted helminths. Public Health Papers 10, World Health Organization, Geneva, pp. 35-38.

Research Problems on Ancylostomiasis—Excerpts from a letter dated 4 March 1961 from **Prof. Dr. H. F. Nagaty,** Chairman, Department of Endemic Diseases, Faculty of Medicine, Ein Shams University, Cairo, Egyptian Province, United Arab Republic.

A simple measure that would control the spread of hookworm disease would be the compulsory wearing of sandals or some other form of shoe out of doors. Apparently a law to this effect does exist in Deir Ez Zor Governorate, Syria, but it is not enforced. Apart from protection of the feet, attention should also be given to preventing the continuous pollution of the soil by providing all houses and schools with latrines. Where such a measure would be too expensive, public latrines might be a satisfactory alternative. Disinfection of faeces or soil is too difficult and expensive to be applied over large areas.

Besides these hygienic precautions, mass treatment of the entire population should be carried out in areas where an appreciable number of cases have been detected, all members of the community being treated within a short period of time. With modern drugs it is possible not only to give immediate relief to the patient, but also to reduce the number of eggs reaching the soil and thus cut down the rate of reinfestation. Nevertheless, since some reinfestation does occur and a single treatment is scarcely ever sufficient to eliminate all the worms, it is necessary to repeat the treatment at suitable intervals. Supplementing the diet with additional proteins and with iron is in itself sufficient to reduce the severity of symptoms and to enable the patient to build up a resistance by increasing the production of gamma globulin.

Wherever financial resources permit, these measures should be applied simultaneously. At the same time efforts should be made to improve the living standards of the population, particularly with regard to sanitation, and to educate the public by means of extensive health propaganda. Finally, the need for strengthening the health services, including the school medical services, should be emphasized.

FILARIASIS

Research Needed on Filariasis—Submitted 13 February 1961 by **Dr. Frank Hawking,** National Institute for Medical Research, Medical Research Council, London, England.

I. *BANCROFTIAN FILARIASIS AND B. MALAYI*

A. *Practical control of the infection.* This is the most important thing of all and the aim should be to eradicate the disease completely in suitable areas. Once eradicated, or brought to a low level, it would not return quickly, if at all. Eradication could be accomplished by attacking (i) the worms, or (ii) the mosquitoes (or both).

(i) *Worms*: Research directed to improve the use of hetrazan in mass campaigns—partly to improve dose schedules—much more to improve administration and propaganda to persuade people to take it. Other drugs should also be investigated.

Dr. Friedheim (now working in East Africa) claims that Mel W (a derivative of Mel B) is promising. This should be thoroughly investigated, especially as regards its safety for mass use.

Search should be made for other drugs, but hetrazan will be hard to beat, in view of its safety.

The therapy of individual patients does not need much further study. (But see elephantiasis I.B.)

(ii) *Mosquito control*: especially *Culex fatigans*—insecticides, larvicides, etc. Mosquito control of filariasis is more difficult than drug-treatment of worms and it would be slower to yield results. Probably *Culex fatigans* mosquitoes ought to be controlled anyhow. There is much scope for field research in all this.

As a side line, investigations should be made of plant poisons to destroy water weeds (*Pistia*) which support *Mansonioides* mosquitoes which transmit *B. malayi.*

B. *Treatment of elephantiasis, especially of leg.* Improved methods would be welcomed at the present time, especially to gain goodwill while conducting mass campaigns with hetrazan. It is hoped that in the future filariasis will be eradicated and that there will then be no elephantiasis to treat.

C. *Methods of diagnosis.* These are satisfactory. Immunological methods are not promising and they hardly seem worth pressing.

D. *Immunity reactions.* Interesting academically.

E. *Existence of animal reservoirs.* These have been shown in certain areas of Malaya, and they should be sought elsewhere (especially in monkeys and cats). But this remote possibility should not hinder determined efforts to eradicate filariasis (as in A above).

II. *ONCHOCERCIASIS*

A. *Therapy.* An effective non-toxic drug is greatly needed which would sterilise infections in (a) individuals (b) populations in mass campaigns. Hetrazan does not kill the adult worms, and suramin is too toxic for mass campaigns. Search should be made for this drug by the usual chemotherapeutic screening, using mostly *Litomosoides* in cotton rats.

B. *Control of Simulium.* Study of its life cycle. How does *Simulium* survive the dry season in West Africa? Application of insecticides to streams and breeding places.

C. *Relation of Onchocerciasis to blindness*—especially to lesions in the posterior part of the eye. This is at present controversial and ought to be settled particularly by careful geographical surveys of the incidence of onchocerciasis, and the distribution of eye lesions. Are there contributory causes to the blindness, besides *Onchocerca?*

III. *LOA LOA*

A. *Habits and control of Chrysops.*

B. *Possible animal reservoir in monkeys.*

In both of these problems, the work already done by B.O.L. Duke and W. Crewe at Kumba, British Cameroons, West Africa, indicates the lines which are worth following up. Further, Duke's work on the development of *Loa* in monkeys, the reservoir of microfilariae in the lungs, and the action of the spleen in destroying microfilariae is all excellent and it should be followed up and extended (See Annals of Tropical Medicine).

In addition pilot studies should be made to see if it is possible to eradicate *Loa* in a district by mass administration of hetrazan; this is promising.

IV. *OTHER HUMAN INFECTIONS viz. Acanthocheilonema perstans and Mansonella ozzardi*

These infections are not pathogenic and they do not deserve much attention, at any rate on practical grounds.

V. *ACADEMIC PROBLEMS* related to filariasis

A. *Microfilarial periodicity.* This is of no practical importance, but the study of its causation is fascinating and it might yield results significant for biology and also for physiology. Apparently during the day time the microfilariae of *W. bancrofti* actively congregate in the lungs in response to some stimulus provided by the 24-hour cycle of the body of the host. What is this effective stimulus? The microfilariae are certainly remarkably sensitive to changes of oxygen pressure in the lungs, but it is not possible at present to explain their migrations on this basis.

Probably different species of microfilaria respond to different stimuli. Further, how do they hold themselves in the lungs, against the current of blood?

B. *Filarial infections in animals.* These infections should be sought out and studied, especially so that they can be adapted to small animals (rodents) and maintained in the laboratory. This would provide other experimental infections for study, besides *Litomosoides* and *Dipetalonema vite (blanci)*.

C. *General problems of nematode physiology, etc.* Filarial infections offer good opportunities for studying many aspects of this.

VI. *VETERINARY PROBLEMS*

There are various veterinary infections with filarial or parafilarial infections, e.g., hump-sore in Indian cattle, due to *Stephanofilaria* which deserve study both for practical and academic reasons.

VII. *TROPICAL EOSINOPHILIA*

Present evidence suggests that this is possibly due to infections by nematodes (possibly animal filariae in some cases) trying to develop in an unnatural host (man). Much more research is needed to elucidate the cause of this complaint, after which studies can be made how to prevent it and how to cure it.

Excerpt from Dr. Hawking's letter:

"According to my own personal views the most important practical problems are (1) how to eradicate bancroftian and malayan filariasis (probably by mass campaigns with hetrazan) and (2) how to cure onchocerciasis, and to eradicate it (either by drugs, or by destruction of *Simulium*). There are also many interesting academic problems, of course, especially the periodicity of microfilariae."

*Note on the Research Interest in Pathogenic Mechanisms of Filarial Disease due to W. bancrofti, and of Elephantiasis in French Polynesia**—Submitted 19 April 1961 by **Dr. Emile Massal,** Director of the Institute of Medical Research in French Polynesia, Papeete, Tahiti.

The campaign against filariasis which has been waged for ten years in French Polynesia by the Institute of Medical Research, with the cooperation of the University of California, is essentially based on the administration of diethylcarbamazine according to several schemes. It has entailed a considerable reduction in the number of individuals showing microfilariae in the peripheral circulation (from 35 percent to around 5 percent of the population) and has much reduced the clinical manifestations of the infestation without, however, causing them to disappear.

To assure the ultimate success of the campaign which has been undertaken it is indispensable, perhaps now more than ever, to define exactly the pathogenic mechanisms which condition the clinical manifestations; in other words, to explain how the attack of the parasite and the reactions of the host interact to determine the observed clinical syndromes.

These syndromes are of two sorts: obstructive and allergic; both mechanisms, moreover, being able to come into play in the same individual.

Among the obstructive syndromes, adenolymphocele, hydrocele, and hematochyluria are the most characteristic because they are often observed in the pure state (it is understood that secondary microbial infections are not under consideration). In patients presenting these pathological manifestations there is almost always noted a strong infestation of the peripheral blood by microfilariae and, very rarely, acute "crises" of localized or extended lymphangitis. In the absence of any immune or allergic reaction on the part of the host, it seems that the infecting larvae develop freely into adults, the large number of which produces a local reaction of obstruction and abundant production of microfilariae. These subjects are neither immune (or "premune") nor allergic, but they may become so. The explanation of this absence of reaction on the part of the host, with its variations, constitutes a primary subject for research.

More important, because more frequent and more serious, are the allergic manifestations: crises of lymphangitis being repeated with a variable rhythm and able to result in elephantiasis. A very high percentage of subjects having these manifestations show no microfilariae in the peripheral circulation. It is as if

1) Some of these subjects who are allergic and "premune" due to an old (perhaps extinct) infestation resist the introduction of any new infesting larva of a human or animal (*D. immitis*) filaria, the destruction of which gives rise to an acute crisis by liberation of antigen. The present distribution often in localized foci, the appearance of these manifestations by fits and starts in an epidemic fashion in sectors where the domestic culicine density is elevated, the large number of parasitized dogs, etc., have placed suspicion on this pathogenic mechanism. The question merits serious study for, straining for the absurd, it is possible to envisage the maintenance of these acute manifestations for years, at least, after eradication of the human filaria if the endemic canine filaria persisted (*Aëdes aegypti*, the vector of *Dirofilaria immitis*, willingly biting man). This presents, then, a second aspect of possible research. NOTE: desensitization treatments by weekly intradermal injections in increasing doses of an antigen prepared from *D. immitis* have given very good results, spacing the acute manifestations out and even causing them to disappear completely, whereas the administration of corticosteroids has only a transitory effect and the action of diethylcarbamazine is nil.

2) Certain subjects demonstrate a certain unstable and insufficient immunity or premunition permitting the development and reproduction of the adult parasites and an allergy, or a certain reduced sensitization. The peripheral blood in these subjects often contains microfilariae; clinical manifestations are spaced at greater intervals and are provoked either by the administration of diethylcarbamazine or by massive inoculations of human or animal infective larvae (on the occasion, for example, of a temporary sojourn in an area of elevated culicine density) or by diverse reasons such as physical excess, variations in environmental temperature, etc. Research into the precise reasons for variation in the state of sensitization of these subjects could be the object of a third series of researches.

Finally, there is one last category of subjects: those who show microfilariae in their peripheral circulation over many years and who, at no time, even after administration of diethylcarbamazine, reveal the slightest clinical manifestation of filariasis. Everything else being equal, they would constitute the healthy carriers such as exist with several other parasites. The reasons for this "inertia" on the part of the host escapes us completely and would merit being studied in a fourth series of researches.

Perhaps to some these researches may seem superfluous. It may be thought that chemical treatment and the campaign against the mosquito vectors ought to permit eradication of filariasis. In point of fact, what is important is the disappearance of the disease and not of the parasite and/or vector which is so difficult to effect under present conditions in French Polynesia. In New Caledonia, among certain tribes *no* clinical manifestation of filariasis is ever found in spite of microfilarial indices of 35-40 percent. That is, there exists an elevated filarial infestation without disease. Why? Is it because of the temporary activity of the mosquito vector during the course of the year? How? By unfitness of the subjects for sensitization as a consequence, perhaps, of a weak frequency in encounters with hosts by larval inoculations which are rare or spaced out? The answers to these questions would open up new horizons in the fight against filarial *disease.* (translation)

*The views expressed in this paper are personal and do not commit in any way the Institute of Medical Research in French Polynesia or the University of California.

Some Aspects of Researches in Filariasis Needing Early Attention at International Level—Submitted 18 February 1961 by **Dr. N. G. S. Raghavan,** Deputy Director, National Filaria Control Programme, Malaria Institute of India, Delhi, India.

This note presents some personal opinions and is restricted to *W. bancrofti* and *B. malayi.* The gravity of the problem as a psycho-social disease with pronounced economic considerations and its importance as a public health problem needs no emphasis. Suffice it to say that the estimates of Norman Stoll (1947) in the main hold good and present the grim picture of filariasis as a global problem of great public health importance. For India the estimate of Jaswant Singh and Raghavan (1953) of 25 million at risk is currently stated to be about 65 million. (Ramakrishnan, Raghavan et al. 1960). Beye (1958) estimated the number of sufferers at 3 million and assumed those at risk as 25 million.

The various studies in the control of filariasis in different parts of the globe including in India have brought out many lacunae in the understanding of the infection and its control. The important projects needing immediate attention are stated below. These are strictly personal opinions.

Control aspects

On an analogy with malaria control, it was expected that the synthetic insecticides would yield good dividends against the adult and/or aquatic phases of filaria vectors. The experience has however been that in the vast rural areas in India with absorbent surfaces the synthetic chlorinated hydrocarbon or organo-phosphorus insecticides had a residual effect of not even a month against *C. fatigans* when applied in doses equivalent to 200 mgm/sq.ft. of D.D.T. Against Anophelines the effect of synthetic chlorinated hydrocarbon insecticides has been good and thus should work well in areas where Anophelines are vectors of filariasis. *Culex fatigans* transmitted *W. bancrofti* is prevalent to a large extent globally. Hence it is important and urgent to find a better, long-lasting residual insecticide against this mosquito naturally more tolerant to the chlorinated hydrocarbon insecticides than other species which are vectors of filariasis. Such studies have naturally to take into account the handicaps in the use of available insecticides. This field is important, as larviciding is beset with difficulties in the large scale rural filariasis (*W. bancrofti*) and drainage of all such areas is not possible to be carried out for about two decades, if not more.

The effect of residual insecticide against *Mansonioides annulifera* in India has however been relatively more encouraging. In such areas the houses are built of non-absorbent material. However, more studies are needed in other areas of the world, with a *B. malayi* problem particularly in view of the different results obtained in Malaya with *M. longipalpis (M. bonneae/M. dives)* in Malaya.

Larvicides: In addition to the need for search for insecticide, equally urgent is the need for studies in the production of a good larvicide. The synthetic insecticides have their drawback for such use—resistance—whilst mosquito larvicidal oils have their innate difficulties of proper preparation of surface areas and dispersion large quantities to be procured, stored, transported and applied. Chemicals like Paris Green in suitable formulations have shown possibilities against *Culex* control and more studies are needed in similar lines for a suitable larvicide.

In this context the study of sewage chemistry, economic methods of sewage disposal, particularly in rural areas, also need to be undertaken.

Antiparasitic: This is a very important field for further research. Diethylcarbamazine was produced due to war emergency plus the fear of risk of introduction of infection to nonendemic areas, e.g., U.S.A., by returning servicemen infected in such war areas. This discovery can be stated as due to an "Experiment of expediency" following high pressure research. This emergency is now gone. The iron has become too cold.

Diethylcarbamazine though a great advance over other filaricides in that it can be orally administered, yet has the chief drawback of producing reactions following therapy especially in apparently symptomless (but infected) persons. The added factor that the drug does not have any marked effect in reducing the filarial disease conditions also weighs heavily against its larger acceptability.

The need of the hour is to be able to produce a drug which can be orally administered, have an action on the adult worms and microfilariae and not produce undesirable side reactions. One can draw attention to the parallel in anti-malarials. The lack of suitable experimental animals is no longer tenable as a variety of filarial infections can be kept in experimental animals—including *B. malayi. W. bancrofti* as yet is still a problem to be experimentally maintained in animals. Detailed and concerted studies may yet produce satisfactory results in this line also.

Therapy: The control programmes suffer this handicap, i.e., not being aimed at therapy of the disease condition. They are aimed at the reservoir of infection, i.e., the macro/microfilariae in the human beings, i.e., usually the symptomless persons. Disease varies from the earliest manifestations of fever/lymphangitis to the well established gross elephantoid conditions. The social stigma restricts hospital/outpatient attendance to either the very early or late advanced cases. The armamentarium at the disposal of the practitioner or hospital authorities is limited. Surgery plays its limited role.

By and large the therapy has to be medical. For the early cases (especially lymphangitis/fever stage) the work in the Pacific and of the Malaria Institute of India has shown the utility of intradermal inoculations of antigens from heterologous filarial infections as *Dirofilaria immitis* or *Conispiculum guindiensis* in that "clinical cure" was noted. An extension of such studies using purified fractions of adult filarial worms needs to be encouraged.

Any attempt at therapy of established lymphoedema presupposes a knowledge of the causation of such a condition, physiology of extracellular fluids, pathology of lymphoedema and experimental studies in their production and of means to relieve the same. Very little work has been done in such studies. They have to be carried out in full force.

The above studies naturally involve the use of newer tools and techniques of research in the laboratory and the field. They may include among other things studies in a) immuno-chemistry, b) enzymology, c) histopathology, including study of mesenchyme, d) lymphangiography, e) use of radioactive substances including use of scintograms, f) experimental attempts at production of lymphoedema, g) study of lymphatic and lymphoid system in germ-free animals—normal and infected with filaria, h) axenic culture may be needed for providing material for diagnosis as also of therapy. This could be developed for the homologous human infections. Naturally provision is to be made for evaluation of such measures in the field.

Studies in the life cycle of the vertebrate host

The chief lacuna is the lack of quantitative knowledge of development of the infective larvae in the vertebrate host. Parallel studies in experimental epidemiology of animal filarial infections is possible especially in view of the bird filariae with selective adult habitats. (*Splendido filaria sp.*) Use of radioactive isotopes in tracing the stages and for quantitative studies is suggested.

There are other studies connected with the dynamics of transmission—in the invertebrate host—like critical density, flight range, the quantum of transmission and factors connected with the biology of the mosquitoes, which it is felt, should be left to the individual institutions or workers in the various endemic areas to work out. There are other routine investigations needed which are not listed here.

The suggestions for research set out in this note, it is felt, are those for which international interest and collaboration would be needed in countries where such filarial infections are a significant public health problem.

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MALARIA

Malaria Research—Submitted 23 February 1961 by **Dr. C. A. Alvarado,** Director, Division of Malaria Eradication, World Health Organization, Geneva, Switzerland.

Needs of research in the field of malaria

1. *The research activities of WHO.* The aim of WHO is to stimulate, assist and co-ordinate research activities in the field of malaria all over the world. The attention paid by WHO to problems of research on malaria has been steadily increasing during the past years and this trend is gathering more momentum.

Although satisfactory results are being obtained in the world-wide programme of malaria eradication, there are still some difficulties to be overcome before the global programme can succeed. These difficulties can be divided into two main groups: (a) administrative and socio-economic, and (b) technical.

The first group includes problems of obvious importance, such as the following: shortcomings or errors in the planning or implementation of antimalarial activities, lack of personnel, insufficient popular support, and the presence of some underestimated sociological factors or of specific cultural patterns (locking up of houses, the use of crop huts, replastering, aversion to interference). Particularly important, however, is the mobility of the population, showing itself in the form of migration or other forms of nomadism. There is no doubt that these "non-specific" factors often carry considerable weight, and when errors are recognized at a late stage of the programme, their correction is far from easy. It is obvious that the existing difficulties in this first group of problems cannot be readily solved by any amount of research, but even in this group a special type of applied social research on the migratory habits of populations can be of much value, and this has already been undertaken by the Organization.

In the second group of purely technical problems the following objects of research are of primary importance: (a) better knowledge of local epidemiology of unstable and stable malaria; (b) the improvement of the technique of surveillance; (c) fuller understanding of the behaviour of a number of important vectors; (d) assessment of activity of old and new residual insecticides at given dosages and cycles on different surfaces and in various environmental conditions; (e) development of new antimalarial drugs and improved methods of their administration; (f) increased knowledge of the resistance of malaria vectors to insecticides.

From the practical point of view one could broadly divide the research activities in the field of malaria into three groups: (1) operational research, (2) applied research and (3) fundamental research. The term *"operational research"* is applied to the gathering, sifting and assessment of a number of facts and observations reported as a result of normal field activities in malaria eradication projects. The term *"applied research"* refers to a specific technical problem of general and immediate importance which has to be rapidly solved in order to overcome obstacles standing in the way of malaria eradication. The term *"basic"* or *"fundamental research"* refers to the pursuit of knowledge in a definite branch of science, without necessarily assessing the potential usefulness of the results obtained.

The general policy of the Organization in the matter of malaria research is to give the highest priority to problems that have a direct, almost immediate bearing on malaria eradication. Problems of basic research are undoubtedly important, but, being somewhat removed from the current world-wide malaria eradication programme, cannot receive the same degree of priority or financial support. Thus the greatest attention is generally given to applied and operational research, but without losing sight of the fact that at times the solution of a practical problem may be found as a result of some fundamental discovery. Basic research of this type is stimulated, encouraged, guided and supported by the Organization, even though most of it is done independently by national scientific organizations.

Only problems of applied and fundamental research need to be discussed in this note.

2. *Applied research.* Identification of the major technical problems and evaluation of their priorities, should be followed by planning realistically for their rapid and practical solution. This is the domain of applied research; the necessary work can occasionally be done in a scientific institution, but is often better carried out in the field.

(1) *Research on the epidemiology of disappearing malaria.* Of direct interest in this connection is information on parasitology of malaria, on genetic and other factors in immunity, on the duration of untreated malaria infections, on the duration and infectivity of asymptomatic parasitaemia.

Thus few remaining problems concerning parasitology of malaria can be clarified unless many morphological, immunological and biochemical characteristics of the parasite species and strains are better known. Further studies in this field may be greatly speeded up by the development of practical and relatively simple methods of cultivation of malaria parasites *in vitro* through many generations. A method of growing the pre- and exo-erythrocytic forms of malaria parasites in tissue cultures of liver cells would constitute a major advance. The need for increased investigation of parasitology of malaria applies particularly to tropical Africa, where evidence is accumulating that some local *P. falciparum* may differ more than anticipated from other known strains of *P. falciparum*. It is desirable that further comparative studies on this parasite should be carried out so that the full morphology of its blood and liver stages, the duration of infection, response to drugs, infectivity to anopheline vectors and other characteristics should be known.

The problem of genetic factors and their relationship to various degrees of tolerance of malaria infection is assuming an increasing fundamental and practical importance. The particular aspect of genetics in relation to malaria is linked with the discovery of various haemoglobin types and with the study of their distribution in tropical areas. A number of studies have indicated that the high frequencies of the haemoglobin S gene in some populations are due to a balance of powerful selective forces, some tending to increase and others to decrease the frequency of this gene. It has also been shown that any two different haemoglobin types tend to be mutually exclusive in populations. There is some evidence that the frequency of the sickle cell gene (initially a rare mutant) has been favoured by natural selection in malarious areas. It is probable that the same situation exists in other malarious areas in which the genes for other different haemoglobin types (C and E) and thalassaemia are common. Research on this problem should be carried out jointly by the malariologists and haemotologists in the field and in the laboratory. Precise studies on the invasion and maintenance of the parasite in erythrocytes containing various haemoglobin types must await the development of present methods of cultivation of malaria parasites *in vitro*. Nevertheless, studies on the pathology of malaria in relation to the presence of some haemoglobins and epidemiological field investigations will also elucidate (or discover) a number of problems connected with genetic factors in immunity to malaria. Such studies deserve much encouragement and should be given adequate assistance.

There is some evidence in certain areas of *P. falciparum* and *P. vivax* infections occasionally lasting for more than 18 months or three years respectively. The infectivity of subjects with these protracted parasitaemias to anopheline vectors has not been sufficiently investigated. The presence of such sporadic cases is not necessarily of great importance in malaria eradication in temperate climates, but they may be of importance in those subtropical and tropical areas where malaria eradication is in one of its later phases. This problem is of fundamental interest and of sufficient urgency to deserve a full investigation of cases of induced malaria in institutions devoted to the practice of malaria therapy, as also in the field in some programmes during the consolidation phase.

The problem of transfusion malaria may be of some importance in certain countries in the consolidation or maintenance phase of malaria eradication, where the probability of infected donors is greater than anticipated. The collection of data on the frequency, distribution and other aspects of transfusion malaria in those countries deserves attention.

Asymptomatic parasitaemia, its duration and infectivity. The presence of asymptomatic (afebrile) carriers of malaria parasites may be of considerable practical importance in the later phases of malaria eradication programmes. While some asymptomatic infections might only represent a temporary stage preceding or following overt malaria, there is evidence of the importance of a carrier state throughout the sub-clinical or inapparent infections of some duration. This problem deserves the fullest investigation and the difficulty of such an investigation in experimental conditions, based on a follow-up of a small number of subjects, is obvious. Well-planned and thoroughly conducted epidemiological and parasitological field studies of asymptomatic phase of malaria are needed and should be carried out in areas of stable and unstable malaria. Moreover, some aspects of the epidemiology of disappearing malaria could be elucidated in the course of investigations on the apparent failure to eradicate stable malaria in some areas of the world.

(2) *Research on determination of the best practical and economical surveillance procedures.* The difficulty in tracing failures to interrupt transmission in areas of stable malaria is due to the inadequacy of appraisal methods still insufficiently orienated to the natural history of malaria. This is especially true when new methods of analysis must be used for the investigation of a disappearing disease. The most significant gap is in our understanding of the pattern of persistence of transmission. The results of a large number of blood examinations presented as over-all rates of infection give a general impression without any details of the pattern of transmission; and yet it is important to know whether the transmission is uniformly distributed over the area or focal in character, whether it is continuous or restricted to a season or to an interval after the application of insecticide, whether it reaches all groups of the population or only some sections of it, whether it is due to an unusual degree of exposure, to migration, or any other factors.

There is need to develop new techniques of collection, classification and analysis of all data necessary for such a study and which would be readily applicable to countries without fully-developed vital statistics.

Research on the persistence of transmission should be initiated in representative areas, chosen after a preliminary study of the efficiency of the operations carried out or being carried out. Many of the difficulties have been encountered in places where the administrative or supervisory structure was inadequate. The analysis of the cause of failure should include studies of the efficiency of planning, administration, utilization of technical staff and of the quality of executive work; information on the speedy and efficient use of technical information followed by suitable modifications of the operational pattern is of particular interest.

Such studies should be undertaken by experienced epidemiologists with a good statistical background and assisted by adequate auxiliary staff. Delineation of the pattern of persistent transmission provides the proper background for studies of a more conventional entomological or parasitological character, inasmuch as it indicates the place, time and the circumstances in which they need to be pursued. Though the techniques would conform to a conventional plan, there is still some uncertainty about the actual process of recognition of the cause of noninterruption of transmission. Thus suitable modifications of standard techniques may be needed for the parasitological and entomological aspects of malaria transmission. On the one hand, precise assessment of the volume and infectivity of the parasite reservoir is necessary; on the other hand better techniques are needed for the collection of representative samples of the anopheline population biting man indoors or outdoors, more precise identification of groups of mosquitos with unduly long survival and finally, the study of the factors which have permitted this survival.

(3) *Research on the practical methods best suited to deal with continuing transmission due to nomadism.* The behavioural and cultural patterns of the population are known to have a bearing on exposure to malaria risk and on the success of eradication procedures. There is need for the study of the human population with the object of recognizing behavioural characters favouring the persistence of transmission. Population movements constitute at the present time one of the important obstacles to the achievement of malaria eradication in some parts of the world. These population movements comprise various larger or smaller groups, changing seasonally or irregularly their places of abode. In all developing areas of the world such movements are bound to increase with the improvement of communications. There are no standard methods for the protection of such populations or for preventing these groups from acting as new foci of malaria infection. Attempts at regular spraying of tents or temporary dwellings with new and adequate insecticide formulations, mass drug administration and better knowledge of these population movements in time and space are possible means of dealing with the problem. A general sociological study of the pattern and volume of population movements in several developing areas of the world will be of great value.

(4) *Research on the use of more economical dosages of insecticides compatible with a residual effect adequate to interrupt transmission.* This extremely important problem has been carefully studied by the Expert Committee on Malaria at its Eighth Session. The following passage deals with the subject:

> "With the advent of DDT and the recognition of the importance of this insecticide in the control of malaria, investigations were carried out in a number of countries to determine the minimal effective dosage of active material and the cycles of application.
>
> "The use of 2 g of DDT per m^2, applied once or twice a year, came to be the commonly accepted procedure, based upon these field trials and upon the outstanding success of malaria control programmes in many countries. This was the situation at the time when the change from malaria control to malaria eradication took place. The sixth report of the Expert Committee on Malaria reflected this position, but added that in some places the dosages and cycles described might be "considerably modified" in the light of actual experience.[1]
>
> "Since the publication of that report, experience has shown in some countries that the dosage of DDT could with safety be reduced to 1 g/m^2 in each application. The question arises, therefore, whether this smaller dosage should be adopted as a standard throughout the world. The Committee gave careful consideration to this question, while fully realizing its responsibility in the matter with reference both to the resulting impact on the financial aspects of the programme and to the prospects of the world-wide campaign of malaria eradication.
>
> "It is well known, from a technical point of view, that factors influencing the dosage and cycles of spraying vary markedly from country to country; it would, therefore, be unrealistic to expect that a single standard could be evolved which would be applicable to all malarious areas. Moreover, there is always the danger that local investigations may be

neglected if a standard dosage is laid down. This fact is confirmed by an analysis made by WHO of dosages and cycles currently in operation; despite the above-mentioned reservations appearing in the sixth report of the Expert Committee on Malaria, the dosage of 2 g/m² of DDT per application has been used in seventy-two programmes, as against a higher or lower dosage in only ten.

"Turning to the specific question of the advisability of adopting 1 g/m² as the standard dosage of DDT, the Committee was of the opinion that this must be viewed from two aspects. First, there are areas where the dosage of 2 g/m² is already in use on an extensive scale; secondly, there are areas in which the use of DDT in a dosage of 2 g/m² is only contemplated or has just begun. In the former, a reduction of the dosage would be justified only if epidemiological and entomological evidence were forthcoming, from field trials of appropriate size, to the effect that such a reduction would not jeopardize the success of the malaria eradication programme. With regard to those countries where spraying is about to begin, the determining factor would be either evidence obtained from a neighbouring country with similar epidemiological and ecological conditions, or the results of carefully planned and executed field trials.

"In making these assessments the Committee was not unmindful of the successful experience with lower dosages in India and elsewhere, but it did not consider it advisable to recommend the use of these lower dosages in other countries unless local investigations have proved their efficacy.

"The Committee did not wish to lay down a detailed procedure for these small-scale field trials. It nevertheless believed that the effectiveness and duration of the insecticidal properties of lower dosages of DDT should invariably be balanced against those obtained by using a dosage of 2 g/m². Secondly, it recommended that provision for DDT should continue to be made on the basis of 2 g/m² per application until such time as there is definite and unequivocal evidence that it is safe to reduce the dosage.

"The evidence of effectiveness which the Committee had in mind relates both to epidemiological data on the interruption of malaria transmission and to entomological data on the effects of the spraying operations on the vectors. The Committee realized that many of the countries in which modifications of dosage might have to be made may not be in a position to undertake trials of this nature from their own resources. It will therefore be essential for WHO to pursue such investigations as an integral part of its programme of assistance to malaria eradication.

"The principles discussed above for DDT are equally applicable to other insecticides."

The World Health Organization is fully aware of the technical and administrative importance of adequate and economical dosage and cycle of residual insecticides used in malaria eradication programmes and a number of special field trials have been organized for the speedy solution of the problem.

Some important entomological problems are being pursued from the angle of applied research on the best dosage and cycle of residual insecticides. There is a need for a generally acceptable index of the effectiveness of the vector-kill produced by sprayed surfaces; the index should be obtainable by means of a technique sufficiently elastic to be found practical in most malarious areas throughout the world. The most immediate need for such an index is felt in countries which are still planning their malaria eradication programme, and which have to determine in advance the cycles and dosages of insecticides to be applied. The Organization is taking active steps to develop a method of this kind, in consultation with national institutes and field laboratories. It may be asked why such an obvious need has not been met long ago. The answer lies in the inherent difficulties of developing a satisfactory and widely practicable method. A tentative standard method for estimation of the optimum dosage of the insecticide to be applied and the frequency of spraying cycles has been developed. It is based on the use of traditional entomological indices, bioassays and on the assessment of the proportion of female *Anopheles* killed by the contact with the insecticide and collected in window-traps.

(5) *Research on the behaviour of vectors in sprayed areas.*

(a) *Study of indoor behaviour of main malaria vectors in sprayed areas.* The methodology of study of indoor behaviour patterns of mosquitos in the preparatory and attack phases of malaria eradication should be adapted to new knowledge on the varying behaviour of strains of malaria vectors in different parts of the world. The three entomological factors of basic importance are: (a) the density of the vector population per unit space and time; (b) its degree of contact with man; and (c) the proportion of females of epidemiologically dangerous age.

The most useful techniques applied to the study of these factors are those which give their direct measurements. It appears that there is a great deal of diversity in the assessment of the relative density of the vector population. The use of techniques better adapted to the behaviour of the local vector should be stimulated. The degree of contact of the vector with man, assessed by means of precipitin tests on the blood ingested by the mosquito, is of obvious importance, providing that some basic information on the site, the time and method of mosquito collection is known. Simple precipitin tests, using only the antihuman sera, might be sufficient in some instances but standardized and competently carried out precipitin tests using a number of specific antisera are of great value, as they often reveal the unsuspected behaviour patterns of some malaria vectors.

A collaborative international work was stimulated and organized by WHO, in the domain of the study of behaviour of vectors of malaria for the investigation of feeding preferences of *Anopheles* by means of precipitin tests. During the 1955-59 period over 50,000 tests were carried out and the published report on this study is of much interest. The results of operational studies on the behaviour of *Anopheles* vectors showed that there are considerable differences between strains of the same species of the vector.

(b) *Change of behaviour of malaria vectors as a result of application of residual insecticides.* Deposits of residual insecticides, DDT in particular, have the property of irritating mosquitos in contact with them; under certain conditions some irritated species may already have picked up a lethal dose of insecticides and will eventually die, but under other conditions some species can be irritated before picking up a lethal dose, and thus may escape unharmed.

Theoretically this latter phenomenon may militate against the use of DDT deposits in malaria eradication, but in fact irritated mosquitos, although unharmed, may have their contact with man interrupted or reduced in some way, thus bringing about indirectly a reduction in transmission.

Further research into this problem is required with regard to the following points: (1) How widely distributed is the irritability phenomenon among different species of anophelines? (2) Is irritability influenced by dosage, formulation, type of surface, temperature, etc? (3) To what extent is this irritability likely to be intensified during the course of a regular spraying campaign? (4) To what extent does irritability lead to the greater use of animals as a source of blood rather than man? (5) Although many irritated mosquitos appear to escape unharmed, have they been affected in some other way, such as in their behaviour or longevity?

All these points may have a direct bearing on certain problems of malaria eradication. Such an investigation might be organized best within the framework of malaria eradication pilot projects in which all the prerequisites for detailed observation of the bionomics of the local vector before and during the residual spraying are available.

(c) *Importance of exophilic vectors and related aspects of mosquito behaviour.* Exophilic vectors of the following two categories, (i) those that feed indoors (endophagic) and rest outdoors (exophilic), and (ii) those that feed outdoors (exophagic) and rest outdoors (exophilic), are of particular importance in malaria eradication programmes.

The first category includes several species such as *A. maculatus* and *A. leucosphyrus*, in which exophily takes the form of a natural exodus from houses after varying periods spent indoors during the night on which they feed. Because of this regular contact with inner surfaces of houses such species—although exophilic—can still be amenable to control by residual insecticides.

This category also includes those species in which exophily has appeared only as a result of residual spraying, the irritation caused by the insecticide deposit (mostly DDT) driving them out of houses shortly after feeding. The latter aspect of induced exophily, which is shown in varying degrees by several major vectors of malaria, is one that requires much more detailed study before it is possible to judge what effect residual spraying will have on transmission by such species. Such study will have to be based on general bionomics, precipitin tests of blood meals, sporozoite and oocyst rates, the temperature factor in relation to the development of the parasite, etc. It will also necessitate a more critical appraisal of the various mosquito sampling methods currently used.

With regard to category (ii), some species, such as *A. coustani* in parts of Africa, may show such extreme exophily as to remove them entirely from any possible contact with treated habitations. With other species, such as, for example, *A. (Kerteszia) bellator*, the mosquito although rarely entering houses may feed on open verandas and have sufficient contact with the external walls to render it partly susceptible to house treatment. (Other species of *Kerteszia* are entirely exophilic and exophagic.)

In both groups more critical observations are required to define exactly what degree of contact takes place with the inner or outer surfaces of houses.

If no possible contact with houses is confirmed, a careful re-appraisal of the vector status of such species would be indicated before contemplating further specialized control measures.

(d) *Longevity of malaria vectors.* The study of age-composition in vector mosquitos capable of persisting and maintaining their link with man in sprayed areas is probably of greater relevance to the success of malaria eradication than is the actual density of the vector. An efficient vector may cause some transmission, even if present in comparatively small numbers, whereas it cannot do so, whatever may be its breeding and biting densities, if its expectation of life has been drastically shortened by the presence of insecticide in the houses. A refined methodology has already been developed for studying mosquito age-composition, but great difficulty is experienced in attempting to apply this technique to the small anophelines which are the major vectors of malaria in most parts of the tropics; in any case the technique is so advanced and so laborious that it cannot be considered suitable for general operational use in malaria eradication programmes. Alternative methods exist which are easier and more rapid, though definitely less accurate; they involve measurement of the ratio of nulliparity in populations of mosquitos, from which it is possible to calculate approximately the proportion which might attain epidemiologically dangerous age. During 1960 research has continued at a number of places into the application of these various methods under field conditions, much of this work being actively promoted by WHO.

(e) *Resistance of Anopheles vectors to residual insecticides.* The problem of insecticide resistance presents probably the greatest challenge for applied research. Its importance will be well appreciated if we remember that in 1955 the number of resistant vector species was three; in May 1958 six; in May 1959 seventeen; and today, in December 1960, it is nineteen. The disturbing feature of this trend is that cases of resistance are being recorded from an increasing number of countries, and that, in some instances, the resistance is evident against both of the two main groups of insecticides, DDT and dieldrin. It is true that the problem of insecticide resistance by malaria vectors should be viewed in its proper perspective, and that the total population living in malarious areas where resistant *Anopheles* have been found is only a small proportion of the total population living in malarious areas and adequately protected by insecticides.

It should be emphasized that the discovery of an *Anopheles* vector having become resistant to an insecticide does not necessarily mean that the further use of such insecticide is precluded. The interruption of transmission of malaria can be effected if the residual insecticide continues to kill a large proportion of the vector population still susceptible to the insecticide, or if the insecticide has an irritant action on the resistant *Anopheles* resulting in their diversion from man, or if it changes the normal biting habits of the local vector. Nevertheless, the importance of the problem is such that the greatest possible effort is needed to overcome the growing threat of resistance to insecticides. On the other hand, there are already programmes of research in special laboratories devoted to long-term investigation on the biochemistry of the insecticidal action, the genetics of acquired resistance, the discovery of negatively correlated compounds, etc. On the other hand, there is need for more applied research aimed at finding an urgent solution to the threat of resistance of malaria vectors to chlorinated hydrocarbons. This can be done by a more or less empirical testing, in the laboratory and in the field, of toxicants likely to be of value. The Organization has provided facilities for testing the new and less toxic insecticides in the field. For this purpose a special Insecticide Testing Unit was set up; it has assessed the effectiveness of some new organophosphorus insecticides in Greece, and is now working in Nigeria.

It is important that as many as possible of the resistant strains of anophelines be colonized in suitable research institutions where the spectrum of the resistance can be determined and the pattern of its inheritance be investigated. There are difficulties in colonizing certain anopheline species and some of these difficulties can be overcome by the use of new techniques, the development of which should be encouraged as much as possible.

Formal genetics constitute an immediate tool for the recognition of resistance patterns affecting the dynamics of vector populations. More advanced studies of formal genetics would be facilitated by the development of techniques for ensuring cross-mating without uncertainty about identification of the male parent. New methods of controlled insemination of mosquitos offer prospects of success in this field and should be more widely used. This could be effected by the specialized training of selected research workers. Cytogenetics have less prospects for their immediate application to problems of malaria eradication but are a valuable tool for basic research.

(6) *Research on the best and most economical methods of drug administration in malaria eradication projects. Field trials of new antimalarial drugs, drug combinations or drug media (medicated salt).** Modern antimalarial drugs are adequate for suppression, treatment and radical cure of malaria in individuals or small well-supervised groups. The exigencies of malaria eradication programmes, especially in developing countries, are such that the drugs available today often fall short of expectations, mainly because of difficulties of their adequate administration. Chemotherapy of malaria is bound to occupy a place of increased importance, not only in the consolidation phase of malaria eradication but also, at least in some parts of the world, in the attack phase. The attention of the pharmaceutical industry and research institutions is drawn to the vast possibilities and growing importance of antimalarial drugs in medicine and public health. An

*A technical meeting on chemotherapy in malaria eradication was convened by WHO in November 1960. The final report of this important meeting is now in preparation and should be available in March 1961.

increased effort is necessary to expand the fundamental and applied research on the biochemistry of the malaria parasite and the applied research on antimalarial drugs to fill the gaps that remain.

Two needs are obvious today: (a) the improved *usage* of available drugs, and (b) the discovery of drugs with improved *action* against the malaria parasite.

All the present drugs have a relatively short "carry-over" effect and this is a drawback for the full use of antimalarials in many areas of the world. In most of the malaria eradication programmes, particularly in developing countries, there is an urgent need for an antimalarial drug with a long activity, either on the pre-erythrocytic cycle of the development of the parasite in man or as a long-term schizontocide. Such a quality would allow an easy and less frequent administration.

The desirable long-lasting effect of the drug might be achieved either by the use of techniques which permit reposition of the existing drugs or by the development of a new drug or new preparation with an extended activity. It is doubtful if repository media combined with an antimalarial and given by intra-muscular injection would be acceptable for a large-scale administration. Search should be made for a drug which, given orally, is retained and gradually re-distributed in the body, maintaining a satisfactory concentration in the bloodstream. Research should aim therefore at the discovery of drugs which become fixed for a longer time in the internal organs such as the liver and are at the same time sufficiently well tolerated to permit the administration of large single doses at long intervals. The search for such a drug should be made in the laboratory, using animal malaria parasites and employing compounds with a radioactive marker to discover the localization of the drug and the duration of its persistence.

The development of drugs or preparations with a long activity refers particularly to schizontocidal drugs but new drugs are also required for radical cure of relapsing infections with *P. vivax* and *P. malariae* in order to shorten the time needed for the treatment. The best drug for this purpose would be a drug with a full effect after a single dose or after a treatment not exceeding three days. There is no evidence that any of the present 8-aminoquinolines can be used in such a way.

The development of drugs for the prevention of transmission is a requirement of lower priority. Such drugs which might or might not have a gametocytocidal effect are of importance only in conditions when a rapid interruption of transmission is necessary, as for instance in times of epidemics. For other situations schizontocidal drugs given periodically will exert an indirect gametocytocidal effect by attrition and eventually interrupt transmission of malaria. Nevertheless, the search for an easily administered, non-toxic sporontocidal drug with a prolonged action and not liable to induce resistance, is desirable.

Sporontocidal drugs are important when rapid interruption of transmission is needed and in the special circumstances of surveillance operations in which temporary medication must be given to individuals suspected of having malaria, pending confirmation of diagnosis and full treatment. There is some risk that the virtues of pyrimethamine for this purpose may be nullified by the development of resistance to it. There is in consequence need for a new sporontocide with similar freedom from side-effects and with a prolonged action.

The value of mixtures of 4-aminoquinolines and 8-aminoquinolines for mass administration in areas of highly endemic malaria without residual insecticides is worth consideration. Previous experience with early drugs of these two series showed that permanent interruption of transmission by mass drug administration is very difficult as it depends on the operational efficiency of the drug distribution. Nevertheless, well supervised use of combinations of 4-aminoquinolines and 8-aminoquinolines in highly endemic areas might achieve more impressive results and a field trial should be carried out.

The use of medicated salt might be the best method for interruption of transmission of malaria amongst people living in remote areas. A large-scale experiment is now taking place in Brazil.

Development of new antimalarial drugs and of better methods in their administration is of importance, and a number of research projects are now in progress. The ideal antimalarial, containing the virtues of causal prophylaxis, suppression, rapid and complete curative action, sporontocidal effect, inability to create parasite resistance, absence of toxic effects, palatability and low cost, is still waiting to be discovered. There is little doubt that the importance of chemotherapy in some parts of the world is bound to increase; what we need today is a new drug or a new formulation of an existing drug which, after having been given in a single dose orally or by injection, would maintain its action for at least three months. A large-scale field trial of a combination of amodiaquine and primaquine was begun in 1960 in Tanganyika, and three pilot projects (in Cambodia, Netherlands New Guinea and Ghana) for assessment of the value of medicated salt have been stimulated and assisted by the Organization.

Recent progress in the development of a relatively simple quantitative method of assessment of chloroquine in urine is under study. This method would be of value in pilot projects or special field trials. For programmes based on mass administration of drugs, further simplification of this method is suggested. A simple qualitative method of estimating the presence of chloroquine above an arbitrary minimal concentration of the drug might be more suitable for large-scale use. Such a method would have an additional advantage as it could be readily used for a rapid assessment of the presence of chloroquine in samples of medicated cooking salt.

New avenues for chemotherapy in malaria eradication. The increased demands for new drugs with fundamental advantages over the antimalarials available now are made at a time when screening of new drugs on human subjects becomes increasingly difficult because of the declining importance of malaria therapy (induced malaria); the first stage of screening of prospective antimalarials can still be done using classical methods of experimental chemotherapy of malaria. For the later stages of screening there is, however, a great need for centres specializing in experimental simian malaria. In the last screening stage of antimalarial drugs there remain two possibilities: (a) the use of non-immune volunteers, and (b) the wider use of standard field trials in areas where endemic malaria exists. The latter facilities available to the Organization should be used more fully than heretofore.

A preliminary world-wide inquiry has been made by the Organization on the pattern of drug administration in malaria eradication programmes. It appears that the drug regimens adopted in various countries are widely different; the reasons for such differences are not always apparent and seem to be arbitrary. More information on this subject should be collected. Although it is agreed that (a) the various strains of malaria parasites have different sensitivities to drugs and, (b) that the different populations require dissimilar age-group dosages, it seems that more standardization of drug administration in malaria eradication programmes is needed.

Resistance of malaria parasites to drugs. Resistance developed by some strains and species of human malaria parasites to such drugs as pyrimethamine and proguanil which act on early stages of nuclear division is of limited immediate importance but presents serious potential obstacles in some malaria eradication programmes. Recent reports from the field indicate that the phenomenon of drug resistance is more common in tropical Africa than was anticipated. The importance, range, geographical distribution and spread under field conditions of specific drug resistance in human malaria parasites should be fully assessed.

Although there is some evidence that the mechanism of experimentally induced drug resistance in avian malaria is based on the selection of a mutant gene, the selection from a clonal variation is not excluded.

Large gaps in our understanding of the mechanism of drug resistance in malaria parasites are equalled by the lack of precise knowledge of the different biochemical processes linked with the appearance and maintenance of resistant strains.

Genetic and biochemical studies of the phenomena of resistance in malaria parasites are of great fundamental and practical importance.

It is obvious that most of the basic research work on this problem will have to be done on avian and perhaps rodent malaria but undoubtedly more information closely associated with human malaria could be obtained through an experimental approach using simian malaria.

(7) *Sociological research on attitudes of peoples, their customs and their motivations of behaviour in relation to malaria eradication activities.* In any malaria eradication programme systems of administration should be developed which will be: (a) elastic enough to increase or decrease staff in relation to the size of the area or population concerned, and (b) reveal immediately unauthorized departures from planned procedures or objectives, failures in reasonable productivity, or unsatisfactory accomplishment. Such systems would recognize meritorious achievements by promotion or reward, and encourage employees to devise more effective and economical techniques in accomplishing their tasks. Finally, they would ensure adequate communications with higher and lower echelons to maintain continuous co-ordination of effort.

The knowledge of specialists in such social sciences as anthropology, ethnology, human behaviour, educational methods and similar disciplines, should be utilized in securing compliance and avoiding conflicts with the objectives of malaria eradication, especially in developing areas. Where this knowledge does not exist, it should be obtained.

Lastly, malaria eradication is having and will have increasingly profound effects upon demography, human resources and world economics. These and cognate considerations should be the subjects of current rather than *post facto* studies. The benefits of these operations, direct and indirect, must be computed fairly and unemotionally and arrayed against their monetary costs and social liabilities.

(8) *Research on spraying equipment.* Another form of applied research consists in the evaluation of spraying equipment. In 1960 some 500 million persons lived in areas in the attack phase of a malaria eradication programme and about an equal number lived in areas not yet under attack. Some 70,000 compression sprayers, 40,000 stirrup-pump sprayers and 2,000 knapsack sprayers were being used in eradication programmes. The quality and standardization of spraying equipment has been greatly aided by the establishment of purchase specifications, but for some years it has been felt that, in addition to these specifications, controlled field trials of models available on the market were needed, in order to establish their field worthiness, to determine necessary modifications, and to suggest spare part requirements. A research project was set up in 1959 with these objectives; by the end of 1960 it will have tested under field conditions, in two different countries (Nigeria and Iran), five makes of compression sprayer. Two makes of stirrup-pump and a number of sprayer components are also under test. Each unit is subjected to preliminary examination and calibration; it is then used by spraymen of the national service for about three months, being checked at regular intervals and is re-examined at the end of this time. Evaluation is based on performance, wear, breakage and users' comments.

3. *Fundamental research.* The Organization attempts to fill in some gaps in our knowledge of fundamental aspects of malariology or in the means of the technical application of the existing knowledge. In this respect it acts by encouraging and materially assisting research projects carried out by the national institutes and organizations.

It is obvious that some aspects of fundamental research, such as the study of immunity of populations in highly endemic areas, of strain specificity of malaria parasites, of genetics of resistance in laboratory colonies of *Anopheles,* of the biochemistry of malaria parasites, of the frequency of abnormal haemoglobins in some human races, etc., are of great interest. These researches are stimulated, assisted and followed up by WHO.

An interesting problem, which could be considered as lying half-way between fundamental and applied research, is that of simian malaria. The significance and implications of the problem of malaria of lower monkeys recently investigated by the workers at the National Institutes of Health in USA has been discussed by the Expert Committee on Malaria (eighth session, Geneva, August 1960) which commented on it as follows:

> "In the present state of our knowledge, it seems that malaria, as a zoonosis, is of only limited importance in the global programme of malaria eradication. The areas where foci of human malaria could perhaps be maintained from a simian reservoir of infection are few and relatively small in relation to the enormous territories where monkeys either do not exist or are in very small numbers, or where simian malaria parasites are absent, or non-infective to man, or not transmissible by those *Anopheles* which transmit human malaria.
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> "The true significance of simian malaria in relation to man will become apparent when the eradication of human malaria is accomplished in such areas of the world as Malaya, Borneo, Indonesia, Philippines, Taiwan, Central and West Africa. It is interesting to note that in large areas of Venezuela, in which malaria eradication has been achieved and which are known to contain large populations of monkeys, no sporadic cases of malaria have arisen, as would have been expected had there been a simian reservoir of malaria."

The significance of these infections of human beings lies in the fact that they were transmitted by mosquitos which had fed on rhesus monkeys. The theoretical possibility of natural infection of man with monkey malaria had already been suspected. But it still remains to be seen whether this monkey malaria could become human malaria and be transmitted from man to man under natural conditions. If it were to be definitely proved that man and monkey share the same malaria parasite, and that consequently monkeys could be considered as reservoirs of human malaria, then, and then only, could the matter be of real relevancy to malaria eradication. Meanwhile it can be stated that there is no reason why this new discovery should retard the successful progress of malaria eradication in most parts of the world. There are many large tracts of territory where monkeys are few or absent; in places where monkeys exist, they do not necessarily suffer from types of malaria which could be transmitted to man by the local mosquitos. It might happen exceptionally that in some part of some country the persistence of infective foci of malaria, despite total spray-coverage and efficient surveillance, could possibly be found in the future to be traceable to some association between the monkey, the vector, and the human being. If that were proved (and this is purely hypothetical), appropriate action would have to be taken, either by elimination of the animal reservoir, or by drawing on our large inventory of measures against the vector, or by some other means.

Much research in the field is still needed on the problem of simian malaria and on its future implications. In the meantime it should be noted that the discovery of the transmissibility of this parasite to man is likely to be of great importance in chemotherapeutic research, since for the first time a malaria parasite of a higher mammal, easily transmissible by *Anopheles,* can be used for laboratory trials of those drugs that may be of importance in malaria eradication.

Data on research being conducted at present

A number of specific research projects assisted by the Organization were undertaken in 1960. The following table gives the list of these projects which comprise both fundamental and applied research.

(a) Research on the mechanism and dynamics of induced resistance of malaria parasites to drugs. (Malaria Institute of India)

(b) Field trials of mass administration of an antimalarial drug composed of a mixture of 4- and 8-aminoquinolines. (Tanganyika Malaria Unit)

(c) Study of bionomics of *A. sergenti* and *A. claviger*. (Ministry of Health, Israel)

(d) Research on *in vitro* invasion of erythrocytes by exo-erythrocytic stages of plasmodia as a model for studying the effect of antimalarial drugs. (Department of Parasitology, University of Jerusalem, Israel)

(e) Assessment in the field of bioassay methods and their application for determining the activity of residual insecticides.

(f) Research on the behaviour pattern and longevity of *A. punctulatus* group in Netherlands New Guinea. (Ministry of Health, N.N.G.)

(g) Continuation of the investigation on feeding preferences of malaria vectors by precipitin tests. (Lister Institute, England)

(h) Research on entomological problems (genetics of resistance) related to malaria eradication. (Ross Institute, London)

(i) Research on the use of fluorescent antibody technique for parasitological studies in malaria. (School of Tropical Medicine, Hamburg, Germany)

Assistance to research activities

(a) Purchase and distribution to the regions of susceptibility test kits and bioassay kits for assessment of susceptibility levels of *Anopheles* to insecticides.

(b) Study of the problems of nomadism and their importance to malaria eradication in the African and Eastern Mediterranean Regions.

(c) Insecticide Testing Unit set up in Lagos, Nigeria, and administered jointly by the Division of Malaria Eradication and the Division of Environmental Sanitation.

Reference

[1] Wld. Hlth. Org. Techn. Rep. Ser., 1960, *123*, 36.

Mainly From the Report of the Technical Meeting on Malaria Eradication Held in Africa, 1 November 1959—Submitted 22 February 1961 by **Dr. F. J. C. Cambournac,** Regional Director for Africa, World Health Organization, Brazzaville, Republic of Congo.

Epidemiology

Duration of *P. falciparum* infection in various parts of Africa
Methods for detecting symptomless carriers (also detection of carriers presenting fever and other symptoms but no parasitaemia)
Studies about the importance of few carriers in connection with the possibility for malaria to be spread

Entomology

Factors influencing host preferences
Studies on the maintenance of transmission of occasional feeding on man by mosquitoes normally feeding out-of-doors and feeding on animals
Study of the methods for estimating the chance of survival of man-biting section of the population to an age at which infectivity is possible
Methods for identifying sporozoites of malarial parasites (mainly of human and animal plasmodia)
Studies on the possible vectors other than *A. gambiae* and *A. funestus* in certain parts of Africa
Studies on larval and adult susceptibility to insecticides
Methods for estimating the degree of outside resting of vector population
Studies on the reasons for *A. gambiae* to change its behaviour as a result of house spraying with insecticides, mainly DDT

Drug Prophylaxis

Studies on the effective single dosage treatment of drugs now available
Possibility of antimalarial drugs to pass into the milk of nursing mothers (especially in relation to 4-aminoquinoleines)
Studies on basic mechanism of drug-resistance
Studies on the collection and collation data on the plasma levels of pyrimethamine in relation to periodical administration of the drug
Studies on the possibility of preparing antimalarial drugs non-toxic, easy to take and with long-lasting effects

Insecticides

Studies on new insecticides to replace DDT Dieldrin BHC in case of development of resistance by anophelines

Research Problems on Malaria—Excerpts from a letter dated 16 February 1961 from **Dr. G. Robert Coatney,** Chief, Laboratory of Parasite Chemotherapy, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland.

The research needs in the field of malaria are many and varied but, in my opinion, the most important are those listed below.

1. The development of a long-acting suppressive drug, 4-6 months, plus a fool-proof method for its administration. A long-acting compound that could be administered through a hydraulic gun would be ideal.

2. Critical studies to evaluate the efficacy of drug combinations in malaria eradication programs.

3. Development of a binding agent, i.e., drug to salt, that is cheap, easy to use, and will not interfere with drug release in the stomach.

4. Fundamental studies on the phenomenon of resistance (drug or insecticide): What triggers it? How can it be overcome?

5. Studies on the relation of simian malarias to human infection

a. Is simian malaria a zoonosis of importance to world-wide malaria eradication?

b. Are human malarias transmissible to simians, experimentally or in nature?

c. What is the life-pattern of simian malarias in man?

d. What is the response to drugs by simian malarias in man?

e. What are the vectors of simian malaria in nature and do these vectors bite man?

f. How many species of simian malaria are there?

Research Problems on Malaria—Excerpts from a letter dated 23 February 1961 from **Dr. F. J. Dy,** Director of Health Services, Regional Office for the Western Pacific, World Health Organization, Manila, Philippines.

1. *Simian malaria.* The intensified malaria eradication programs being undertaken in many parts of the world today have reduced the incidence of this disease considerably; several countries have achieved eradication. There have been reports of possible transmission of simian malaria to man under laboratory or experimental conditions. What role does simian malaria play in the global epidemiology and what are the implications in relation to our world-wide campaign to eradicate human malaria? I believe that research on this subject will be of considerable value.

2. *Parenteral antimalarial drugs.* Would it be possible to produce injectable antimalarial drugs with long repository effect so that their action may be extended over a much longer period? Such a drug would overcome the relatively short duration of action of antimalarial drugs given by mouth and would be a great help in the global malaria eradication program.

Research Problems on Malaria—Translated excerpt from a letter dated 22 March 1961 from **Dr. Arnoldo Gabaldon,** Ministro de Sanidad y Asistencia Social, Caracas, Venezuela.

The problem which we confront in Venezuela of having two vectors which bite and rest outside of houses has, up to this moment, impeded the eradication of malaria in two zones which, although small, have been refractory to control with insecticides. This indicates to me that, in spite of the large number of investigations which have been dedicated to the treatment of malaria, the most important problem is still to find a drug which produces radical cure of infections with one or two doses, or to find another drug which could keep one person free of parasitemia for six months or longer.

Research Problems on Malaria—Excerpts from a letter dated 22 February 1961 from **Prof. George Macdonald,** Director, Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, London, England.

The main problem of malaria at the present time is how to eradicate it, and the importance of research projects can only be evaluated in reference to this. The foreseeable technical difficulties in eradication lie in (1) resistance to insecticides; (2) resistance of the parasite to drugs; (3) persistence of infections after assumed effective treatment; (4) persistence or re-emergence of the infective state after the expected period of disappearance; (5) failure to recognise infections, despite examination; (6) the emergence of abnormal strains of mosquitoes which may be more or less dangerous than the type forms.

Resistance to insecticide is the most important of these. The method of selection of resistance to DDT and dieldrin is now well known, largely as a result of work carried out in our laboratories. Much effort is being spent on the development of new insecticides, but inadequate research is devoted to the population dynamics of resistance and methods of controlling these dynamics. There is a well-established theory for the prevention of selection of drug resistant organisms by the use of mixtures designed to limit selection of one type. Both theoretical and preliminary laboratory experiments suggest that this mechanism is applicable in the field of resistance to insecticides, but it has not yet been explored. Exploration would require laboratory and field work, the latter being carried out in three types of areas: a) normal, to test the insecticide efficiency and economy of mixtures, a subject in which there is preliminary encouraging evidence; b) areas where the gene of resistance to DDT is known to exist though still in small numbers—such an area apparently exists in Indonesia; c) areas in which the gene of dieldrin resistance is known to exist, though again in small numbers—such an area is believed to exist in Bombay State.

In my opinion, studies of this type hold out more prospect of solving the resistance problem than does the very expensive search for new insecticides.

Resistance to drugs may well become an important difficulty. Chloroquine resistance has been demonstrated in Colombia and may be expected to occur elsewhere, whilst resistance to pyrimethamin—which is widely used for its sporonticidal effect—is well established in many places. Laboratory study of the genetics and biochemistry of normal and resistant types is urgently required. This could be carried out in a limited way on human strains of parasite but should be extended, if possible, by the deliberate creation of resistance in animal strains; the recent demonstration of the mosquito transmission of *Plasmodium berghei* might well be a start to work of this sort. Studies should extend as quickly as possible to the dynamics of resistance and methods of prevention of selection based on principles similar to those quoted above.

The chief knowledge required in connection with the duration of infection, whether with or without treatment, is information on the frequency, period and infectivity of long-established cases. This is difficult to organise but can be encouraged in connection with field epidemiological work.

The human element makes the detection of parasitaemia less likely as it becomes rarer; fatigue and carelessness increase with the constant examination of large numbers of negative slides. Improvement in staining and examination techniques might lessen the consequent risk. It has been suggested that mechanical screens should be employed, though I am not very hopeful of wide and effective application, for administrative reasons, even should suitable apparatus become available. There is, however, room for advancement in staining techniques which would make the visual recognition of parasites more probable. I have in mind the fluorescent techniques which make parasites startlingly easy to see, though not necessarily easy to identify by species. But there may well be other techniques for improving methods of examination.

There is strong evidence of the occurrence of a number of genetically distinct strains of anopheline species. It is believed, but not substantiated, that a non-house-haunting, non-man-biting strain of *Anopheles gambiae* has emerged in a part of Africa. This could have a very considerable bearing on the prospect of eradication. Other variations may have a less beneficial effect. They can only be identified and studied in laboratories where mosquitoes are freely colonized and genetic studies are thus possible. Encouragement of the development of these genetic studies would be a considerable insurance of the future of eradication. It would have a continuing value as an academic study, apart from eradication, because it is amply demonstrated that *Drosophila* cannot be relied upon exclusively for basic formal genetic work, and the mosquitoes have been shown as promising material.

The Report of the Scientific Group on Malaria Research, held in Geneva in November 1959, lists many research subjects. All of them are of some interest, but I would apply strictly the criterion of relationship to eradication in evaluating their relative importance.

SCHISTOSOMIASIS

Research Needs in the Field of Schistosomiasis—Submitted 3 March 1961 by **Dr. N. Ansari,** Chief Medical Officer, Endemo-epidemic Diseases, Division of Communicable Diseases, World Health Organization, Geneva, Switzerland.

Although improvements in sanitation and health education will no doubt aid materially in solving the schistosomiasis problem until such improvements can be realized and made permanent, other measures will need to be strengthened and new methods devised. The major objectives of research in schistosomiasis should be to deal with the problems which are directly related to interrupting transmission of the disease. Two approaches may be taken towards restricting the disease: (1) control of the molluscan intermediate host; and (2) chemotherapy.

Of the known methods of control, the elimination of the molluscan intermediate hosts gives the quickest and most effective results. These methods are of two general types: (1) habitat reduction and control; and (2) the application of molluscicides. The selection of one of these or a combination of them requires a thorough understanding of the ecological and epidemiological conditions in each area. In most foci this type of information is not available.

It has been shown in one low-lying endemic area with a heavy annual rainfall that a combination of engineering and improved agricultural methods can be used to eliminate many snail colonies and reduce the average snail population by more than 95 per cent. At the same time agricultural productivity was greatly increased.

In arid and semi-arid regions the conservation of water or its introduction into the areas is essential for the development of their economic potential. In nearly all endemic areas, the construction of storage and distribution systems, the irrigation techniques, and the agricultural methods used have caused the spread of the intermediate and definitive hosts, and marked increases in the prevalence and intensity of schistosomiasis. In a few places improved engineering, irrigation, and agricultural methods apparently have reduced this trend and the final phase of schistosomiasis control with molluscicides is practical. It is essential that this approach be investigated further and that the methods used be adapted to other areas.

In recent years, thanks to some governmental agencies who have sponsored programs, several thousand chemicals have been screened and a number of effective compounds have been found. However, wide variations in the success and failure of attempts at snail control with present molluscicides are being observed. Some of the failures are due to improper or faulty methods of application and, in other cases, to insufficient knowledge regarding the ecology of the snail host or the behaviour of chemicals under different ecological conditions.

A wider range of chemicals is required to meet the diversity of ecological conditions where the intermediate snail host is found. The importance of having several effective molluscicides is clear when one considers the possibility of acquired resistance, as evidenced in attempts to control other organisms.

Encouraging physico-chemical studies of the influence of environmental factors on molluscicides, stimulating industry in the screening of new compounds, and devising more effective and economic methods of applying the present molluscicides, could correct or improve schistosomiasis control.

Schistosomiasis control could be successfully achieved by snail control but, because of the long life span of the parasite, permanent control could only be obtained when elimination of snails could be combined with mass treatment or mass chemoprophylaxis.

Although it is known that many thousands of compounds have been tested in animals, particularly for their therapeutic effect against *S. mansoni* in mice, the results of only a small part of these have been published. Hence, it is not possible at this time adequately to review, even in broad outline, all that is known regarding structure-activity relationships among schistosomicides. A survey of the available literature indicates that activity is restricted to surprisingly few groups of chemicals. There is still need for more active and less toxic drugs.

Although the "empirical approach" in chemotherapy has given important results, the "rational approach" based on physiological research has still greater expectations.

In contrast to bacteria, relatively little is known about the metabolism of parasitic helminths. Investigations of the biochemical characteristics of these organisms should reveal metabolic reactions essential for the survival of the worms and such studies would throw light: (1) on the physiology of helminth parasitism and host resistance; (2) on the effect of infection on malnutrition by competition with the host for food; and (3) inversely, on the effect of malnutrition on the subsequent course of infection, which depends on antibody production.

Ancillary to these studies, it would be possible to isolate and identify the metabolic product of parasites and to provide means of stimulating the defense mechanism of the host against infection by active immunization and more accurately to direct search for potential antihelminthic agents.

Nutritional studies of schistosomes might have some immediate practical importance. For example, the production of eggs may have special bio-synthetic requirements and this particular function may be more susceptible to inhibition than mere survival of worms. The practical results of such a discovery would be to reduce to a minimum the pathological lesions which are due mainly to the schistosome eggs and to reduce the risk of transmission.

Axenic culture of the schistosome and of the tissues of its intermediate snail host seems to be the main trend which would lead to better understanding of parasitism and the factors governing the physiological relation of parasite versus host.

Although considerable progress has already been made in the development of procedures for screening schistosomicidal drugs in the laboratory, it is felt that the approaches made so far have not been sufficiently all-embracing.

These short-comings are, at least in part, due to a lack of multi-disciplinary approach to investigations of schistosomiasis. For example, nothing is known about: (1) the metabolic differences between the immature and mature forms of schistosomes; (2) the biochemical basis of egg production; (3) the mechanisms underlying the differences in the distribution and metabolism of drugs and other chemical agents between man and experimental animals; and (4) the biochemical and physiopathological effects of schistosomiasis on the host. It is felt that information about problems of this nature, as well as on the use of a schistosome species naturally adapted to its host and on the development of a suitable experimental primate would be of considerable value towards supplying further leads for the development of clinically useful anti-schistosomal agents.

There is a great need for more investigation of the biochemical and physiological aspects of schistosomiasis. It is strongly recommended that existing facilities and manpower resources be coordinated to stimulate research and training on these aspects. For instance, scientists conducting research on biochemistry, cellular physiology, nutrition, and immunochemistry should be apprised of the scientific and medical significance of problems in their own field of activity as applied to schistosomiasis. If such scientists were interested in the field of schistosomiasis, a qualified parasitologist should be made available to them for active participation in the research project. This association would be mutually advantageous.

It is recommended that industry be informed that, apart from the discovery of curative drugs, great importance is attached to the development of a well-tolerated drug which effectively suppresses egg production or which has a long-lasting prophylactive activity. This would be of value in interrupting transmission in areas where animal host reservoirs are of little significance, and also in reducing host morbidity.

For a period of fifty years many kinds of antigens and different tests have been used in the diagnosis of schistosomiasis. Within recent years increasing use of immunological methods has been made in epidemiological studies. The relative simplicity and specificity of these techniques, as compared with stool and urine examination, warrants their exploitation in studies of prevalence and incidence in a population, evaluation of worm burden, evaluation of chemotherapeutic cure, and evaluation of control measures. To realise the full benefit of sero-immunological methods, it will be necessary to make studies on the biochemistry of antigens, their quantitation, to standardize methods for using them and interpreting the results, and to prepare a reference antigen for evaluation of techniques.

Research Problems on Schistosomiasis—Submitted 3 February 1961 by **Dr. Frederico Simões Barbosa,** Chief, Department of Schistosomiasis, Instituto de Higiene do Nordeste, Universidade do Recife, Recife, Pernambuco, Brazil.

The following suggestions are limited to schistosomiasis mansoni and are concerned specially with Brazilian problems. Another limitation which I cannot avoid is that I have mentioned only those research problems which can be carried out in Brazil.

1. *Distribution of the snail vectors in the endemic areas.* Although the Brazilian snails are well known under the taxonomic point of view, we do not know well the distribution of the three recognized species vectors of *S. mansoni* in this country. An accurate and extensive survey in this direction would be very important.

2. *Potential vectors.* Since it has been demonstrated that potential vectors of *S. mansoni* exist out of the endemic areas, it would be important to complete these studies in order to verify the possibility of the introduction of the disease in other regions.

3. *Differences in susceptibilities to S. mansoni of the snail vectors.* It is well known that the vectors of *S. mansoni* in Northeastern Brazil, *A. glabratus* and *T. centimetralis*, exhibit different susceptibility in regard to their capacity to take the infection, shedding of cercariae and life-span while infected. It has also been demonstrated that these differences can be intra-specific. Thus, it is an urgent need to find out the distribution of the snail vectors according to their susceptibility to the infection.

4. *Epidemiology.* a) Conditions governing the transmission of schistosomiasis are not well known. b) Field work is very necessary to clarify some aspects of the epidemiology of schistosomiasis especially those connected with evolution and the severity of the disease. c) The role the animals (rodents and opossums) may play in maintenance of the life-cycle of *S. mansoni* is still ignored.

5. *Experimental pathology. Immunity.* Notwithstanding the numerous papers recently published on experimental pathology of schistosomiasis many problems need solution. Among them are the questions of the repeated re-infections and the evolution of the disease.

Some aspects of the resistance to re-infection are not completely understood.

Immunochemic studies concerning the fractioning of the active antigenic substances are needed.

6. *Methods of laboratory diagnosis.* Standardization of the procedures usually utilized for diagnosis of the infection is necessary as well as the development of new techniques.

7. *Ecology.* Although sound knowledge has been gained in these last years on the auto-ecology of the snail vectors of *S. mansoni* not much is known about the ecology of the fresh water snail environments of the endemic areas.

If control of schistosomiasis is possible by measures directed against the vectors, much more basic information about snail biology is required. A broad ecological approach and long term studies on the structure of the fresh water communities and the dynamics of the snail vector populations is required for a better understanding of control measures to be taken against the intermediate hosts.

8. *Control of the disease.* Pilot areas for observation of the main control measures against the disease could be established. Sanitation, health education, therapeutics and molluscicides should be used in those areas alone or under certain scheduled combinations in order that our knowledge on the control of the disease may progress.

The use of molluscicides is the only efficient isolated method of control of schistosomiasis. Thus, all research in this direction should be highly recommended and stimulated. Development of new chemical substances, methods of application, new formulations, residual effects, etc., covering both laboratory and field tests are very desirable.

Suggestions for Research in the Field of Bilharziasis—Submitted 28 February 1961 by **Dr. J. Gillet**, Director, Institut Supérieur d'Hygiène, Université Catholique de Louvain, Belgium.

The molluscan intermediate hosts.

1. *Ecological studies.*

   Complete if possible the data which are known to date in this field: average depth of the several snail species, pH of the medium, oxygen tension, mineral content, influence of pollution on the environment. Research on the microclimate is very desirable. Likewise, the nature of the soil following hibernation: sandy, clay.

2. *Physiological studies.*

   Mobility of snails (radius of activity).

   Normal physiology and physiological disturbances under the influence of parasitism and molluscicides.

   Fertility of snails during the various seasons.

   Continue studies on the physiology of hibernation and study reasons why certain species or varieties tolerate hibernation better than other identical or closely related species or varieties.

   Reconstruction of the cycle *in vitro*: for this, (1) attempts at culture of snail tissues and especially the hepatopancreas and (2) maintenance of the parasite developing through its cycle *in vitro* in these tissues.

3. *Biological control of snails.*

   Complete research on molluscophagic fish and other molluscophagic animals (crabs, etc.), bacteria and molluscicidal agents. It would be interesting to continue studies in this area to determine the extent of biological control in a limited or closed environment, on the one hand, and in a much larger environment, on the other.

   In the same train of thought, if a worker were lucky enough to determine that an important snail site was gradually disappearing, it would be interesting to follow the density of population until the site had disappeared. During such an observation, it would be necessary to look for ecological modifications or the contingent presence of a biological factor explaining the reduction, or disappearance, of the snails.

4. *Chemical control of snails.*

   Continue to study the interesting molluscicides, first in the laboratory, then in the field. It is understood that such a molluscicide ought to possess, or nearly, these ideal qualities: ability to destroy snails at concentrations of the order of a millionth (ppm), to destroy eggs at these same, or closely similar, concentrations, if possible to destroy cercariae, if possible to have no ill effect or to be very slightly toxic for the fauna (notably fish) and the flora, to be non-toxic for warm-blooded animals, to be easy to use and not dangerous to the users, to be cheap and easily obtained. Research on a selective molluscicide is most desirable.

   With reference to products which are already known for their molluscicidal properties or which have been tested in the laboratory, it is necessary to study the most economical and best method of application, taking into account (1) the chemical character of the water, (2) the species of snail in question, (3) the configuration of the location to be controlled, (4) the plan of the irrigation network. There is a need to study the most economical and still efficacious method of application while taking into account local circumstances (continuous or discontinuous application, application in a single spot or simultaneously in several places, chemical barriers, etc.). Such a field study requires (1) specialized personnel and equipment which will permit precise and regular chemical applications or biological controls, (2) personnel able to control the effect of the product on the fauna, flora, and snails. The collection of snails, or at least their study, requires use of a method which must be determined upon and eventually perfected: collection by net, trap, or hand.

Epidemiological research.

1. *Animal reservoirs.*

   Continue to study the possibility of a reservoir of infection for human bilharziasis of Africa and America. These studies are particularly desirable in foci where the prevalence (global frequency) of bilharzia is important and exceeds 50 per cent. These studies would be principally on mammals with aquatic habits.

2. *Studies on species of schistosomes which are morphologically closely related if not identical but which have different definitive hosts.*

Ex.: *S. matthei* developing in bovines and *S. intercalatum* in man. Typical *S. japonicum* developing in man and various animals whereas *S. japonicum* var. *formosa* cannot adapt to man.

3. *Collaboration of physician and engineer.*

   Insist without further ado on the necessity and usefulness of such a collaboration; if possible, present in evidence the fortunate results of such collaboration.

Studies on the influence of the parasite on its definitive host, man.

1. *Bilharziasis and work capacity.*

   This sort of study is made difficult among backward peoples by the numerous parasites affecting them, as well as malnutrition, etc.

2. *Bilharziasis and psychological disturbances.*

3. *Research on immunity.*

4. *Bilharziasis and alimentary regime.*

   In man and animals.

5. *Bilharziasis a serious disease or not.*

   Study of this problem in African regions where, to date, human bilharziasis has been considered by health authorities as a problem of secondary importance among *current* epidemiological conditions.

   (From personal experience, I persist in believing that bilharziasis constitutes a potential danger under the epidemiological conditions ordinarily found in African villages in which the inhabitants continue to live according to their customs.)

Research on treatment and prophylaxis in man.

1. *Research on new products using parasitized mice.*

   These studies should be based on the physiological needs of the adult parasite.

2. *Health education of the population.*

   Studies on methods of health education adapted to the psychology of the population at risk. It is well understood that health education of a population is only efficacious if there does not exist any important reservoir of infection among the animals. (translation)

Research Problems on Schistosomiasis—Excerpts from a letter dated 7 March 1961 from **Dr. Y. Komiya,** Chief, Department of Parasitology, National Institute of Health, Tokyo, Japan.

The chief items of the research work in my laboratory are now studies on the ecology of *Oncomelania*, the vector snails of *S. japonicum*, on the molluscicidal effect of various compounds against these snails and on the resistance of these snails against molluscicidal compounds. For the prevention of schistosomiasis one of the shortest ways is, as you well know, the control or eradication of its vector snails, and from the point of view the main effort of our laboratory is directed to the control of the snails.

One of the important problems, however, should be the development of effective compounds for the therapy of schistosomiasis japonicum, because *Schistosoma japonicum* is more resistant to any compound than the other *Schistosoma* and we have yet no highly effective compounds against this worm.

Important Needs to Control Schistosomiasis—Excerpts from a letter dated 13 March 1961 from **Dr. Hans Vogel,** Tropeninstitut, Hamburg, Federal Republic of Germany.

1. Development of a drug that is more active and less toxic than those hitherto in use.
2. Development of a drug that acts on the young post-invasion stages of schistosomes.
3. Development of new molluscicides, preferably compounds which possess residual activity.
4. A research problem worth investigating is resistance of man against superinfection. Are infected persons actually protected more or less against subsequent infections? If such a resistance exists in humans, what is its nature?
5. The pathogenesis of hepato-splenic bilharziasis is another problem which needs further investigation.

AMOEBIASIS

Research Problems on Amoebiasis—Excerpts from a letter dated 6 February 1961 from **Dr. R. Elsdon-Dew,** Director, Amoebiasis Research Unit, Institute for Parasitology, Durban, Republic of South Africa.

The distribution of the parasite—*E. histolytica* and of authenticated pathology due to it, by no means coincide, for though the parasite is to be found from Finland to Tierra del Fuego, true disease is only important in some places in the tropics and sub-tropics.

However, and probably in no small part due to the *ex cathedra* statements of well-known and widely publicised experts, the tradition has become established that infection with the parasite and disease are synonymous. This has led to a vicious cycle in an attempt to link any symptom presented by a patient with the chance finding of the parasite. Thus a protean pathology has been attributed to the parasite. The ameba has been blamed for practically every possible clinical syndrome except pregnancy. Further this amebophilia amongst physicians has led to an amebophobia in the public with unfortunate repercussions.

Further, the standard of laboratory diagnosis in many parts of the world leaves much to be desired. In fact, and I quote: "The enthusiasm of the uninitiated is only to be matched by the caution of the expert". This mis-diagnosis has been further accented by the recent establishment of *E. hartmanni* as a species. One hesitates to think just how many thousands of patients have been subjected to violent therapy because of the findings of a quadrinucleate cyst of uncertain ancestry.

The whole position was outlined very sharply at an Informal Session on Amoebiasis held during the last International Congress on Tropical Medicine and Malaria.

Whilst not decrying the value of "academic" study, it is my feeling that a lot of energy is being dissipated. The true problem of amebiasis does not lie only with the parasite, which most thinkers would now regard as normally a commensal, but with the host-parasite relationship, a relationship complicated by the activities of the bowel flora and fauna. The disease amebiasis (*sensu stricto*) is an abnormal state, not only for the host, but also for the parasite. It must be recalled that tissue invasion is racial suicide for the ameba.

Without being too specific about the research approach, I would suggest that more weight be attached to the host-parasite relationship, to determine what factors induce invasiveness in the ameba, and whether these factors can, in any way be modified to ensure that any ameba living in the human gut retains his commensal status.

There are not many places where adequate work on this aspect of the disease can be done, for as I have outlined above, though the manifestations attributed to the parasite are protean and widely distributed, the true position of the ameba in this context is clouded by many misconceptions. The assessment of the importance of the ameba in any area cannot be based on the case incidence—for it is usually a commensal, or on the occurrence of dysentery—for it can be a chance finding in many diarrhoeic conditions, and certainly not on popular clinical opinion. Possibly the best criterion is the incidence of liver abscess (or a better term, focal amebic liver necrosis) in the population. Certain areas immediately spring to mind—Dakar, Brazzaville, Durban, Thailand, Southeast Asia, Indonesia and Korea. There are probably others, which I hoped would be revealed by the W.H.O. questionnaire.

As to the approaches to be made. Basically these should be aimed at the trigger which initiates invasion by the ameba. This may be dietetic in origin, as suggested by the epidemiology in Durban; it may be that some other labile organism may set off the invasion as suggested by such explosive outbreaks as occurred in South Bend; it may be a sensitisation phenomenon—as suggested by the work of Maegraith; it may be a manifestation of some types of bowel flora—as suggested by the immediate efficacy of an antibacterial approach; it may be that in areas of poor hygiene the rapid transfer of amebae from host to host enhances its virulence—in fact there are a host of maybe's. Fundamentally, however, the first-line attack should be on the host-parasite relationship and based on clinico-laboratory studies. These two aspects should not be separated, for study of an *in vitro* ameba alone is as valueless as a clinical opinion without a laboratory backing.

Research Problems on Amoebiasis—Excerpts from a letter dated 24 February 1961 from **Dr. Henry E. Meleney,** Interim Professor of Medicine, University of Florida, Gainesville, Florida.

I can do no better than to refer you to my paper, "Some Unsolved Problems in Amebiasis," Am. J. Trop. Med. and Hyg., 1957, *6*:487-498. The problems discussed in that paper, none of which have yet been solved, are as follows:

I. Biological Problems

A. The identification of the factor provided by living bacteria which stimulates nuclear division and multiplication of the amoebae.

B. The identification of the lytic toxin of the amoeba.

C. The reason why some strains of large-race *E. histolytica* invade the wall of the colon while others apparently do not.

D. Explanation of clinical differences in South Africa.

E. Can so-called "avirulent" strains become "virulent" by changing bacterial flora? Extension of observations of Westphal (1937)?

II. Diagnostic Problems

A. Development of a test such as the fluorescent antibody test into a practical laboratory test for rapid and accurate identification of *E. histolytica.*

B. Development of a more sensitive but highly specific serological test for diagnosis of *E. histolytica* infections, such as the hemagglutination test. (Kessel, J.F.: J. Parasit. *46*: no. 5. Sect. 2. 19, abstract).

III. Epidemiological Problems

A. Research on methods of prevention of spread of amebiasis in mental institutions, including personal sanitation of patients, sterilization of toilet equipment and inexpensive chemoprophylaxis.

In addition to the above problems I suggest the following studies:

1. Can small race *E. histolytica* become large by repeated passages in highly susceptible animals such as kittens, or by change of bacterial associates *in vivo* or *in vitro?* Extension of observation by Meleney and Zuckerman (Am. J. Hyg., 1948, *47*:187-188).

2. The epidemiology of small race amebiasis in Chicago. A fairly high prevalence has been reported repeatedly since the water-borne epidemic of 1933. This should be authenticated by a study group from the CDC on invitation from the Chicago City Health Department. If a prevalence higher than in comparable communities is found, I suggest that the city water supply be studied to determine whether cysts can resist the present method of "purification." If chlorination alone is employed, as was true a few years ago, this may be the factor responsible for the high prevalence. This may have implications for the general problem of the small race of *E. histolytica.*

KWASHIORKOR AND OTHER NUTRITIONAL DISORDERS

Research Problems on Kwashiorkor and Other Nutritional Disorders—Excerpts from a letter dated 20 March 1961 from **Dr. J. F. Brock,** Professor and Head, Department of Medicine, University of Cape Town, Cape Town, Republic of South Africa.

I am very pleased to accept your invitation to discuss "the most important research problems in connection with kwashiorkor and other nutritional disorders" against the background of "the planning of international health programmes and research needed for the control of disease in tropical areas." I am indeed happy to see this broad approach to the subject of tropical medicine and hygiene since the diseases of the tropics are often as directly related to malnutrition as to parasites or tropical climate.

On the organization of research in this field, I think the greatest need is for interchange of personnel. In developed areas such as the United States there are abundant resources of personnel and laboratory equipment but very little awareness of the extent and nature of nutrition problems in the field. In the underdeveloped areas the problems are all around but equipment and personnel are deficient. In certain institutions, notably in Central America, India and Africa, fine laboratory facilities have been provided in proximity to the problems in the field but it is still difficult to obtain adequate personnel. I would suggest that interchange holds great promise. There is some interchange on a short term basis which has been most valuable but there could with advantage be much more, particularly for interchange of method and ideas with the younger or more specialized research workers who are not heads of departments or project directors. The most important need is for scientists from well developed laboratories such as you have in the United States to be seconded for a minimum period of two years to work in a laboratory such as my own. The conditions of secondment should be such that the individual knows that he will be going back after two years or more to the sort of appointment in which he wants to make his permanent career. He will then go back with a clear and urgent sense of the need arising from the problems in the field.

On programmes for research in nutrition in the tropics, I think all will agree that protein malnutrition is the burning problem provided it is recognized that the term "protein malnutrition" is not synonymous with amino acid deficiency but that it means relative shortage of "protein-rich foods" which contain important vitamins and minerals in addition to amino acids. The subject was so fully covered by the symposium arranged by your Academy in Washington in August 1960 that it is not necessary for me to go into detail.

The field of activity chosen by Dr. Hansen and myself and supported by the United States Public Health Service was stated as follows:

(1) The minimal requirement of protein (amino acids) in the pre-school child (the most common age incidence of kwashiorkor is 1-4 years).

(2) To what extent and in what way should low protein diets be enriched by natural or synthetic nutrients.

(3) The relationship of protein malnutrition to the high morbidity and mortality rates from infections.

(4) The effect of protein malnutrition on body composition and function with special reference to protein, lipid and electrolyte metabolism.

Other fields which spring to mind at once are those of the tropical anaemias and the tropical factors which underlie problems of malabsorption and steatorrhoea. Members of the staff of this Medical School are individually interested in these problems but no concerted programme of action is under way.

*Research Needs in Nutritional Diseases in the Tropics**—Submitted at the suggestion of **Dr. Nevin S. Scrimshaw,** formerly Director, Instituto de Nutrición de Centro América y Panamá, Guatemala, C.A. Presently Head of the Department of Nutrition, Food Science and Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts.

1. *Title:* Prevalence of nutritional disease.

Objectives: a. Development of simplified methods of determining the prevalence of nutritional disease in large population groups.

b. Application of simplified methods to surveys within areas in which serious malnutrition is occurring.

Areas: All technically underdeveloped areas.

2. *Title:* Epidemiological study of kwashiorkor.

Objective: To study the factors that converge on the individual child to produce kwashiorkor.

Areas: Africa, Mexico, Central and South America, and Southeast Asia.

3. *Title:* Follow-up studies of kwashiorkor and marasmus.

Objective: To determine whether treatment of various kinds completely eradicates all signs of kwashiorkor, or whether there are permanent sequelae.

Areas: Africa, Mexico, Central and South America, and Southeast Asia.

4. *Title:* Characteristics and treatment of marasmus.

Objectives: a. To determine the metabolic characteristics of marasmus and compare them with those of kwashiorkor.

b. To determine the optimum dietary treatment of the marasmic state, including the desirability of using adjuncts such as vitamins or hormones.

Areas: In Latin America, Africa, India, and the Middle and Far East where marasmus cases are common.

5. *Title:* Use of outpatient treatment for malnourished infants and young children.

Objectives: To discover: a. whether many children who have kwashiorkor can be satisfactorily treated as outpatients, with a view to reducing the need for hospital admission; b. how outpatient centers can best be used for the rehabilitation of children after treatment, and for the education of their mothers in nutritional matters.

6. *Title:* Study of the intracellular changes in kwashiorkor.

Objective: To determine the nature and extent of cellular changes in kwashiorkor.

Areas: Caribbean, Mexico, Central America, India, Uganda, Great Britain, and Carlsberg (Denmark).

7. *Title:* Prevalence and type of anemia.

Objective: To determine the prevalence of anemia and the relative frequency of different types of anemia.

Areas: In regions where wide prevalence of anemia is suspected.

8. *Title:* Methods of prevention of anemia.

Objective: To compare methods for the prevention of the iron deficiency type of anemia.

Areas: Southeast Asia, Latin America, and Africa.

9. *Title:* Magnitude of losses of iron from the body.

Objective: To determine the magnitude of the losses of iron from the body through various channels as contributory factors to the development of iron deficiency anemia.

Areas: Asia, Africa, and Latin America.

10. *Title:* Prevalence and epidemiology of hypovitaminosis A.

Objective: To determine the prevalence of xerophthalmia and keratomalacia and to study the epidemiological factors associated with their occurrence.

Areas: Indonesia, India, Philippines, and East and Central Africa.

11. *Title:* Laboratory studies on hypovitaminosis A in nursing infants.

Objective: To determine the significance of vitamin A and carotene levels in breast milk in relation to hypovitaminosis A in children.

Areas: Philippines, Indonesia, India, and Latin America.

12. *Title:* Effect of malnutrition on absorption and utilization of vitamin A and carotene.

Objective: To determine if nutritional deficiencies other than those of vitamin A influence adversely the absorption and metabolism of vitamin A and carotene.

Areas: In units already engaged in research in kwashiorkor and marasmus. Indonesia, India, East and West Africa, and Latin America.

13. *Title:* Diagnosis, epidemiology, and prevention of infantile beriberi.

Objectives: (a) Determine the level of depletion in the individual at which the danger of beriberi occurs, either in the mother or the infant.

(b) With this knowledge assess the magnitude of the problem in countries in which infantile beriberi is occurring.

(c) Devise sound public health measures for its prevention.

Area: Southeast Asia.

14. *Title:* Medical and public health significance of endemic goitre.

Objective: Determine the relationship between the prevalence of endemic goitre and the occurrence of cretinism, deaf mutism, feeblemindedness, thyrotoxicosis, thyroid carcinoma, and other conditions which have been historically associated with endemic goitre.

Areas: Wherever goitre is endemic to a high degree, i.e., Latin America, Africa, India, etc.

15. *Title:* Effect of intestinal parasites on nutritional status of children.

Objective: To determine the influence of *Ascaris*, hookworm, and mixed intestinal parasite infections on the metabolism of nitrogen, calcium and possibly iron, vitamin A and carotene, thiamine, riboflavin, and other nutrients in children.

Areas: Wherever severe intestinal parasitic infection in children exists, i.e., most tropical and subtropical regions.

16. *Title:* Interrelationship of nutrition and infection with special reference to diarrheal disease.

Objectives: (a) Determine the effect of nutritional improvement on the course and outcome of infections in young children.

(b) Observe the relationship between acute infectious episodes and the development of marasmus, kwashiorkor, and other forms of clinically apparent malnutrition.

(c) Observe the effects of recurrent infection and of dietary improvement on growth and development.

Areas: Wherever high mortality in the 1 to 4-year age group and kwashiorkor are prevalent, i.e., parts of Central and South America, Africa, India, and the Middle and Far East.

17. *Title:* Causes of medically uncertified deaths in children.

Objective: Determine the relative proportion of deaths in which the terminal episode involved kwashiorkor, marasmus, or other form of acute malnutrition and those associated with acute infectious diarrhea or with other types of infections.

*Proceedings of the Fourth Conference on Research Needs in Tropical Medicine, New Orleans, April 29-30, 1960, pp. 109-123.

Areas: Countries where child mortality represents 50 per cent and more of total mortality.

18. *Title:* Relationship of serum cholesterol to severity of aortic and coronary atherosclerosis.

Objective: To determine the relationship between the great variations among populations in serum cholesterol and the severity of the anatomical lesions of atherosclerosis.

Areas: Wherever there is an interested pathologist with access to a sufficient number of medico-legal autopsies annually.

19. *Title:* Relationship of serum cholesterol levels to dietary habits.

Objective: To determine the dietary factors influencing serum cholesterol levels.

Areas: All areas, but priority should be given to studying populations that have the greatest possible variety in protein, fat, and other nutrient intake.

20. *Title:* Measurements of patterns of growth in underdeveloped areas.

Objective: To make base line studies in underdeveloped areas for obtaining data on rates of growth in children in relation to differences in dietary habits.

Areas: In areas where reliable information on growth patterns is not available at present.

21. *Title:* The effect of acute malnutrition on future growth and development.

Objective: To discover the immediate and later effects of a period of acute malnutrition on the growth and development of pre-school children.

Areas: Latin America, South and East Asia, and Africa.

22. *Title:* Effect of supplementary feeding of the lactating mother on lactation performance.

Objective: To determine whether the giving of protein supplements to the lactating mother significantly increases the total quantity of protein available to the child receiving breast milk.

Areas: Those technically underdeveloped areas in which breast-feeding is vital for survival of the child.

23. *Title:* Use of dried skim milk for supplementary feeding of mothers and children.

Objective: To ascertain the value of practicable schemes for the distribution of dried skim milk in underdeveloped countries.

Areas: Africa, Latin America, and the Middle, Near, and Far East.

24. *Title:* Feeding of school children.

Objective: To determine the value of supplementary feeding of school children in underdeveloped countries.

Areas: Wherever school feeding schemes are planned or are in operation.

25. *Title:* Minimum protein requirements in adults and children consuming diets based on cereals and legumes.

Objective: To determine the minimum protein requirements where a large proportion of the dietary protein is derived from vegetable sources.

Areas: Southeast Asia, Africa, and Latin America.

26. *Title:* Protein requirements in lactation.

Objective: To determine the requirements of dietary protein in relation to breast milk output.

Areas: Latin America, and South and East Africa.

27. *Title:* Nitrogen balance and protein reserves.

Objectives: (a) To determine the significance of changes in N balance when they are not accompanied by changes in body weight.

(b) To throw light on the problem of so-called protein reserves, their nature and significance.

Areas: Anywhere where suitable facilities exist.

28. *Title:* Development of new protein rich foods.

Objective: Develop new low cost protein rich foods which will be useful in the prevention of protein malnutrition.

Areas: Africa, Mexico, Central and South America, and Southeast Asia.

29. *Title:* Introduction of new foods into the diets of young children in underdeveloped countries.

Objective: To discover how prejudice against the introduction of new foods can be overcome, the best accepted forms for the foods, and the most suitable means for distribution.

Areas: Wherever a suitable food has been developed and is ready for distribution.

CHOLERA

Suggested Studies on Cholera—Submitted 21 February 1962 by **Dr. A. H. Abou-Gareeb,** Department of Epidemiology, High Institute of Public Health, Alexandria, Egypt.

1. In continuation of a previous study,[1] the seasonal endemicity of cholera may be studied statistically, taking smaller administrative units and shorter time units. The practical outcome of this approach is that it makes possible comparisons between the different seasonal components involved in the various factors suspected of playing a part in cholera endemicity—relative and absolute humidity, rainfall, temperature, etc. It will also be helpful in selecting the most suitable times for carrying out or intensifying control measures. It is felt that this method might be applied to the other states of India, and to Pakistan, Burma and Nepal, where cholera is endemic in certain regions.

It is important also to survey all the cholera endemic centers in other suspected parts and unforeseen regions of the world. Dormant foci or centers of temporary endemicity have to be identified and well defined. Again, once cholera appears in a new locality, international teams have to be sent immediately for investigation, with particular emphasis on the source of infection.

2. To find out the smallest units of endemic cholera in an urban community, a study was undertaken in Calcutta city.[2] Similar studies may be attempted using the most recent statistical information. During the inter-epidemic and pre-epidemic periods, these presumptive endemic centers have to be carefully investigated through case finding programs.

3. Recent experience of the present writer (unpublished report) provides evidence that the agglutination reaction applied to sera of healthy individuals may be utilized with success in epidemiological investigations undertaken on biological grounds. The results obtained through careful serological surveys may be compared with those obtained through statistical analysis of the available data.

4. Various cholera-like vibrios have been isolated under a variety of circumstances. Some workers believe that some of these vibrios undergo transmutation to true cholera vibrios and cause cholera epidemics and may be partly responsible for maintenance of the endemic state in certain regions. This line of thought may be finally proved or disproved through the help of human volunteers, by repeated passage of some of these strains in their gut. The writer is under the impression that these human volunteers can be offered from the regions concerned where cholera is a standing endemiological problem.

5. In certain parts where cholera is endemic, water tanks are used for disposal of excreta. The existence of tanks with latrine connections does not seem to be of rare occurrence, as a previous study among shanty dwellings in ward 18 of Calcutta city has shown that 17.9 per cent of latrines were in direct or indirect connection with the adjacent ponds.[3] These tanks are also used as

a source of water supply. *V. cholerae* has been isolated once from a tank with a latrine connection.[4] This observation led the author to suggest, as a working hypothesis, that this tank was contaminated through the excreta coming from the connected latrine which was under heavy use. A large number of similar tanks with latrine connections should be widely investigated during the various seasons of the year, using tanks with no latrine connections as adequate controls. A thorough search for the *Vibrio cholerae* excreters should be included in such a study. A study of this nature may be of interest particularly during the inter-epidemic periods when the clinical cases of cholera are minimal or negligible, and what type of *V. cholerae* excreters are responsible for contaminating these waters, if any.

6. To find out the role that might be played by healthy carriers in maintenance of endemic cholera, more specific media than those in routine use now have to be tried. The sampled persons should be drawn from localities with high cholera endemicity. It should be considered that although the carrier state is a transient one among certain individuals, yet it is not necessarily so among groups of individuals who might be grouped in families or, for example, "bustee" dwellers living together in a communal manner. Certain groups of people have to be considered with special interest as regards the possibility of a suspected occupational hazard for cholera. An example may be given among the following occupations: coolies, fishermen, boatmen and dwellers of houseboats, and ricksha pullers.

7. There is but little doubt that improvements in sanitation will lead to a betterment in the cholera situation in regions where cholera is a major health problem. However, an appreciable improvement in the sanitary conditions in the regions with endemic cholera seems to be far beyond the reach of their national economies. Therefore, it may be necessary to estimate the minimum acceptable level of sanitary conditions that would help a community to live with no cholera problem. Estimation of the required level of sanitation may be done in the field on groups of localities with similar cholera situations. The tested localities will have a gradation of better sanitary environment and the minimum desirable level may be estimated and used as a standard for generalization.

8. The values of the available cholera vaccines have to be reexamined in the field in well controlled experiments.

9. The cholera research studies have to be coordinated among the various countries concerned under the leadership of the interested international organizations. Similarly, the cholera eradication campaigns may be carried out on an international level.

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4. ——— (1962). The detection of cholera vibrios in Calcutta waters: the tanks and dhobas. (Document under publication.)

Research Problems on Cholera—Excerpts from a letter dated 14 February 1961 from **Dr. Joseph E. Smadel,** Chief, Laboratory of Virology and Rickettsiology, Division of Biologics Standards, National Institutes of Health, Bethesda, Maryland.

A thorough examination of the needs in cholera has been considered on a number of occasions during the past two years by the NIH Cholera Advisory Committee. Moreover, this matter was again discussed at the recent Conference on Cholera held in Dacca, East Pakistan, in December. A fairly good summary of the status of cholera and of the research needs on this disease was given at the last session of the Dacca conference.

A somewhat more concise statement of the most important research needs in cholera is given below:

1. Role of carriers and persons with *V. cholerae* diarrhea, but without cholera gravis, in the spread of disease in epidemics in different global areas and in its maintenance in the endemic area of Bengal
2. Illumination of the basic physiological-biochemical lesion which results in profuse diarrhea in cholera (and other infections)
3. Development of a generally acceptable animal model of cholera gravis
4. Determination of which antibody, if any, in convalescent cholera cases is associated with resistance to disease
5. Reinvestigation of cholera vaccines with points 3 and 4 in mind and including the undertaking of a carefully planned vaccine field trial which might, for the first time, provide conclusive scientific data on the efficacy of the preparation under investigation
6. Extension and simplification of present procedures for correcting fluid and electrolyte imbalances in the acute cholera case, with the view to making these lifesaving measures available to cholera patients who cannot be hospitalized

*"Direction of the Wind"—SEATO Conference on Cholera**—Submitted at the suggestion of Dr. Joseph E. Smadel, National Institutes of Health, Bethesda, Maryland.

A Conference on Cholera, sponsored by the South-East Asia Treaty Organization and the National Institutes of Health, Public Health Service, as part of the SEATO Cholera Research Program, was held in Dacca, East Pakistan, December 5-8, 1960. The conference was attended by official representatives of all SEATO nations. Reports on all aspects of cholera—clinical, public health, and research—were presented and discussed by scientific delegates from the SEATO nations and Japan. Summaries of each session were prepared by the chairmen and rapporteurs and read at the final session, "Direction of the Wind." Dr. Joseph E. Smadel, chief, Laboratory of Virology and Rickettsiology, Division of Biologics Standards, and Jane Stafford, chief, Scientific Reports Branch, Office of Research Information, National Institutes of Health, have made it possible for *Public Health Reports* to publish an early account of the major developments. The complete proceedings of the conference will be published in the near future. Following are the summaries of each session essentially as given at the conference.

Clinical Manifestation and Management

Chairman: Dr. Luang Binbakya Bidyabhed (Pyn), Under Secretary of State, Ministry of Public Health, Bangkok, Thailand

Rapporteur: Dr. Theodore E. Woodward, University of Maryland, Baltimore

The comments of the essayists and discussers provided the assembly a thorough review of the classic manifestations of this violent diarrheal disorder and an authoritative account of the dramatic effect of properly implemented, enlightened corrective and control measures.

Modern cholera does not vary from the illness which ravaged Bengal and the world in the past century. Asymptomatic patients are undetected unless sought carefully, and a mild illness similar in many aspects to various types of gastroenteritis accounts for many cases. Historically, cholera as described vividly by Dr. A. K. M. Abdul Wahed, Pakistan, is characterized by an unrelenting purge leading to dehydration which knows no peer in clinical medicine. The published proceedings of this conference will provide an authoritative and readable description of cholera in its florid form.

*Reprinted from Public Health Reports, Vol. 76, No. 4, April 1961, pp. 323-334.

Cholera gravis is a medical emergency of catastrophic proportions. Ironically, the vibrio may cause human illness so subtle as to elude diagnosis and so rapid as to outdistance treatment. The physician who adopts a casual and inadequate attitude toward patients with acute cholera will assume the role of executioner. Delay can be tragic.

Fatalities, which conventionally run about 50 percent, were reduced during the Bangkok epidemic in 1958-59 to 8 percent. This achievement resulted from teamwork and the application of rational scientific principles. Physicians, nurses, students, public health workers, civil servants, and others joined to make it possible.

Each speaker emphasized the need for prompt detection of cholera with immediate attention directed toward restoring the patient's normal circulation and tissue lubrication. The time-honored methods used in Thailand in 1958-59 to bring the epidemic under control were applied with dispatch. Many played a significant role. It is not remarkable that patients soon appreciated the value of corrective treatment and voluntarily sought help through hospitalization. It was recalled that the first Thai patient with cholera became ill on May 23, 1958, came to the attention of health authorities on May 24, and the disease was confirmed bacteriologically by May 26.

With extreme dehydration, there are systemic manifestations as well as the prominent intestinal involvement. Circulatory collapse is common in all severe cases, and it is likely that all organs show changes which are either primary or secondary to circulatory abnormalities.

The physiologist has given the practitioner a practical, workable treatment guide. Copious quantities of water with added saline, glucose, and alkali are essential to rejuvenate the circulation, bathe the tissues, and correct the electrolyte imbalances. The physician cannot delay or be too cautious.

However, occasionally overzealous intravenous alimentation can lead to adverse circulatory sequelae, such as cardiac failure and pulmonary edema. Careful bedside observations of the skin, pulse, blood pressure, respiration, and general reaction aid in management. Simple laboratory aids, such as the determination of specific gravity of plasma or blood by the copper sulfate method, may be applied in most situations. Each speaker emphasized forcefully the rewards which accrue from prompt fluid replacement soon after onset in the home or while the patient is en route to the hospital.

Cholera patients react poorly to drugs such as opiates, atropine, antibiotics, and cardiac stimulants. These should be used only when unmistakably indicated, and then with care. The rationale for using adrenalin is unclear, and its routine use should be condemned.

Dehydrated patients are thirsty. Cholera patients are no exception, although vomiting interferes with administering fluids via the natural route. No effective means other than intravenous alimentation has allayed this sign. Perhaps an efficient antiemetic drug would serve a useful role and aid in treatment of those patients for whom intravenous fluids are unavailable.

Our nursing associates have made many valuable contributions including instituting progressive care by having patients contribute to their own care.

There is much to be done in the future in spite of the recent revelations which have more clearly defined the physiological abnormalities of the gastrointestinal tract and elucidated the key fluid and electrolyte changes. The whole patient must be studied as a dynamic unit by a clinically oriented team including physiologists, endocrinologists, and biochemists. The greater and lesser circulation from the heart to the capillaries must be appraised by direct and indirect methods. The blood, including leukocyte function, should receive concentrated attention. The liver, pancreas, kidney, and adrenal must be brought into sharp focus. The central nervous system and particularly the mysteries of its circulation in cholera are untouched. Isotope techniques can contribute to developing a clear view of blood supply and function of the intestine and other organs. It would be redundant to outline the various indicated studies required to provide the necessary information. Determination of the venous pressure as suggested by Dr. Graham Bull, United Kingdom, should be included.

Limited groups of well-chosen cases of cholera gravis should be studied on the ward of the Pakistan-SEATO Cholera Research Laboratory when personnel and facilities can be assembled. The groundwork established by the U.S. Naval Medical Research Unit No. 2 and Thai groups is of inestimable value and represents a firm reference point. Obviously, bacteriological and immunological determinations should be a facet of the total case analysis. Examination of all tissues obtained at postmortem is essential and should include differential staining procedures. Likewise, it may be possible to perform biochemical analysis of intestinal and hepatic tissue. Dr. Eugene J. Gangarosa's group at Walter Reed Army Institute of Research has provided much needed impetus.

Antibacterial drugs should be given a critical trial before they are scrapped from the cholera regimen. The study should be designed carefully, utilizing sufficient numbers of patients who receive antibacterial drugs and appropriate fluid and electrolyte replacement and a control group who receive only the replacement therapy. Whether the sulfonamides, antibiotics, or steroids are useful or necessary is unknown since there are no reliable controlled data.

All of this should make interesting hunting since mechanisms of the disease are unclear, and the fatality rate in patients with cholera gravis is too high.

Physiological Changes in Cholera

Chairman: Dr. Graham Bull, Queen's University, Belfast, Northern Ireland

Rapporteur: Dr. Robert S. Gordon, Jr., National Institutes of Health, Bethesda, Md.

This session was important for two reasons: first, two papers explained the genesis of the cholera stool, a most important advance; and second, a further series of papers provided information on which an improved therapeutic regimen can be based. In summarizing the session, we propose to consider the papers in three groups.

Pathogenesis

The papers of Dr. Robert S. Gordon, Jr., National Institutes of Health, and Dr. G. S. Huber, U.S. Navy, in conjunction with Gangarosa's paper at the session on pathology and pathogenesis, give for the first time a real understanding of the genesis of the cholera stool. The picture that emerges is as follows.

The intestinal mucosa, contrary to past belief, is histologically intact, and in confirmation of this, Gordon has shown that large molecular weight substances do not traverse it. This explains why the stool protein content is low. The fluid making up the stool is not an exudate. Why then does an apparently intact mucosa allow such a large loss of water and electrolytes?

Huber's convincing explanation is that there is a specific poisoning of the so-called sodium pump byproducts of the cholera vibrio. This requires an explanation.

Normally, the cells of the body are in a state of equilibrium with the extracellular fluid. This is not a static condition but one in which large volumes of water and quantities of electrolyte move rapidly across the cell membranes in both inward and outward directions. Despite the large flux of water and electrolytes, the ionic compositions of the cell fluid and the extracellular fluid are quite different. Sodium is present in much higher concentration in the extracellular fluid than in the cell, and potassium is in higher concentration in the cell than in the extracellular fluid. This is due to the fact that enzyme systems in the cell, which derive their energy from oxidative processes, selectively extrude sodium from the cell and retain potassium. This system is known as the sodium pump. In fact, it is a coupled double pump simultaneously moving sodium out of the cell and potassium into it. When there is a failure of the pump, sodium enters the cell and potassium leaves it. In the gut, this means that sodium enters the gut lumen by diffusing along a concentration gradient from the extracellular fluid and potassium also leaks along a gradient from the cell to the lumen.

We find this hypothesis of a poisoning of the sodium pump entirely convincing to explain the electrolyte losses in the stool, but there is one aspect of the genesis of the stools which we think requires further elucidation. Why is there such a large volume of water in the stools? We hear that the stool osmolarity, as measured by the Fisk osmometer, is some 40 or more milliosmols lower than the plasma, and furthermore, the oncotic pressure of the plasma is presumably some 30 mm. Hg higher than the stool because of the plasma proteins. These two pressures combined appear to be far greater than the available filtration pressure. Why then does water move from plasma to lumen? This is a matter which we think could be approached in a number of ways.

We think more detailed studies on the osmotic properties of cholera stools are required. In particular, we would think it worthwhile to search for oncotically active medium-to-large molecules in the stools. These could not be proteins, proteoses, or polypeptides because the stools contain little biuret-positive material, but we do know that there are considerable quantities of mucopolysaccharides present. It may be that a sufficient amount of these are in the form of small enough molecules to exert a considerable oncotic pressure. Incidentally, if this proved to be the case, one could envisage an effective therapy by feeding substances which would cause aggregation of these molecules.

Apart from defining the osmotic gradients more accurately we think one might attack the matter of the filtration pressure. On the gut nephron hypothesis of Dr. Lee E. Farr, Brookhaven National Laboratory, one might envisage the occurrence of an increased filtration pressure resulting from a decrease in afferent arteriolar tone. His techniques would help here.

A simpler approach is also possible. A semidirect measurement of the capillary pressure might be obtained in the following way. If a glass fiber flexible enteroscope were passed into the intestine inside a transparent balloon, one could raise the pressure in the balloon until the gut blanched. The balloon pressure would then reflect the capillary pressure. Various other approaches are possible, but we think it would be inappropriate to devote more time here to this matter.

Therapeutic Considerations

Three communications from Dr. R. Q. Blackwell, U.S. Navy, Dr. Robert A. Phillips, U.S. Navy, and Dr. Mongkol Kruatrachue, Thailand, provide for the first time detailed information on the state of water and electrolyte balance in cholera patients and information on the quantities of water and electrolytes lost in the stools. Knowledge of these matters is essential if we are to plan therapy intelligently.

There are two problems in the management of any patient with a disturbance of water and electrolyte balance. The first is to decide how much water, what electrolytes, and what quantities of electrolytes should be given to restore a normal milieu intérieur. The second is to maintain a normal milieu intérieur by balancing the losses of water and electrolytes by an equal intake. We are concerned first with restoration and then with maintenance of balance.

We find from these papers that cholera behaves very predictably. From a knowledge of some simple indicators it is possible to assess the extent and type of water and electrolyte imbalance and also to predict from measurement of the stool volume alone what electrolyte losses are occurring.

Such information enables us to make up a repair solution which provides the necessary concentrations of the different ions to correct the imbalance. The actual quantities of such repair solutions have been shown to be predictable from a simple measurement of the plasma specific gravity or, at certain stages, of whole blood specific gravity. This use of the plasma or whole blood specific gravity is so important that we hope you will excuse a repetition of the principle behind it.

When water is lost from the extracellular fluid and plasma, the concentration of plasma proteins rises. The extent of this rise can be used as a measure of the volume of fluid lost. Now, one of the most accurate and simplest methods of measuring the plasma protein concentration is to determine the plasma specific gravity. Phillips and his team have shown that the volume of fluid required to restore balance can be estimated from the following formula: $(x-1.025)200=$ milliliter of repair solution required (where x is the plasma specific gravity of the patient).

As an indicator of underhydration, the plasma specific gravity has been shown to be both efficient and sufficiently simple for use in field conditions.

However, we believe that further work should be done to find even simpler indicators of the extent of underhydration for use in more remote areas. Two of these were suggested in the discussion. One was an evaluation of the skin turgor, and the other the use of venous pressure measurement. Despite certain contrary opinions offered in the discussion, we believe that the latter could be used, not perhaps as an indicator of the volume of fluid required for rehydration but certainly as an indicator of adequate hydration. We would suggest that fluid might be given until the venous pressure is 1 or 2 cm. below the sternal angle. At this point, the patient could not be dangerously overhydrated and would certainly be adequately hydrated. It has been used successfully as an indicator of hydration in conditions other than cholera, and we believe that it should be studied in cholera.

Maintenance Therapy

The data we have been given provide a means of regulating maintenance therapy. On the one hand we have information on the insensible loss of fluid in tropical conditions, and on the other we have data on the composition of the stools. These two pieces of information make it possible to prescribe a routine maintenance regimen without the necessity for laboratory investigations. This is possible because of the small variation in the sodium and potassium content of the stools reported by Blackwell.

The studies of the Navy team are most valuable. The simple routine of management of cholera which they prescribe will become standard practice.

Before leaving this consideration of management there are, however, two points which require comment. First, we are told that there is little or no cellular underhydration and also that there is often as much as 30 percent reduction in potassium balance. We are a little doubtful that these two statements can be reconciled.

The second problem concerns the tonicity of the repair solutions. From Phillips' data one would expect to find that a regimen based on isotonic fluids would lead to cellular underhydration. This does not appear to occur unless one interprets some of the pyrexia as being due to this phenomenon. Why is it that regimens of treatment based on isotonic or slightly hypertonic fluid have been reported previously as being superior to those based on a slightly hypotonic fluid? We doubt whether they are superior, and we think control studies are indicated. This, incidentally, is a problem which is admirably suited for study at the Dacca laboratory.

Farr outlined certain procedures which in the future may be used to elucidate some of the problems of water and electrolyte movement in cholera. Clearly, radioactive isotope techniques are admirably suited to such studies. Of particular interest is Farr's novel concept of a "gut nephron."

Pathology and Pathogenesis

Chairman: Capt. Robert A. Phillips, MC, USN, Naval Medical Research Unit No. 2, Taipei, Formosa

Rapporteur: Dr. Eugene J. Gangarosa, Walter Reed Army Institute of Research, Washington, D.C.

Dr. Chanyo Benyajati, Dr. Natth Bharamapravatpi, Thailand, and Col. S. M. H. Bokhari, Pakistan, have given us a lucid account of the pathology of cholera. We are sure Chanyo is correct in assuming that the majority of the damage is due to ischemia. However, if one assumes that inhibition of active transport plays a role in the intestinal lesion, then one should examine the acute and convalescent patient to ascertain whether the active transport mechanism in the nephron is also inhibited. If such were found in the kidney, it would imply that the transport mechanism in the entire body is deranged and not just in the intestine.

Bull has called attention to the need for considering lymph flow in estimating renal function and to the idea that lymph flow assumes increasing importance as renal function decreases. His studies again emphasize the need for a suitable experimental animal in which this disease can be reproduced. If such a model were available, one could determine the rate of flow and the electrolyte composition of lymph from the gastrointestinal tract. Studies of this type are required if one is to postulate precise mechanisms for movement of water and electrolytes across the mucosal cell. This has been fully discussed by Dr. Maurice B. Visscher and his group at the University of Minnesota.

Natth emphasized the alterations of adrenal histology in fatal cases of cholera. Obviously, future clinical studies should attempt to assess the role of corticosteroids in the initiation or the maintenance of the diarrhea of cholera.

The papers of Gangarosa and Gordon, at the session on physiological changes in cholera, provided the coup de grâce for the theory that cholera is a disease characterized by demonstrable destruction of the mucosal cells of the intestine with "weeping" of protein containing extracellular water into the gut lumen.

The failure to find viral agents as frequent inhabiters of the gastrointestinal tract in patients with cholera has been reported in papers by Dr. F. S. Cheever, University of Pittsburgh, and Dr. P. B. Johnston, U.S. Navy, and their associates. Until new virological techniques are developed, comparable in their importance to tissue culture methods, the idea that cholera gravis may represent a dual infection, that is, virus plus vibrio, can be shelved.

Dr. Abbaya Chamuni, Thailand, reported reasonably consistent success in reproducing a choleralike disease in rabbits and poor success in monkeys. Perhaps these data provide a tool for ascertaining why some human beings become cholera victims while others are spared. Abbaya employed adult rabbits while Dr. Nirmal Dutta of the Haffkine Institute in Bombay, India, used baby rabbits as his experimental host. Such studies should be repeated and extended in other laboratories. Inability to reproduce the disease in experimental animals with assured regularity has greatly hampered studies of the basic physiological lesion in cholera which accounts for the severe diarrhea. This fact has led the Navy investigators to turn from a bacteriological to a physiological approach in an attempt to replicate the disease in animals.

Vaccines and Immunity

Chairman: Dr. Kenneth Goodner, Jefferson Medical College, Philadelphia, Pa.

Rapporteur: Dr. Joseph E. Smadel, National Institutes of Health, Bethesda, Md.

Remarks from representatives of each delegation opened the session on vaccines and immunity. These comments were concerned mainly with the current status of cholera in each country, the kinds of vaccine employed and the methods of use, and the opinions of the speakers regarding the efficacy of the vaccination program in controlling the disease.

Dr. Daizo Ushiba, Japan, pointed out that there has been no cholera in Japan since 1947, the disease having been reintroduced the preceding year by repatriates. He mentioned that, prior to 1926, cholera was introduced each summer but never overwintered in Japan whether vaccine was or was not used. In several instances prior to 1926, data collected retrospectively suggested that the disease was appreciably less frequent among the vaccinees than among nonvaccinated persons in the same area. However, he did not consider the observations as providing definitive data on the efficacy of the vaccine. He concluded by referring to the earlier experience of Japanese health and preventive medical officers in Manchuria. They were of the opinion that cholera vaccine was probably as good as typhoid vaccine.

Dr. Jesus Azurin, Philippines, indicated that at no time had more than 41 percent of the population of the Philippines been vaccinated against cholera and that many of these had not had a second injection. He stated that no field studies on the efficacy of the vaccine had been conducted in the Philippines. His country relies more heavily on quarantine procedures than on an immunization program to prevent cholera.

Dr. Luang Binbakya Bidyabhed (Pyn), Thailand, said that the Thai experience with cholera in 1958-59 did not permit him to say much regarding the efficacy of vaccine even though about 20 million inoculations had been given during the period, and many persons in the epidemic area had been vaccinated on more than one occasion. He noted that an inverse correlation occurred each year between the number of inoculations and the number of cases; as the former rose higher and higher the latter dropped lower and lower.

Dr. J. Gallut, France, reviewed the experience of French investigators and health officers in Indochina. He noted that it was difficult to form an opinion about the efficacy of a vaccine when it is used only during an epidemic. However, the experience over the years suggested that when about 70 percent of the population in an area was vaccinated the epidemic died out.

Dr. M. M. Siddiq Husain, Pakistan, stated that a modified Haffkine vaccine was employed in Pakistan. He noted that epidemics came and went before vaccines were developed, and this increased the difficulty of evaluating the efficacy of such immunogens.

Dr. Ataur Rahman, Pakistan, summarized data on field experience with vaccine in East Pakistan. The results suggested some immunity among the vaccines.

Dr. Joseph E. Smadel, National Institutes of Health, summarizing the remarks of the preceding speakers, said he was impressed with the unanimity of opinion that cholera vaccine was of some value even though everyone stated that conclusive scientific data on its efficacy were lacking. It was apparent that an adequate field evaluation of cholera vaccine was necessary.

The latter half of the session consisted of more formal presentations on several different subjects.

Dr. John C. Feeley, National Institutes of Health, summarized experimental observations on a potency test for cholera vaccine using mice. This procedure, which compares the vaccine under test with a reference vaccine, gives consistent results. Moreover, representative vaccines from different sources have markedly different potencies. Feeley emphasized that before any potency test could be accepted with confidence as a biologics control procedure, its results must be shown to correlate with demonstrated capacity of vaccines to protect persons in the field against the disease.

Ushiba reported data on serologic and cellular immune responses in mice inoculated with several types of vaccine prepared for *Salmonella typhimurium.* He indicated the need for similar studies with *Vibrio comma.*

Dr. Kenneth Goodner, Jefferson Medical College, summarized his studies on the antibody response in patients with cholera. This development provided a much needed test for epidemiological and immunological investigations. Both group and type-specific antibodies were found in convalescent patients. The latter were of particular interest since they correlate by type with the organism isolated from the patient. These type-specific antibodies may be associated with immunity and certainly will be valuable in diagnostic work. Presently available cholera vaccines varied greatly in their capacity to induce type-specific antibodies in animals.

Dr. Colin MacLeod, New York University, listed a number of essentials for a field trial of cholera vaccine:

1. Conduct the trial in a readily accessible area where cholera occurs in epidemic form at reasonably frequent intervals.

2. The supporting laboratory should have sound and adequate facilities for isolation and identification of *V. comma* and for serologic diagnostic work with the vibrio. In addition, diagnostic facilities for *Salmonella* and *Shigella* should be available. In brief, the associated laboratory should be capable of establishing etiological diagnoses on the acute diarrheal diseases which occur in the study area.

3. Give the vaccine under investigation in a properly randomized manner with a control vaccine, presumably typhoid vaccine, given to those who do not receive cholera vaccine.

4. Immunize the population under investigation before the anticipated epidemic, with two or three doses so spaced as to take full advantage of the booster phenomenon.

5. Staff the trial with an adequate number of trained personnel to gather information and maintain proper records on patients with classic clinical disease and, equally important, on those with milder involvement and with asymptomatic infections.

6. The study group cannot be very large if the individuals are to be maintained under the intense observations proposed. The exact size of the population will depend on the likelihood of predictable epidemic conditions.

7. Vaccine used in the field trial should be studied by standard and special laboratory assay procedures. Moreover, adequate samples of the field trial vaccine should be retained for possible future use as a potency standard.

In discussing MacLeod's criteria, Dr. H. E. Shortt, United Kingdom, emphasized the need for a controlled experiment of the type outlined. He indicated the essentiality of a marriage of field and laboratory procedures if an answer were to be obtained on the efficacy of cholera vaccine. He favored careful selection of a relatively static population for the trial and suggested that the vaccine should contain fresh local as well as classic strains. He noted a proper trial may be some years away since much needs to be done in the laboratory and in the study area before the definitive test could be undertaken.

We would like to turn for a moment from the pleasant task of reporting, in an objective fashion, on the scientific presentation of the session on vaccines and immunity to a few personal observations. We wish we were able to express in words the enthusiasm and faith of the participants in the idea that recent developments have provided us, health officers and scientists from various nations, with the tools to build a worthy edifice on the foundations laid by our predecessors. We believe that the crusading spirit of this group is such that the individual members will use the new tools in the vigorous pursuit of their own studies on cholera, both here and at home. Perhaps the emotional drive generated at this meeting will be even more important than the current array of factual data in the early attainment of the control of cholera and in its eventual eradication. In closing we express our esteem and thanks to the participants. Their efforts have made the session on vaccines and immunity a memorable meeting.

Epidemiology

Chairman: Dr. Fred L. Soper, director, Pakistan—SEATO Cholera Research Laboratory, Dacca, East Pakistan

Rapporteur: Dr. J. L. Stockard, deputy director, Pakistan—SEATO Cholera Research Laboratory, Dacca, East Pakistan

This century has seen a great reduction in the geographic distribution of cholera in the world in comparison with that of the preceding one. No invasion of the Americas has occurred since 1900, and during the past 30 years, and even since World War II, cholera has receded from the Pacific. The only notable spread of cholera in recent years to a noncontiguous area was a short-lived invasion of Egypt in 1947.

The first decade of the second half-century began with a minimal recognized distribution of cholera; both West Pakistan and Thailand which had outbreaks in late 1940's were free from 1950 to 1958. However, in the past 3 years, 1958 to 1960, cholera has shown a capacity for expansion. In 1960 outbreaks were recorded in many parts of India, East Pakistan, Burma, Nepal, West Pakistan, and Afghanistan. Classic clinical cholera apparently disappeared from Thailand in 1959 during the second year of an epidemic first noted in May 1958.

The generally accepted concept of the epidemiology of cholera is that East Pakistan and a contiguous area of India constitute the permanent endemic focus where the infection is always found and from which it tends to spread more or less widely each year as circumstance permits. Health authorities of Thailand were alerted to the increased threat of invasion by cholera early in 1958 by reports of increased activity of the disease in Calcutta.

The story of the recent epidemic in Thailand is a fascinating one when superimposed on a history of practically constant endemicity from 1916 to 1949 (with marked epidemic waves 1919 to 1920, 1925 to 1929, 1935 to 1937, and 1943 to 1947) followed by a total absence of observed cases from 1950 to May 1958. This outbreak was characterized by great rapidity of spread to some 38 Provinces of the country in a few weeks and a rapid decline following the onset of the heavy monsoons, but with a considerable recrudescence in 1959. On the basis of clinical observation, it has been assumed that the cholera outbreak in Bangkok terminated in October 1959. Continuing bacteriological studies have resulted in reports of continued isolation of *Vibrio cholerae* from certain diarrheal cases and from the environment until the summer of 1960. The epidemiological significance of this report is not clear.

West Pakistan is not part of the endemic cholera focus. It suffered a serious outbreak during the troubled period from 1947 to 1949, but was then free until November 1958 when the disease was observed in a few towns not far from the Indian frontier. After a quiet period in 1959 the disease reestablished itself in West Pakistan in May 1960, apparently imported from the port of Bombay. The spread of the infection has been attributed to both water and food, and the epidemic was still continuing in certain areas in November 1960.

Unfortunately, details of the outbreaks of cholera reported in 1960 are not available from Afghanistan, Nepal, and Burma.

The many gaps in our knowledge of the epidemiology of cholera in its permanent endemic seedbed and in the widely varying epidemic conditions such as those in Thailand and West Pakistan emphasize the need for a careful restudy and evaluation of existing knowledge. The organism itself, its biology, in vivo, in vitro, and its ability to persist under natural conditions must all be reexamined. How does the cholera vibrio vary in nature, and what are the factors which cause it to become avirulent? To recover its virulence (if it does)? Other points needing careful study are immunity, vaccination, susceptibility, interepidemic foci, the effect of the habits of the people, the climate, the environment, and the salinity of contaminated waters. What are the factors which permit the natural resolution or the involution and disappearance of the infection responsible for epidemics?

Do East Pakistan and parts of India constitute a permanent endemic focus of cholera because the natural conditions there permit the persistence of the cholera vibrio in contaminated waters throughout the year? Will improved water supplies and sanitation alone be sufficient to end cholera in these endemic areas?

The data on reported cases of cholera in East Pakistan for the past decade, averaging almost 18,000 annually, established beyond doubt the wisdom of locating the SEATO Cholera Research Laboratory in this area. It must be remembered, however, that it is not sufficient to study a communicable disease only in the endemic area.

The experience with yellow fever in the Americas is most significant. A survey of the geographic distribution of immunity to yellow fever and the systematic collection and routine examination of postmortem material from individuals dying after any rapidly fatal febrile illness revealed two unrecognized mechanisms for the maintenance of the yellow fever virus: (*a*) silent yellow fever endemicity in northeast Brazil based on an uncommonly close association of man and the domestic mosquito vector, *Aëdes aegypti*, in rural areas and (*b*) yellow fever of forest primates transmitted by mosquito vectors other than *A. aegypti*.

It is important that studies continue in Thailand, now that cholera is apparently absent, and that West Pakistan be studied as another area where conditions are quite different from those in East Pakistan. Although the cholera research laboratory is located in Dacca, it is not intended that studies should be localized here, but rather that Dacca may serve as the center for studies of the disease in this region.

In considering the adequacy of quarantine regulations for the prevention of the international dissemination of cholera, it should be remembered that any regulation capable of preventing absolutely the movement of cholera from one area to another, particularly across extensive land frontiers, would, for all practical purposes, interrupt the movement of normal traffic and commerce. Countries as intimately related as are East and West Pakistan and India, Burma, and Thailand will always find it difficult to apply quarantine measures. Cholera represents, par excellence, the type of communicable disease which must be prevented and eradicated in its permanent foci of infection, rather than contained by building airtight quarantine walls about these foci for the protection of the rest of the world.

A renewed faith in the reliability of the agglutination test performed with freshly cultured vibrios opens the way to geographic studies of the previous distribution of cholera by laboratory methods without depending on the notification of clinical cases. A better understanding of the true epidemiology of cholera can be expected to arise from the routine study of this disease in different areas over a considerable period of time.

It is only as more knowledge based on observation in the laboratory and in the field becomes available that a reasonable program for cholera control and eventual eradication in its endemic foci can be prepared.

Laboratory Identification of Cholera Vibrios

Chairman: Dr. M. M. Siddiq Husain, Bureau of Laboratories, Karachi, Pakistan

Rapporteur: Dr. Colin M. MacLeod, New York University, New York, N. Y.

Although extensive study has been devoted to it for considerably more than a century, the subject of cholera is confused. In the area where one might wish for and perhaps expect more certitude, that is, the nature and proper ties of the etiological agent, *Vibrio cholerae,* there exists the greatest degree of uncertainty. An understanding of the epidemiology of the disease and interpretation of the effects of infection in the individual patient demand a much more precise knowledge of the biology of this microbial species and its protean manifestations. It is by no means agreed that we are dealing with disease caused by a single bacterial species or that under the term "cholera" there is jumbled together a group of diseases that might better be referred to as "vibrioses," as Goodner suggested.

The problem can be stated in two questions. What are the criteria for inclusion of bacteria in the species *V. cholerae*? What are the significance and relationship of the many variants of *V. cholerae* that have been described, of the non-agglutinable vibrios, and of the multitudinous water vibrios?

Dr. Abdul Saeed Khan, Pakistan, reviewed the current cultural, morphological, and serologic criteria for identifying *V. cholerae*. Saeed emphasized the necessity of multiple criteria with final decision resting heavily upon the use of antiserums to subgroup 01 and specific Inaba and Ogawa antiserums.

Dr. Ampan Tasniyavej, Thailand, reviewed and discussed critically the laboratory methods employed in the Bangkok epidemics of 1958-59. Specimens were collected by means of rectal tubes and implanted on three solid media and in alkaline peptone water. Cultures negative for *V. cholerae* were obtained from clinically positive cases in the following incidence on the various solid media.

Solid medium	*Percent of cultures negative for V. cholerae*
Lactose bromthymol blue agar	22.0
Alkaline human blood beef extract agar	8.8
Taurocholate beef extract agar	17.0

Further identification was made by direct slide agglutination with specific Inaba and Ogawa antiserums of micro-organisms from emulsified colonies on these three media. In addition, suspected colonies of *V. cholerae* were picked and planted on triple sugar iron agar.

Ampan concluded that at least two solid media, such as alkaline human blood beef extract agar and taurocholate beef extract agar, should be used for direct inoculation of stools during epidemics, and that slide agglutination with specific Inaba and Ogawa antiserums is a most valuable procedure for rapid and accurate identification.

Dr. Kazi Abdul Monsur, Pakistan, reviewed his experience with the modified gelatin taurocholate tellurite agar medium, pH 8.5, developed by Goodner. This medium, as tested in Philadelphia with artificial stool mixtures containing some 38 different strains of vibrios, has the advantage of being highly selective for *V. cholerae* without being seriously inhibitory. The distinct halo about colonies of *V. cholerae,* due to the action of its gelatinase, is of great assistance in making a presumptive identification. Monsur concluded that this medium is promising and should be tested in the field. Field trials have begun at the SEATO Cholera Research Laboratory in Dacca.

Maj. Samnieng Buspavanich, Thailand, reported on his group's experience in the 1958-59 epidemics with the use of alkaline tellurite lauryl sulfate agar and the Wilson-Reilly-Pandit agar medium, which contains bismuth sulfite, mannitol, and phenol red. Both media were found to be useful for primary isolations, although not entirely selective. Samnieng noted that under the climatic conditions of Bangkok during the hot season plain alkaline agar, blood media, and alkaline agar containing bile salts were unsatisfactory for primary culture because they permitted overgrowth of *Pseudomonas* and *Proteus.*

Gallut reported on variations in titer of *V. cholerae* 0 agglutinability in subgroup 01 antiserum as related to differences in polysaccharide content of the 0 antigen in various strains. Employing phenol extraction, Gallut found that the polysaccharide content may vary between 1.0 and 6.5 percent of the weight of the bacteria. However, the content of polysaccharide of a given strain on a given medium remains relatively constant under uniform conditions of growth and extraction. If autolysis is permitted to occur, polysaccharide is liberated into the medium and the bacteria become relatively inagglutinable. Under these circumstances a strain of *V. cholerae* might be diagnosed as a nonagglutinable vibrio.

Similar differences in agglutinability may be observed with certain strains and monospecific Inaba and Ogawa antiserums.

Gallut reported a correlation between agglutinability of *V. cholerae* and the color of colonies under oblique illumination. The agglutinating titer of vibrios from blue colonies was about half that of vibrios from green or orange yellow colonies. Variation in color of colonies of *V. cholerae* under oblique lighting is believed to be due to differences in content of polysaccharide in the 0 antigen complex.

Finally, Gallut, on the basis of agglutination studies with four recently isolated strains using specific Ogawa and Inaba antiserums, was able to confirm the report of Burrows and co-workers (*Journal of Infectious Diseases* 79: 168, 1946) that a fourth type of *V. cholerae* exists.

Goodner emphasized the great variation in characteristics of "authentic" *V. cholerae* isolated in different places, in different epidemics, and even at different times during the same epidemic. He discussed the strong possibility that there is a group of diseases and not a single disease. He suggested that it might be more appropriate, therefore, to speak of "vibrioses" to indicate this group or series of diseases which are now included under the term "Asiatic cholera."

Goodner stated there are at least 50 different variants among the 500 strains of cholera vibrios in his collection. This finding emphasizes the inadequacy of picking only a single colony for identification from a plate. Such demonstrated variability also raises the possibility that the vibrios growing on the wall of the bowel during the disease may differ in an important way from those found in the rice water stool or following primary isolation on one or other of the selective media in current use.

Goodner was of the opinion that it is premature to standardize the preparation of serologic reagents used in diagnosis because the present state of knowledge is not adequate to do this intelligently.

In the general discussion there was sentiment expressed for and against the term "vibrioses." It was stated that the word has already been employed to describe infection by *Vibrio fetus.* This was not held to preclude the use of the term in the present context.

Many discussants commented on the difficulties in bacteriological diagnosis because of the variability of the vibrio under various conditions of culture and maintenance. In order to resolve some of the pressing problems Samnieng suggested that a small working committee of the present conference be set up. This committee would be concerned with the cultural and serologic characters of the micro-organisms and their relation to disease production. The suggestion was seconded by Goodner, who noted that a good beginning could be made through correspondence.

The co-existence of enteric infections caused by various species of *Salmonella* and *Shigella* during cholera outbreaks was commented on by various participants. They emphasized the need to use culture media in addition to those which are highly selective for *V. cholerae* to obtain a complete picture of enteric infections. In this regard, Husain reported the occurrence of an enteropathic strain of *Escherichia coli* during the latter part of the cholera epidemic in Karachi in 1958. This agent, represented by 38 strains, was associated with bloody diarrhea. Husain also referred to the possibility of interaction between various different species or genera of enteric bacteria to produce strains of high pathogenicity.

The session on laboratory identification highlighted the need for a detailed study of the nature and extent of variation in the cholera vibrio employing modern techniques. The study should include selection of spontaneous mutants in the presence of specific antibody and other selective agents and especially the role of genetic transduction of various characters by bacteriophages and correlation of these changes with morphological, chemical, and metabolic analysis. Unless extensive studies of this type are made, it is likely that we will remain in the present unsure but opinionated state.

It should also be possible to learn more about the behavior of the cholera vibrios as they grow in the gut, since this might give a lead to possible toxic products not yet identified. Specifically, are the vibrios growing under partially anaerobic conditions during the acute stage of the disease when they are found in overwhelming numbers in the fluid stools? Their relatively poor growth in the laboratory under conditions of complete anaerobiosis suggests that in the bowel growth is more likely to be aerobic, especially when this finding is taken in conjunction with the alkaline reaction of the rice water stool. However, the conditions in vitro are so dissimilar to those in the intestinal tract that active multiplication under conditions of anaerobiosis might take place in the gut, although this is not found in laboratory media.

RELAPSING FEVER (ALL FORMS)

Evaluation of the Research Problems of Greatest Importance Concerning Relapsing Fever—Submitted 8 March 1961 by **Dr. M. Baltazard,** Director, Pasteur Institute of Iran, Teheran, Iran.

In spite of the fact that relapsing fever is a clinical and pathological entity, it would be better to write "relapsing fevers" from the epidemiological point of view, on account of the existence of two sorts of relapsing fevers: one sporadic or endemic transmitted by ticks, the other one purely epidemic, or rather pandemic, transmitted by lice.

I. *Tick Relapsing Fever*

This exists in all tropical countries, taking the word "tropical" in the largest sense, including the South of the U. S. or of the U.S.S.R. or Iran, for example. It is naturally transmitted by ticks of the genus *Ornithodoros*, and a number of species of *Ornithodoros* and of *Borrelia* related to them have been described. However, the largest number of these relapsing fevers have a very small importance from the Public Health point of view, occurring in nature in wild animals, especially wild rodents, in whose burrows live the *Ornithodoros*, having a rare chance to bite and infect man.

It is only in very poor conditions of human habitat that certain species of *Ornithodoros* having a large distribution and living not only in the wild but on domestic animals in the stables, can invade dwellings and produce more frequent human cases of relapsing fever. This is the case of *Ornithodoros erraticus* in North Africa and Spain, *O. rudis* in Southern and Central America, *O. nicollei* and *O. talaje* in the South of the U. S. down to the Paraguay. However, even in the latter case, human infection remains an accident, the true cycle starting between animals and ticks.

Nevertheless, two of these tick relapsing fevers have a greater importance from the Public Health point of view, being transmitted by *Ornithodoros* almost completely adapted to human habitat, biting almost exclusively man, who seems to be the single "reservoir" of the disease. These are the so-called "Asiatic relapsing fever" (*Borrelia persica*) transmitted by *Ornithodoros tholozani* from Egypt and Cyprus up to India East, U.S.S.R. North and Arabia South and the "African relapsing fever" (*Borrelia duttonii*) transmitted by *Ornithodoros moubata* throughout Africa up to Madagascar. In that case, the disease cannot be called sporadic, but endemic, the frequency of human cases being high.

Tick relapsing fever, in that last condition, is for endemic countries a serious Public Health problem for three reasons. The first is the extraordinary antigenic multiplicity of the strains of the same species of spirochaetes even in the same area: each strain giving almost no immunity against other strains, even isolated from the same house or hut (though giving a complete and durable immunity against itself). This signifies that people living in an infested house, being quite continuously bitten by ticks, can be very frequently infected and reinfected, which seems to be proved by the fact that a systematic examination of all people in an infected village gives always at any moment a number of cases with spirochaetes in their blood.

The second reason is the difficulty of eradication of the vector *Ornithodoros*, protected against insecticides by its mode of life (in the dust or sand of the hut's ground for *Ornithodoros moubata*, in the crevices of the earthbuilt walls for *O. tholozani*) with rare emergence for feeding, especially the adult forms. The third reason is the resistance of these tick relapsing fevers to treatment: the arsenical compounds and penicillin salts being completely ineffective, only aureomycin giving better results.

Limited to these two endemic relapsing fevers and to the practical Public Health point of view, the research in the field and in the laboratory is at present, to my knowledge, restricted to a very small number of research centers, i.e.: the NAMRU-3 at Cairo with H. Hoogstraal et al., the Medical Research Laboratory at Nairobi with Heisch et al., the Institut Pasteur de

Madagascar at Tananarive with E. R. Brygoo et al., the Institut Tropical Suisse at Basel with Geigy et al. for *O. moubata* and African relapsing fever; and for *O. tholozani* and Asiatic relapsing fever, the Institut Pasteur de l'Iran at Teheran with Baltazard et al. We do not speak about the U.S.S.R. research centers, which are extremely active on that subject, especially about eradication purposes.

The research purposes from this point of view seem to be limited to:

1. Epidemiological and/or experimental verification of the fact that man can be infected several times by different strains of the same species of spirochaetes with each time the same complete symptomatology.

It seems possible, from experimental observations in laboratory animals done by numerous authors and from a few human experiments done at the Institut Pasteur de l'Iran (unpublished), that there can exist in certain cases some degree of protection between strains isolated from different *Ornithodoros* of the same batch, collected for example in the same house, providing an attenuation of the symptoms: shortening and lowering of the attacks, decrease of their number, etc. The possible explanation of this phenomenon will be examined in the paragraph: pure research.

2. Systematic study of the action of insecticides on the *Ornithodoros* in the conditions of their natural habitat.

From previous experiments performed by different authors and from some tests done by the Institut Pasteur de l'Iran with the Malaria Eradication Service of Iran (unpublished), it seems that the dispersible powders (in water) even at high concentrations and with a deep wetting of the walls and ground do not have any action, in contrast with the insecticides soluble in kerosene, on condition of a deep penetration of the solvent into the walls and ground.

3. Study of the action of the different antibiotics on these two relapsing fevers in Africa and Asia.

If, as seems to be proved by the large surveys performed in Africa and Asia showing the almost complete absence of animal reservoir, the cycle of these infections is tied between man and tick only, the problem of the treatment of man is the second basis for a possible eradication.

Pure research. But beside these research needs of immediate practical interest, there remains an important need of research that we can call pure research, which can and must be (and is already) conducted in several laboratories on all sorts of spirochaetes, human or not, transmitted by ticks. That we call it pure research does not signify that we consider it as wanting in practical interest; on the contrary, as will be seen in the following chapter, it is possible that the key to the major problem, i.e., the birth of the epidemics of louse relapsing fever may be found in this way.

The laboratories which are at present at work on those subjects are in fact very few: in the U.S., the Rocky Mountain Laboratory, Hamilton, Montana, with the staff previously conducted by Gordon E. Davis (now retired), the Institut Pasteur de Paris with Colas-Belcour, the Institut Pasteur du Maroc with Georges Blanc et al., the Institut Pasteur de Tunis with Hélène Sparrow, can be added to the list given for practical research (U.S.S.R. not included).

The researchers (more or less active) aim at:

- —Genetic studies on the variations of the numerous *Ornithodoros* species previously described, with a view to regrouping and simplification.
- —Same studies for the enormous number of spirochaete species described.
- —Studies on the behavior of all these species in the human louse.
- —Studies on the "antigenic mosaic" composing every strain, giving possible relative cross immunity between apparently different strains, etc.

It does not seem, however, that your Advisory Committee has to be concerned with that sort of research.

II. *Louse Relapsing Fever*

The story of this most epidemic among the epidemic diseases still involves a complete mystery. Nothing is known of the manner, and very little is known of the possible places, in which the infection persists during the longest interepidemic periods ever recorded in epidemiology.

Taking the example of North Africa, where an epidemic appeared in 1908, lasting until 1920, and where the best teams worked on that question—the one of Sergent at the Institut Pasteur d'Algérie, discovering the role of the louse, and that of Charles Nicolle at the Institut Pasteur de Tunis discerning the curious mode by which it transmits the disease[1]—no strain of louse relapsing fever could be identified after the end of the epidemic in spite of systematic research done by these Instituts Pasteur and later by the Institut Pasteur du Maroc on all diagnosed cases of relapsing fever (which were always tick relapsing fever), until the reappearance of an epidemic in 1943. After the end of World War II the disease disappeared again completely.

It was the same in all countries invaded during the first pandemic of this century (especially during the first World War) and again during the second. No case of louse relapsing fever could be identified between the two pandemics or after the last. Only in certain countries in Asia or Africa was it said that the disease persisted in the endemic form; but a frightful confusion existed in those countries between louse and tick spirochaetes, under the name of *Borrelia* (*Spirochaeta*) *recurrentis*, in spite of the fact that the epidemic louse spirochaete presents the clear characteristic of non-pathogenicity for any adult laboratory animal, except monkeys.

However, a true epidemic appeared "de novo" in Ethiopia in 1937, at the time of the invasion by the Italian troops, giving an extension to the Anglo-Egyptian Sudan, and it was said that the disease existed in the endemic form on the high plateau of Ethiopia. It shall be accepted that the disease took its origin in Ethiopia itself, as it was accepted in the past by Charles Nicolle that the epidemic of Tunisia in 1908 originated from the desert zone of the south of Tunisia and Libya (known under the name of Fezzan), again suspected to be the origin of the last pandemic (1943).

This notion of a desert origin of the epidemics was the basis of an hypothesis formulated by Charles Nicolle which gave rise to numerous works at the Institut Pasteur de Tunis and thereafter in many laboratories. Taking note of the short duration of the infection in man on the one hand and in louse on the other hand (infection being non-hereditary in the louse) and of the curious mode of "going out" of the spirochaete only from the broken louse (louse seeming to be a cul-de-sac), Charles Nicolle supposed that the epidemic louse relapsing fever could be only a temporary phenomenon, originating from a mutation of a tick spirochaete by passage through man and his louse. This hypothesis would explain the rare occurrence of the epidemics (mutation remaining an accident) and at the same time their perpetual return.

In fact, the first experiments of Charles Nicolle et al. demonstrated that, although it was impossible to obtain the "return" of the louse spirochaete to any species of tick, it was on the contrary extremely easy to infect lice with many species of tick spirochaetes. But, in spite of this facility, no mutation, no transformation of the pathogenic characters could be obtained for any tick spirochaete by repeated passages through man and louse. After the death of Charles Nicolle, some of his collaborators like Hélène Sparrow, or disciples like the workers of the Institut Pasteur de l'Iran, or other investigators like Heisch in Kenya, continued to experiment upon his hypothesis and it can be said that the behavior of all species of tick spirochaetes has been largely tested on human (and also animal) lice. However, no "mutation" could be obtained and after so many years the brilliant hypothesis of Charles Nicolle can be considered as forsaken, in spite of very disturbing facts, like the isolation by Heisch et al. in Kenya of tick spirochaetes (*B. duttonii*) from lice collected on naturally infected people.

However, a new possibility for the orientation of the research has recently appeared. In 1955, Hélène Sparrow, who worried about that question quite from the beginning of her scientific life, obtained from the WHO a mission in Ethiopia to try to elucidate the problem of a possible persistence of the louse relapsing fever under an endemic form. The results of her work have been published in French in the WHO Bulletin in 1958 (Vol. 19, p. 673)[2]: the magnificent precision and strictness of that work settle the question in an unquestionable manner: human louse relapsing fever exists in Ethiopia in the endemic form.

Unfortunately no later work has been done in Ethiopia. H. Sparrow returned immediately to the Institut Pasteur de Tunis and (as she says herself picturesquely about the research workers in relapsing fever: "they are very few and they are also becoming older") she had not the possibility to begin the hard field work necessary to elucidate the causes of this endemic persistence. As early as 1956, she informed me of her results and agreed that the requisite research could be done by the active field research team of the Institut Pasteur de l'Iran, well specialized in the subject. We tried together to interest WHO in the question (louse relapsing fever being one of the six quarantinable diseases), but no funds could be made available from 1958 for that research, which will be, to tell the truth, somewhat expensive, being of the same type as we have performed on plague, also with WHO, in India, Java, Syria, Turkey, and Iraq.

This means the sending and maintenance for one year at least of a team of two workers, two jeeps, one truck carrying a field laboratory and accommodations for living in the difficult field conditions in Ethiopia.

WHO is certainly extremely interested, but no research funds were foreseen for that question at the time of the research planning some years ago. Its collaboration is in fact necessary, if only to obtain the agreement of the Ethiopian government and the local facilities.[3]

We shall consider that the potential danger of this disease remains the same as that at the time of the first pandemic of this century, which caused more than 50 million cases and certainly more than 5 million deaths. That was proved by the evolution of the second pandemic, in which, in spite of the use of potent insecticides for louse control and penicillin for the treatment of the sick and of the comparatively short duration of the pandemic (less than four years), the number of cases was evaluated at not under 10 million.

It seems, therefore, that the first (if not the only) research subject on relapsing fever (with the slight shame it can appear as a "pro domo" argument) is the research of the infection reservoir in Ethiopia, since we are sure, thanks to H. Sparrow, that the disease exists at present in that country.

Notes

[1] The bite of the louse is, as you know, not infective, the single way of contamination being the scratching of crushed or injured lice into the small wounds made by the itching.

[2] There is also a good synopsis in English in mimeographed form under the number MHO/PA/225. 59-5 November 1959.

[3] There exists also an Institut Pasteur in Ethiopia which can serve as a base for the research team.

The Relapsing Fevers—Submitted 22 March 1961 by **Dr. Hélène Sparrow,** Pasteur Institute of Tunis, Tunis, Tunisia.

At present the only endemic focus of louse-borne relapsing fever known in the entire world is found in Africa. The Ethiopian focus provided the reason for initiating an investigation during the course of a mission which I performed under the auspices of the World Health Organization, from the 1st of March to the 24th of May, 1955.

I was able to establish that this focus had persisted for 25 years. It is probably older than that. We have picked out the following figures, starting in 1950, the year of the first indication of the disease in world-wide statistics. In 1950, 2860 cases; 1951, 2278; 1952, 5043; 1953, 7499; 1954, 5728; 1955, 2809; 1956, 2227; 1957, 3200; 1958, 5009; 1959, 2979; 1960, 4359.

The exceptional drought in Ethiopia early in 1955 obstructed my work, which was almost exclusively limited to the region of the High Plateaux. I was able to isolate fifteen strains. Eight were studied completely at the Pasteur Institute in Tunis. They were of the type, *Borrelia recurrentis.* These strains were also sent to several specialized laboratories in Europe and Africa. A study of the Ethiopian focus, more complete than would have been possible for me to have done, would be most important. It would permit elucidation of the primordial question of the origin of epidemics. Two hypotheses are current:

(a) According to Charles Nicolle, "the origin of epidemics ought to be sought at the level of the burrows of small wild rodents". Louse-borne and tick-borne relapsing fevers are two distinct diseases which have a common origin. One of the essential distinguishing characteristics is specificity for the vector agent. Nevertheless I was able to infect lice with all of the strains of tick relapsing fever spirochetes that I have studied. But the relative scarcity of spirochetes in the blood of human patients makes the natural infection of lice uncertain. The quantity of spirochetes of tick origin found in the blood of patients varies according to the strain. Systematic study of numerous strains of tick spirochetes, with regard to their ability to infect lice, is still incomplete. This is most important. I have observed, in the laboratory, a mutant strain which had acquired mixed characteristics: it had become nonpathogenic for laboratory animals but now showed a new and very great affinity for lice. The existence in nature of strains intermediate between louse and tick strains has yet to be demonstrated. The coexistence, in Ethiopia, of louse and tick spirochetes gives hope that such intermediate strains will be found if they exist.

(b) The second hypothesis concerning the origin of epidemics of louse-borne relapsing fever can only be the existence of reservoirs of the disease, during interepidemic periods, in endemic foci. This hypothesis is rarely formulated and the existence of true endemic foci of louse-borne relapsing fever has been considered, until very recently, as secondary. It was even thought to be rather improbable, until my first observations made in Ethiopia in the field, and this in spite of indications to the contrary in statistics which one had every reason to suspect because of the difficulty of isolating strains of louse-borne relapsing fever and the uncertain differentiation between tick strains and louse strains.

In analyzing the facts which are reported from known endemic foci, it is important to try to pinpoint the reasons for the persistence of the disease in these foci and to measure its potential for spread.

The persistence in the world of a single endemic focus of louse-borne relapsing fever is inconceivable, in spite of the silence of statistics and of authors which would tend to admit it. We possess no information on relapsing fever in China or in India. The Russian authors give an account, at present, only of tick-borne relapsing fever. It would be interesting to instigate a meeting of specialists from these countries in order to point up the situation.

A survey in Ethiopia, more extensive than was possible for me to perform in 1955, would also permit the assembly of material needed to continue serological research on the spirochetes of relapsing fever, with regard to (a) better differentiation of strains, (b) an explanation of heightened percentage of instances of human resistance to infection, (c) the extreme seriousness of the diseases for the black races.

There should be research on the possibility of infecting insects other than lice and bedbugs.

There would be much interest in establishing a collection of spirochete strains from Africa and Europe similar to what has been done in the USSR for local strains of tick-borne relapsing fever.

From the epidemiological point of view, the confirmation during our mission in Ethiopia of the existence or persistence of a vast focus of louse-borne relapsing fever poses an important problem in prophylaxis, in the country itself and on the international scale. (The origin of the North African epidemic of 1943-1945 was probably Ethiopia.) A new fact must be pointed out: there are vast regions in Africa in which the endemicity of tick-borne relapsing fever has been known for a very long time and in which the disease is no longer mentioned. It must be admitted that such a failure of sanitary control services creates the serious danger that the beginning of an epidemic may pass unnoticed.

The researchers who are interested in the relapsing fevers are becoming fewer and fewer. (They are also getting older.) But there should be no disinterest in a disease which, within the recent past, has submerged entire continents, producing millions of victims, and of which Gear and Deutschman (1956) were able to say: "It is the least known of the quarantinable diseases."

Louse-borne relapsing fever, for which no vaccine exists, and which leaves an immunity of only short duration, may at any moment again become a cruel actuality if conditions favorable to its spread succeed in coinciding.

Now, it is undeniable that the present conditions of life in certain parts of the African continent (for example, the more or less declared states of hostility entailing important movements of human groups which are difficult to control, and social difficulties due to sudden changes in government, which in turn make the regularly bad harvests worse and generate misery and famine) constitute, we are sure, favorable conditions for the recrudescence of relapsing fever. Its extent and seriousness can be predicted by recalling the pandemics which we have known during the last half-century. (Translation)

LEPTOSPIROSIS

Research Problems on Leptospirosis—Excerpts from a letter dated 10 March 1961 from **Lt. Col. William S. Gochenour, Jr.,** U. S. Army Medical Unit, Walter Reed Army Medical Center, Fort Detrick, Maryland.

As the committee is aware, there have been established throughout the world World Health Organization (WHO) Leptospirosis Reference Laboratories. These have been located in the laboratories of the major investigators in leptospirosis over the past few decades. The function of these laboratories has been primarily taxonomic classification of leptospires isolated from various areas of the world. In the several meetings of WHO expert committees on leptospirosis, primary concern has been with serologic and bacteriologic methods of the confirmation of the diagnosis of leptospirosis and of criteria for taxonomic classification of leptospires.

In this country, research veterinarians in teaching institutions, livestock sanitary services, and the several biological manufacturers' laboratories have been principally concerned with study of pathogenesis of leptospirosis in the domestic animals and the prophylaxis and therapy of these infections.

To me, the most important problem presented by the leptospiroses in the tropics is prophylaxis of the infection in man; and the second most important, appropriate therapy of human disease. With reference to the first, I am of the opinion that the current serologic characterization of leptospires affords little if any information bearing on the problem of development of immunizing agents. The situation in regards to classification is fast approaching the Pandora's box presently existing for the *Salmonella*. I feel strongly that studies should be directed toward establishing the cross protection relationships existing between the several serotypes of leptospires to determine whether it may or may not be feasible to think of the development of immunizing antigens of sufficiently broad spectra to merit their use in tropical endemic areas.

Similarly, a related approach in the area of chemoprophylaxis, I feel, warrants serious consideration should the ultimate result of studies on immunoprophylaxis show this to be unfeasible.

The committee is undoubtedly aware of the conflicting reports in the world literature on the efficacy of specific therapy of human leptospirosis. Particularly is this true with reference to the antibiotics thus far evaluated. It is admitted that consideration of time of initiation of therapy may well partially reconcile these conflicts; but, the need for adequate clinical investigation of specific therapy with drugs now available appears self-evident.

I am not aware of developments in the area of diagnosis of leptospirosis that afford real promise in specific early diagnosis of the disease in man. Until a breakthrough in this area is achieved, I am at a loss to suggest a profitable approach.

Research Problems on Leptospirosis—Excerpts from a letter dated 16 February 1961 from **Dr. Ricardo Veronesi,** Associate Professor of Tropical Medicine, Hospital das Clinicas da Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil.

Summary. Making a summary of the studies on leptospirosis carried out in Brazil so far, we could say that in a first period starting in 1917 many demonstrations of leptospirals in rats were accomplished. The average percentage of positive animals was 32 per cent.

Then we had the first human cases, starting in 1923 with Noguchi in Bahia. Human leptospirosis has been reported in different parts of the country, the majority of the cases in São Paulo, in the "Hospital das Clinicas" where Professor Meira has paid special attention to this disease. The disease has been studied in this hospital under different clinical and pathological aspects.

Epidemiological studies have been carried out more recently, and we made an appraisement of these in our report of 1959 (Leptospiroses. Atualização do assunto).

Surveys in human beings (sewer workers and rice planters) have been carried out by us.

Surveys among dogs, horses and cattle were also reported by us. Pamphlets were also published by us in order to make leptospirosis known by a larger number of medical doctors.

Two epidemics have been reported in South Brazil: one in Porto Alegre, State of Rio Grande do Sul in 1947, with 45 cases (caused by floods) and another one in Northwest State of Paraná in 1946 with 180 cases (caused by invasion of villages by wild rats).

The following leptospirals have been found in human and/or animals in Brazil: *L. icterohaemorrhagie*, *L. canicola*, *L. australis B*, *L. pomona*, *L. sejröe* and *L. grippotyphosa*.

Seasonal incidence, age groups and professional activities of 94 patients of the "Hospital das Clinicas de São Paulo" were tabulated by us.

So far, only five states run laboratories with facilities to carry out leptospiral diagnosis: São Paulo, Rio de Janeiro, Minas

Gerais, Rio Grande do Sul and Bahia. Progress in the study of the leptospiroses in Brazil is limited due to inadequacy of laboratory support.

Suggestions for needed research. The first thing to do in this field is to establish leptospiral diagnostic laboratories in north, northwest and central Brazil. The "Instituto Adolfo Lutz" in São Paulo (South Brazil) could be the reference laboratory since it is the laboratory with longest experience in leptospiroses in this country. Dr. Marcelo Alvares Correa is in charge of the leptospiral section and has accomplished with us almost all surveys.

As a result of these studies we will have an improvement in epidemiology, morbidity and mortality data.

We suggest the establishment of leptospiral laboratories in the Departments of Microbiology or Parasitology of the Schools of Medicine already running in Brazil (about 14). The Department of Rural Endemics or the Special Service of Public Health (a Brazilian institution connected with the Rockefeller Foundation) could be in charge of laboratories where there is no school of medicine or veterinary.

Research Problems on Leptospirosis—Excerpts from a letter dated 27 February 1961 from **Dr. J. W. Wolff,** Director, Institute of Tropical Hygiene and Geographical Pathology, Department of the Royal Tropical Institute, Amsterdam, Netherlands.

1. Considering leptospirosis as a zoonosis which affects man predominantly as an occupational hazard, many investigations have been made during the last decades on the distribution of various serotypes of leptospires (*L. pomona, L. hyos, L. grippotyphosa, L. canicola* and some others) in *domestic animals* (bovine, porcine, caprine, canine leptospirosis), but these were mainly carried out in U.S.A., U.S.S.R., Israel, several European countries, Australia and New Zealand, while recently some reports were published from Egypt, India, Turkey and a few South American countries in tropical and subtropical zones. Except incidental observations in Congo (van Riel 1946 and later), no survey has been made in tropical regions in Africa and elsewhere. With regard to the possibility of human cases through occupational contacts with leptospira-infected animals this research on the *distribution of leptospires in domestic animals* would be of much value.
2. In connection with 1 (above), investigations in U.S.A., Malaya, Australia and some European countries have yielded important information on the occurrence of *leptospirosis in wild animals* (rodents, marsupials, hedgehogs, etc.). With the exception of some data from Indonesia and Malaya, no information is available on this situation in other tropical regions in Africa, America and Asia. In areas where agriculture and husbandry are promoted, research in this field would be valuable, especially with the aim of devising preventive measures to protect workers and domestic animals against the hazards of leptospiral infections.
3. The classical Weil's disease, caused by *L. icterohaemorrhagiae*, of which the brown rat in many countries is a carrier, appears to be of less public health importance in tropical countries than in countries in the temperate zone. Nevertheless, single observations on the percentages of rats infested with *L. icterohaemorrhagiae* in a few tropical regions have shown that there also a not negligible number of brown rats may be infected, although few cases of Weil's disease are reported from tropical areas. But, as the clinical symptoms of this disease may be mistaken for those of yellow fever (remembering Noguchi's first investigations on the causative agent of yellow fever in Ecuador, where he isolated *L. icterogenes* which later was found to be identical with *L. icterohaemorrhagiae*) and very little research has been done on leptospirosis in yellow fever areas in Africa and America, data on the *global distribution of L. icterohaemorrhagiae in rat species* including *tropical zones* are of epidemiological value.
4. Finally, much work is still to be done on the classification and *serological analysis of strains of pathogenic leptospires*, isolated from human and animal cases of leptospirosis in tropical countries. This work, at present carried out in a few WHO/FAO Leptospirosis Reference Laboratories and some other laboratories, should be extended to all strains isolated in tropical regions.

   These are only some general suggestions, but I presume that a more detailed programme could better be evaluated at a later stage when suggestions from other workers in the field of leptospirosis will have been assembled and critically reviewed.

TYPHUS FEVER (ALL FORMS)

Research Problems on Typhus Fever—Excerpts from a letter dated 13 February 1961 from **Dr. A. L. Craddock,** formerly Nakuru, Kenya, presently Reigate, Surrey, England.

My interest in rickettsial diseases was first stimulated by epidemic louse-borne typhus in North China, then by mite-borne (or scrub) typhus in Burma, and now by tick-borne typhus which I have been studying for the last five years in Kenya. Lest I should mislead you, it is only right to add that I am not a full-time research worker, and my studies have been carried on *pari passu* with my work as a family doctor.

It cannot be said that tick typhus (or tick bite fever as it is known in South Africa, the causative organism being *R. conorii* var. *pijperi* in both cases) is a big public health problem in Kenya because as far as I can determine, it is uncommon both among Africans and Europeans. The infections are nearly always sporadic, though an epidemic affecting R.A.F. personnel was recorded at Mombasa in the 1940s.

There remain many gaps in our knowledge, and I would list the important research problems as:—

1. Why is tick typhus uncommon when ticks are so widely distributed?
2. Why is infection nearly always sporadic and hardly ever epidemic?
3. The distribution and density of the various species of ticks in East Africa.
4. The distribution and density of infected ticks in East Africa.
5. The feeding habits of the ticks concerned and how frequently an infected tick actually transmits infection when feeding.
6. What part, if any, local tissue immunity at the site of the bite plays in limiting the frequency of infection?
7. What is the frequency of infections with flea-borne (murine) and mite-borne typhus (rickettsial pox)? There is evidence that infections with both these rickettsiae occur in Kenya though they seem to be even more uncommon than tick typhus.

My studies have included Q fever but I am not sure whether this comes within the scope of your inquiry.

You must, of course, be aware of the outstanding contributions of Pijper and Gear and others in South Africa, of Roberts, Tonking, Dick, Lewis and Heisch in Kenya and Hoogstraal in the Sudan. Charters in Kenya is also well placed to contribute to this subject.

Research Problems on Typhus—Translated excerpts from a letter dated 13 February 1961 from **Dr. Paul Giroud,** Chief of Service, Pasteur Institute, Paris, France.

There is no doubt that numerous points concerning typhus would merit particular attention. Although epidemic typhus has disappeared, its consequences may still be seen; moreover, it has permitted attention to be drawn to other agents in the group of rickettsiae.

I think that it would be of interest to resolve four problems:

1. Confirm or disprove the hypothesis regarding the possibility

of maintaining strains of epidemic type in animals and in their ticks.

Following serological confirmation done on domestic animals responding to the strain of *R. prowazeki*, I proposed this study to Mme. Reiss-Gutfreund in Addis Ababa in 1952. To date, no other researcher has confirmed the results of this author, which I presented in 1956 to our Society for Tropical Pathology.

Since 1946, I have seen some absolutely typical cases of "fièvre boutonneuse", originating in the wooded regions of the southwest of France where rabbits and ticks abound, and which reacted serologically with *R. prowazeki*. We have reviewed some analogous data on bovines, ovines and caprines from the higher regions of central Africa, in particular with Prof. J. Jadin.

This study could be done equally well in as well as outside of a country of endemic typhus provided it be a country rich in ticks. These infectious agents should be sought in domestic or wild animals and their ticks (i) serologically, and (ii) by isolation of strains into culture and animals.

Animal experimentation supposes the utilization of clean specimens originating, for example, in uninfected areas or of specimens raised without virus.

Finally, all maintenance of infecting strains in the specialized laboratory should cease.

If the culture studies are negative, it would be necessary to try to isolate strains in animals, whereas other animals inoculated with large doses would present evidence, by their antibodies, of the antigen present in the ticks or in the animals' blood.

2. Transformation in type of an epidemic strain, murine strain, "boutonneuse" strain.

3. Study the agents causing abortions, apart from hormonal or serological causes and without apparent illness, in women.

4. Study the inapparent or latent diseases of various types in connection with vascular illness: vascular lesions of the limbs, blood vessels of the brain, fundus of the eye.

DENGUE

Research Problems on Dengue—Excerpt from a letter dated 15 February 1961 from **Dr. W. McD. Hammon,** Head, Department of Epidemiology and Microbiology, University of Pittsburgh Graduate School of Public Health, Pittsburgh, Pennsylvania.

Some of the problems in dengue are just how many types we do have; there appear to be at least five at the moment. There is no real answer to whether there is a jungle dengue fever reservoir or whether any animal plays any significant role in the dengue cycle, which may or may not be a zoonosis. Next, the vectors capable of transmitting some of the newer dengue types in many parts of the world have not been investigated at all; for example, we appear to have an isolation of one dengue from *Culex tritaeniorhynchus*, a well-recognized vector of Japanese B encephalitis and a heavy feeder upon birds. And lastly, I would point out the relationship of dengue viruses to hemorrhagic fevers of the southeast Asian area as they have been encountered in the Philippines, Thailand and now in Singapore. Are these biological variants of dengues producing classical dengue disease elsewhere? Just how do these viruses fit into the dengue family other than by immunologic classification?

SMALLPOX

Research Problems on Smallpox—Excerpts form a letter dated 1 February 1961 from **Dr. C. Henry Kempe,** Professor and Head, Department of Pediatrics, University of Colorado Medical Center, Denver, Colorado.

We are hoping to establish a small permanent research laboratory in Madras. The areas of activity requiring further investigation seem to be as follows:

1. Air sampling to clearly elucidate the infectious dose.
2. Investigation of chemoprophylactic agents such as N-Methylisatin Thiosemicarbazone and others.
3. Production on a worldwide basis of freeze-dried egg vaccine to take the place of liquid calf lymph.
4. Further investigation of the etiology of hemorrhagic smallpox, particularly as regards its incidence in pregnant women at term.
5. Evaluation of support of medical therapy, particularly as regards adrenal steroids.

You are undoubtedly aware of the worldwide eradication compaign against smallpox now being carried out by the World Health Organization and its member states. It is clear that this campaign is doomed to failure because of the poor nature of the vaccine employed. It is our hope that we might be able to focus attention on some of the research needs outlined above by the establishment of a small permanent research laboratory in Madras in the fall of this year.

Research Problems on Smallpox Vaccination—Excerpts from a letter dated 12 February 1961 from **Dr. R. Sanjiva Rao,** Poona, India.

Smallpox being a recurring problem in India, the strains of vaccinia virus used in the manufacture of vaccine lymph in the different laboratories in India were tested for their immunizing value against smallpox and found to be satisfactory.

However in my opinion the subject of vaccination in this country poses two problems which may require investigation. It is the practice in almost all the states in India, to have four insertions for primary vaccination, two on each arm. As you may be aware primary vaccination in India is practically always carried out in infants. With potent vaccine lymph the maximum reaction is so severe that the infants suffer considerably. In the case of advanced sections of the population who usually cooperate with the Health Authorities the infants are sometimes given only one insertion with the stipulation that the infants should be re-vaccinated after one year and certainly within two years. As is obvious the practice of having four insertions is based on the assumption that the immunity produced is proportionate to the scar area. I have myself attempted on a very small scale an assessment of the immunity conferred by single and multiple insertions by the response to re-vaccination after varying intervals in different groups of children. The results appeared to indicate no very appreciable or clear-cut difference in the immunity response of the different groups, though the number of children tested was not big enough for statistical significance. Unfortunately for several reasons the investigation could not be continued. I have not yet come across any data concerning response to re-vaccination after varying intervals ranging from one year to three years after primary vaccination with a single insertion ¼ inch long as is prevalent in most Western countries. It appears to me therefore that an investigation on this subject may prove useful to India and other countries where multiple insertions for primary vaccination are prevalent.

Another aspect of the vaccination problem may in my opinion require consideration. It is usual to consider that it is necessary to have a typical Jennerian vesicle with marked areola for the production of adequate immunity. Does response with a smaller vesicle with only little areola after primary vaccination indicate a smaller measure of immunity?

This question will have a bearing on the dilution of vaccine lymph for primary vaccination, it being admitted that for re-vaccination it is necessary to have the usual concentration of virus. With lyophilized virus coming into use in most countries the question of deterioration of the potency of virus suspension during transport does not arise.

The above are the two aspects of vaccination problem which occur to me as requiring investigation. The WHO has sponsored a campaign for the eradication of smallpox by mass vaccination and it is expected to gather momentum shortly. The above investigations should prove of much value in the conduct of the campaign in India.

YELLOW FEVER

Research Problems on Yellow Fever—Excerpts from a letter dated 6 February 1961 from **Dr. Augusto Gast-Galvis,** Director, Instituto de Estudios Especiales "Carlos Finlay," Bogotá, Colombia.

1. Virus behavior in the extra-human reservoirs (vertebrates and arthropods). A careful investigation would probably demonstrate the virus in other mammalia than monkeys, and also other mosquitoes than *Haemagogus* could be considered in the transmission of yellow fever virus. The very small population of these reservoirs in the endemic zones confirms the hypothesis.

The primates do not offer ideal conditions because of slow procreation and also because after being infected they get immunity forever or they die.

2. The simultaneous apparition of cases of yellow fever in different areas suggests the necessity of investigating how the virus is transported from one place to another. For this reason it is necessary to study deeply the ecology of the animals known as receptives and others that could have an important role in transmission.

3. We do not know how the virus persists in the dormant periods in well-known endemic zones. It is well known that from one to five years have passed without cases of yellow fever appearing in these zones, and we cannot understand how the virus persists during this time.

4. Finally, it is very important to remember that arborvirus investigations in Colombia have the best opportunities.

Research Problems on Yellow Fever—Excerpts from a letter dated 15 February 1961 from **Dr. J. Austin Kerr,** Pan American Health Organization, Washington, D. C.

Three research problems in yellow fever seem to me to be worth study at the present time:

1. Studies of the biology of *Aëdes aegypti*, especially those factors that permit it to survive in the southeastern USA on the northern limit of its range. More specifically, what are the combinations of time and low temperature that are 100 per cent lethal to the eggs of aegypti? Knowledge about this and other points would almost certainly reduce the cost of the eradication of aegypti from the continental USA by many millions of dollars.

2. Studies of the cheapest way to organize and administer the aegypti eradication operations in the USA. Eradication is indicated because we do not want to reinfect our Latin American neighbors, who have eradicated the pest at a very considerable cost.

Present funds for this purpose are extravagantly small.

3. Studies on the duration of immunity produced by 17D yellow fever vaccine. A pioneer study in Brazil showed neutralizing antibody present in 96 per cent of 108 people 17 years after a single inoculation.

Further studies are indicated of vaccinations under diverse and less favorable conditions.

Research Problems on Yellow Fever—Excerpts from a letter dated 6 February 1961 from **Dr. Kenneth C. Smithburn,** Indianapolis, Indiana.

Despite the fact that there are at hand practical methods for control of the urban vectors and effective vaccines for the prevention of yellow fever on a mass population basis, there are unsolved problems which merit investigation. Man is now at risk principally when exposed to extra-human or sylvan cycles of infection, which are still not entirely understood. Points which deserve attention in this field:

Do the outbreaks of infection in wild primates spread through movements of monkeys, movements of vectors, or with the aid of other factors? How are they initiated, or are they continuous? If they are not continuous, how and where does the virus survive between outbreaks? If other hosts than wild primates and the sylvan arthropod vectors are involved, are they amenable to control in such manner as to interrupt the cycles of infection?

With reference to the infection in man, there is need for a method for rapid early diagnosis. In view of the characteristic high level viremia, there is a possibility that modern methods might be applied to yield a "bedside" diagnostic test. Also, since it is known that fatal yellow fever is regularly characterized by extensive hemorrhage, studies should be made (in rhesus monkeys) to determine whether this aspect of the disease can be controlled, and, if so, whether death can thus be prevented.

There is another subject I should like to mention, although it is beyond the scope of the problems I was invited to discuss. For some months in 1940 when I was working in the Belgian Congo, one of my duties was to examine and report upon the pathological findings in tissues—mainly liver specimens taken with the viscerotome—from persons dying in various areas of the Congo after brief illness, the objective being to discover cases of yellow fever. In the course of this work I was much impressed with the very high incidence in persons of all ages of lesions of schistosomiasis. I got the impression that the distribution of cases was in relation to the great rivers, of which there are several. Whether these lesions were coincidental, or part of a death dealing disease I do not know, but I suspect that this disease is a serious medical problem in tropical Africa.

Research Problems on Yellow Fever—Excerpts from a letter dated 3 March 1961 from **Dr. Fred L. Soper,** Director, Pakistan-SEATO Cholera Research Laboratory, Dacca, East Pakistan.

a) *Mechanism of persistence of virus in nature.* It has been suspected for fifty years that monkeys are involved in the yellow fever cycle, and proof of this involvement has been available for almost thirty years. Even as this proof became apparent, however, some field workers encountered difficulty in explaining all of the epidemiological observations on the assumption that this was the only non-human cycle. Considerable effort was expended over a number of years without coming up with anything else, except for some very suggestive results in marsupials, but still today there remains a hard nucleus of unconvinced workers. (Areas of difficulty include the Muzo district in Colombia, and areas in Africa in which immune bush babies are found, without evidence of the involvement of other species.)

b) *Behaviour of Aëdes aegypti in Africa.* In the Americas, though *A. aegypti* was widespread in most of the lowland regions of the areas other than the Amazon Valley the invasion of which by aegypti had not been completed when eradication was undertaken, probably because of the difficulty of working up river beyond the line of the water falls, aegypti has not been found breeding in the forests completely away from human habitation. And this in spite of the fact that the range of aegypti was roughly from Buenos Aires to Oklahoma! The limitation of aegypti breeding to the vicinity of human habitations has made possible the continental program for the eradication of aegypti from the Western Hemisphere. This program is well advanced, so far advanced in fact that it is certain that no difficulties are to be encountered with jungle breeding aegypti. As a result of the anti-aegypti work in the Americas, there has been no evidence of aegypti-man-aegypti endemicity since August 1934. On the other hand, I learned in Accra in December 1959 of an aegypti-transmitted outbreak nearby at Tema a few months previously, which had been discovered almost accidentally.

The existence of jungle yellow fever precludes the possibility of eradicating yellow fever and forces one to raise the question of whether eradication of aegypti in the towns and cities of Africa is possible, or whether an attempt at such eradication would be doomed to failure through the rapid re-invasion of human habita-

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* ERADICATION CARRIED OUT ACCORDING TO THE STANDARDS ESTABLISHED BY THE PAN AMERICAN HEALTH ORGANIZATION

tions by the aegypti which are still to be found breeding in the forests of Africa. If the aegypti which were able to come to the Americas aboard ships, breeding in artificial containers, were unable to adapt to life in the varied forest conditions between Argentina and the United States, is it not possible that the urban aegypti of Africa is not adaptable to the conditions of the African forest, and conversely that the forest aegypti, persisting in the original forest habitat of Africa, may not be immediately and easily adaptable to life in African villages? On the answer to this question rests the possibility of making Africa impervious to aegypti-transmitted yellow fever, since this species is not present in the forests in sufficient numbers to be an important factor in maintaining the infection there.

c) *Combined 17 D yellow fever and smallpox vaccination.* Studies on getting a practical easy method of using these two vaccines together should be completed. In absence of evidence of difficulties in use of combined vaccine, effort should be made to remove time restrictions now being imposed in certain countries preventing the simultaneous double vaccination for the two diseases.

I am purposely refraining from suggestions on further studies on yellow fever virus, immunology, etc. Likewise, I am not referring to questions relating to susceptibility and resistance to insecticides of aegypti. It is not that I do not consider these important problems but that I know you will get more adequate suggestions on these matters from others who have been personally involved in working on the yellow fever problem long after I joined the bystanders on the side lines.

LEISHMANIASIS

Research Problems on Leishmaniasis—Excerpts from a letter dated 5 March 1961 from **Dr. Leonidas M. Deane,** Departamento de Parasitologia, Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil.

Many of the present problems on leishmaniasis have been recently pointed out by Prof. Garnham (WHO paper, June 20, 1960), and I don't see much to add to his recommendations. I would like, however, to emphasize the following items:

1) What is the systematic position of the different *Leishmania* of man? The reference centers, for the maintenance of strains and species of *Leishmania* from different areas, as recommended by Prof. Adler (in Lisbon, 1958) would help to answer this question. The various strains kept in cultures, hamsters and deep-freeze could be thoroughly compared as to their morphology by electronic microscopy, their immunological behaviour and development in different species of sandflies. The agar-precipitation test could be of much value, and in this Department Dr. Nussenzweig has adequate experience on the technique and is interested in the subject.

2) What is the frequency of the so-called "aberrant forms" of kala-azar? Are there asymptomatic infections in man and, if so, in what proportions? Proper diagnostic techniques should be developed to detect such infections.

In the New World more attention should be given to the follow-up of treated cases in order to find out the rate of rechutes and of post-kala-azar dermal leishmaniasis.

3) Which is the adequate method of diagnosis to be used in epidemiological surveys to detect human cases of kala-azar? Bone marrow, spleen or lymph node punctures of the suspected cases would not include the aberrant forms. The complement-fixation test with acid-fast bacilli antigen seems to be very sensitive and could possibly be used as a screening method; however, since it is not quite specific (cross-reactions occur with Chagas' disease, among others), additional tests would have to be performed with the positives.

4) The importance of man as a source of infection should be more thoroughly investigated by feeding laboratory-bred sandflies not only on typical active cases but also on aberrant cases and on treated patients, with or without dermal lesions. (Parasites have been found in liver smears as long as one year after clinical cure of the patient; whether such patients are infective or not, remains to be learned.)

5) In areas where dog is a reservoir, compare its importance with that of man through studies on the capacity of each of the two hosts to attract and to infect the sandfly vectors, the duration of their infection and the prevalence of the infection among human and canine populations.

6) Such studies should be extended to the wild reservoirs, where these occur.

7) Look for other reservoirs, domestic or wild, through more sensitive methods than the direct search of leishmaniae in the viscera (i.e., cultures and hamster inoculation, as being done in Africa).

8) Find out how the virulence of the parasites from the wild reservoirs (i.e., the fox, in Brazil) compares with that of human and canine strains. Hamster inoculation could be the first step.

9) Study the habits of the wild reservoirs (habitat, migrations, contact with humans and dogs and the sandfly vectors).

10) Determine the species of sandfly vectors in each area and study their bionomics (domesticity, feeding preferences, longevity, susceptibility to infection, seasonal variation, etc.). Find out simpler and more accurate methods than those presently employed, for detecting the breeding-places of phlebotomi.

11) Establish colonies of sandfly vectors in chosen laboratories. One of such breeding centers, in South America, could be this Department (Parasitology, Faculty of Medicine, University of São Paulo).

12) Give due attention to studies on other means of transmission besides the biting of sandflies and try to evaluate the importance of such methods in nature.

13) Intensify studies aiming to find a vaccine for kala-azar.

14) Evaluate the result of insecticide house-spraying on the incidence of human and canine kala-azar in different areas.

15) Study methods to control the wild reservoir hosts.

16) Advise WHO as to the special facilities which it should provide to investigation centers.

17) Organize periodic meetings of workers from different countries for the exchange of information.

Research Problems in Connection with Leishmaniasis—Submitted 12 October 1961 by **Dr. Marshall Hertig,** Medical Entomologist, Gorgas Memorial Laboratory, Panama, Republic of Panama.

The many aspects of leishmaniasis which are in need of investigation fall into two main categories: (1) the several diseases comprising the leishmaniases themselves (epidemiology, method of transmission, animal reservoirs, therapy), and (2) control. In this memorandum it is at times convenient to consider the individual diseases separately or in terms of different geographic situations, and at other times to consider phenomena or problems common to all.

The leishmaniases include: (i) kala azar, or visceral leishmaniasis, of man and dogs, caused by *Leishmania donovani*, distributed from the Mediterranean littoral to North China and extending southward into the Sudan and East Africa, and also found in certain areas in Brazil and several other countries in the New World; (ii) oriental sore, or cutaneous leishmaniasis (*L. tropica*), extending from the Mediterranean through the Middle East into India; (iii) American muco-cutaneous leishmaniasis (*L. brasiliensis*) which occurs from Yucatan to northern Argentina; (iv) the form of cutaneous leishmaniasis known as "lepromatous" which has been described from Venezuela.

All the leishmaniases have in common the fact that the two most fundamental parts of the whole problem, the reservoirs and method of transmission, remain partly or wholly unsolved. With regard to transmission it is quite true that the ability of *Phlebotomus* sandflies to transmit by biting has been demonstrated for Indian and Chinese kala azar and for oriental sore in Palestine. Even in the absence of comparable demonstrations for other species and regions, the now considerable body of information about sandflies and leishmaniasis,—distribution, abundance, association with leishmaniasis, the striking and characteristic growth of *Leishmania* in sandflies in the laboratory, the occurrence of natural infections in wild-caught sandflies,—fully justify the hypothesis that all the leishmaniases are transmitted by *Phlebotomus*.

I. *The reservoir problem:* Is there a reservoir other than man in all cases or only for certain species in certain places?

A. Situations where reservoirs have been demonstrated or are probable

1. Oriental sore

a. Turkmenistan. Semi-desert region; high endemic human rate; infected desert rodents found, especially gerbils; *Phlebotomus* found resting and breeding in burrows of these rodents; sandflies also infected with *Leishmania.* While no experimental transmissions were carried out, this is one of the few situations where the observed epidemiology seems to be satisfactorily explained.

b. Soviet Middle Asia. Agricultural development forced rodents into open country, leaving oasis free of infection except around periphery.

c. Iran. Similar to Turkmenistan, with infected gerbils found.

d. Dead Sea region. Superficially the situation resembles that of Turkmenistan, although details have never been worked out. The desert far from human habitations has an abundance of sandflies and there are rodent burrows under nearly every bush.

2. American cutaneous leishmaniasis. The disease is closely linked with forests, often sparsely inhabited. The epidemiology "calls for" a reservoir other than man and there is general agreement that there must be such reservoir. Naturally infected rodents have been found in Panama and Brazil, but the reservoir problem is still far from solution.

3. Kala azar

a. Sudan and East Africa. In the Sudan kala azar has been contracted by military patrols in otherwise uninhabited areas. In East Africa Heisch has recently recovered *Leishmania* from rodents in a kala azar area.

b. Soviet Middle Asia. Scene of reclamation of previously uninhabited land in Tadjikistan. Naturally infected jackals found. Elsewhere, in established towns with endemic kala azar, domestic dogs are found infected.

c. Brazil. Deane has found wild foxes naturally infected, as well as domestic dogs in association with human cases.

d. Mediterranean region; China. Infected domestic dogs are frequently found in association with human cases. Various investigators believe that dogs are the reservoir in these areas.

B. No reservoir demonstrated

1. Kala azar in India. It seems that domestic dogs are not infected (for reasons not understood) and this has led many investigators to believe that man himself is the sole reservoir. This point of view is supported by the fact that sandflies can be quite easily infected by feeding on Indian kala azar patients, whereas in other countries it is only rarely that sandflies can be infected by patients.

However, these considerations should be borne in mind: In India kala azar is largely a rural disease and it seems to me that a reservoir is eminently possible. There is also a curious feature of the early history of kala azar in India. In the 1860's and 1870's the disease began to spread in epidemic form in the lower end of the Brahmaputra valley. The epidemic produced panic and was in effect depopulating, not only on account of the high mortality but also the flight of people from infected villages. At that time the Brahmaputra throughout its 300-mile course in Assam had steamboats, commercial traffic, pilgrimages, etc. If the factors necessary for transmission were all present and lacked only the introduction of the parasite via the human host, there should soon have been foci established throughout the valley. However, the disease spread at a steady rate of about 10 miles a year and it took 30 years to reach the upper part of the valley. The slow spread would correspond better with the advance of an efficient vector or reservoir or a combination of them. This, of course, does not exclude the possibility that man himself was and still is the sole or chief reservoir. Nevertheless I believe that in the rural setting of this disease in India, a reservoir other than man should still be looked for.

2. Oriental sore in some Near East and Mediterranean cities. Wild rodent reservoirs have been demonstrated or are probable in the desert regions mentioned above. On the other hand, various cities, closely built up and densely inhabited, have been classic foci of oriental sore. In these cases no reservoir has been demonstrated and various investigators believe that transmission takes place from person to person via the bite of sandflies. In this case it is necessary to assume that sandflies become infected by feeding on the narrow area of unulcerated skin surrounding the ulcer. I know of no observational or experimental evidence that enough sandflies feed accurately on such restricted areas, with resulting infections, to account for the observed epidemiology.

II. Identification and nomenclature of species and strains of *Leishmania.* The three names, *Leishmania donovani*, *L. tropica* and *L. brasiliensis*, are commonly accepted,—for convenience at any rate,—for the respective parasites of human and canine kala azar, oriental sore and American cutaneous leishmaniasis. In the case of kala azar, the disease differs in a number of respects from country to country, e.g., as to age incidence, relative response to treatment (Sudanese kala azar is more resistant to treatment than the others), frequency of dermal involvement after treatment. With oriental sore, two general clinical types, "dry" and "moist", are recognized in some places, as in Soviet Middle Asia, where they are associated respectively with urban or rural environment. In American cutaneous leishmaniasis there are several geographic strains recognizable clinically by the proportion of cases in which invasion of the mucosa occurs (virtually none in Yucatan and northern Guatemala; few, probably not over 3 or 4 percent in Costa Rica and Panama; around 80 percent in Brazil and Paraguay). Furthermore, Guatemalan and Panamanian strains behave differently in experimentally infected hamsters and sandflies and these two strains can be separated by a precipitin reaction.

It will eventually be necessary to revise the nomenclature to take account of these differences of varying types and degrees. A few investigators have already given subspecific names to local strains. At the other extreme there are some who urge the concept of "leishmanial unity," i.e., that all the leishmaniases are caused by one species, with differences in behavior, clinical syndromes, etc., the result of local conditions, and depending on the species of host or vector.

I believe that this phase of the problem can be clarified only by an extensive comparative study of as many species and strains of *Leishmania* as possible. Such study should be done by one group of investigators, with initial objectives the determination for all strains (1) their behavior in a broad series of experimental animals, including hamsters, mice, gerbils, cotton rats, monkeys, etc., as well as any available wild animals which lend themselves to laboratory procedures. (2) Behavior in *Phlebotomus.* (3) Cultural characteristics. (4) Serology, specific or group reactions, including precipitin reactions. (5) Immunology: cross immunity; the Montenegro reaction, its validity other than for American cutaneous leishmaniasis in man. (A workable test which would reveal prior subclinical infections in man, as well a test which could be used in a survey of wild-caught animals, would be enormously useful.) In addition to the mammalian infections, this comparative study should also include those leishmaniae which have been recovered from lizards or other vertebrates.

III. *Method of transmission.* Valid experimental transmission of leishmaniasis has been achieved on only three occasions (kala azar in India and China, oriental sore in Palestine). It is highly desirable that transmission experiments be carried through in other regions with other species of *Leishmania* and *Phlebotomus*, to determine not only which species can and do transmit the disease in a given locality, but also, and of probably greater importance, to determine the factors underlying transmission.

It is well known that mere infection of the sandflies is not enough to insure transmission. There is the record of the many years of failure to transmit either kala azar or oriental sore in the laboratory before hitting upon the very simple devices of giving the Indian sandflies access to boiled raisins and of adding salt to the mixture of culture and blood fed the Palestinian sandflies. In the Chinese transmission, wild sandflies taken from the kennel of an infected dog transmitted kala azar to hamsters. In this case the physiological equivalents of raisins or salt were conceivably available to the sandflies in nature before they entered the experiment. This phenomenon,—the effect of these "extraneous" substances in making possible experimental transmission and the determination of their equivalents in nature, has never been investigated. It may be noted that our group in Panama has been carrying on transmission experiments using both animals and man, so far with negative results, in spite of having infected sandflies and using raisins or salt or both.

The whole kala azar problem is at present being studied in both the Sudan and East Africa, and we may hope for important results. With regard to other kala azar areas it has seemed to me that canine kala azar in the Mediterranean, which is so important in the epidemiology, offers a thoroughly neglected opportunity to work out the transmission problem. Much of the ground-work has already been done. The Mediterranean species of *Phlebotomus* have been worked on for many years and a great deal is known about their distribution, habits, laboratory rearing, and their probable, but not demonstrated, role as vectors. Infected dogs, with large areas of the skin loaded with leishmaniae, are known to be excellent sources of experimental sandfly infections. Differential infection rates as to species of artificially fed sandflies have been determined. Curiously, however, no transmission experiments with sandflies have ever been done with Mediterranean dogs. Work of this sort should throw important light on the whole Mediterranean kala azar situation.

Ecology of Phlebotomus. Any work with *Phlebotomus* in connection with any of the leishmaniases obviously involves not only experimental procedures in the laboratory but a study of the field ecology. Satisfactory techniques of rearing sandflies and their experimental manipulation have been pretty well worked out, but there is still a great deal to be done in the field. Very little is known about the breeding places of various of the supposed vectors of leishmaniasis. For example, *P. sergenti* and members of that group, generally assumed to be the vectors of oriental sore in certain areas of the Mediterranean and Near East, often occur in densely built-up urban communities, such as parts of Baghdad and the old Turkish part of Canea in Crete (at least this was true before DDT). I can't recall that anything is known about the breeding places of this group or its habits outside of buildings. *P. perfiliewi*, a Mediterranean species belonging to the *P. major* group (which group incidentally is ordinarily implicated in the transmission of kala azar) is apparently the transmitter of oriental sore in the Abruzzi, an Italian province on the Adriatic. This is a well cultivated area and these sandflies can be enormously abundant in villages, but again nothing is known about their basic ecology.

Our own group in Panama, starting with almost nothing known about the breeding places of New World species, has been able to recover larvae in large numbers and thus demonstrate the larval habitats (in soil and leaf litter) of 15 species, as well as the diurnal shelters of some of the common man-biting species which were previously unknown. There remains, however, the determination of the natural hosts other than man, flight habits, food other than blood,—in short, the whole natural history of *Phlebotomus* in relation to reservoirs of leishmaniasis.

Much of the work on kala azar and oriental sore in the Mediterranean and Near East has been done in urban and village communities where sandflies freely enter houses and stables and remain during the day. Most of the work has concerned these abundant and easily studied sandflies, with certain species thought (probably correctly) to be the vectors of the local disease. However, the concentration of effort on these house-haunting species has resulted in the neglect of the surrounding countryside. By and large the natural history of sandflies outside Mediterranean villages is a blank. Surveys should be made in the open country, gallery woodland along streams, groves, hedge rows, etc., searching caves, hollow trees, rock crevices and the like, making night time catches with animal bait (e.g., man, horses, cattle) and employing animal-baited and light traps. It could well be that catches of sandflies in areas away from villages would be scanty compared with house catches, but any information secured could be of great significance in connection with sandflies and potential reservoirs, and hence with the basic epidemiology. Any work on the ecology of sandflies in any leishmaniasis area would be a contribution to the whole problem.

IV. Clinical phases; therapy; pathology

1. It would be desirable to develop an oral method of treatment for the sake of rural and forest populations for whom visits to clinics or health centers are difficult or out of the question. In the case of American cutaneous leishmaniasis pyrimethamine has shown much promise.

2. American cutaneous leishmaniasis; some questions:

a. Lymphatic involvement. To what extent does this occur outside of Panama? and in oriental sore?

b. Nature of satellite lesions without parasites?

c. Method of transport within the body? Where does the parasite hide out to reappear years later in the nasal mucosa?

d. Multiple lesions; How caused? Separate bites? Autoinoculation? Transport by blood or lymph? Contrast with typically single lesion of oriental sore.

V. *Control. Phlebotomus* is extremely vulnerable to residual DDT. Experimental projects in the Dead Sea region of Palestine, in Peru and in the Abruzzi in Italy, have shown that sandflies can be promptly and effectively controlled by DDT applied in dwellings and stables as in anti-malaria campaigns. As a by-product of DDT spraying undertaken primarily for malaria control it has been shown (e.g., in Greece) that a single annual application virtually wipes out *Phlebotomus*, indoors and out, within the entire area of a village where the dwellings are close together. The explanation is undoubtedly that sandflies, with their typically short flight range, are bound to encounter lethal surfaces quite promptly. Effective control of oriental sore following DDT has been demonstrated in Crete and Italy. The results in terms of kala azar control seem not to have got into the literature,—at least I know of no clearcut large-scale project in which the results of DDT, whether primarily for malaria control or otherwise, have been measured in terms of kala azar. Anti-malaria work in places such as India must surely have included kala azar areas. The effects on sandflies and kala azar should be evaluated.

So far no effective resistance to DDT has been demonstrated for *Phlebotomus*.

In the early history of DDT the urgency of malaria overshadowed the concurrent leishmaniasis problems and little attention was paid to the incidental effects on the latter. Nonmalarious pockets of leishmaniasis were left untreated and may still remain untreated. Within the past year or so I have learned that in areas in Italy, in at least one case the site of a successful oriental sore project, DDT treatment has been discontinued. It seems to me that with the demonstrated effectiveness of DDT in compact communities, urban or village, it would be worth while to undertake systematic control of leishmaniasis in various Old World endemic areas, notably the Mediterranean region and India. This work would, of course, be properly combined with anti-malaria programs, but leishmaniasis should have its place in its own right.

The control of American cutaneous leishmaniasis, with the population at risk scattered in forests, is another matter. Separation of dwellings from the forest by a cleared space of several hundred meters apparently gives a certain amount of protection in Panama. On the basis of work in Peru it is probable that some protection would be given by the DDT treatment of dwellings and stables and also large surfaces nearby, such as stone walls, rock outcrop, large tree trunks. DDT has not yet been tried in a forested environment with or without clearings around houses. At the invitation of the Costa Rican Government and the International Cooperation Administration, Dr. G. B. Fairchild and I visited Costa Rica in connection with leishmaniasis. Among other things we suggested an experimental test of DDT along these lines, which, we understand, may be carried out in the near future.

Research Problems on Leishmaniasis—Excerpts from a letter dated 7 May 1961 from **Dr. P. E. C. Manson-Bahr,** Department of Health, Nairobi, Kenya.

Present position of leishmaniasis. In India, Central Asia and the Mediterranean area, kála-azar has virtually ceased to exist following malaria eradication programmes which have led to extensive spraying. Cutaneous leishmaniasis has also disappeared from Persia and Iraq following similar spraying. There is just one danger appreciated in India where cessation of spraying when surveillance is instituted may lead to a reappearance of sandflies and the disease kala-azar, which is so chronic that the human reservoir of infection is very persistent.

In the Sudan and East Africa the position is very different. There was a very severe epidemic in 1953 of kala-azar in the Sudan when thousands of cases occurred and when whole villages were decimated by the disease, reminiscent of India in the late nineteenth century. This was ascribed to shifting population and opening up of new areas for development. The disease is still extending its range in the Sudan. A similar epidemic on a smaller scale occurred in Kenya where the disease is still extending its range and where we had over 1,000 cases last year. It appears unlikely that spraying for malaria eradication will affect the incidence of kala-azar in these areas since in the Sudan the incidence has actually increased following some spraying for malaria control. This is because the epidemiology of the disease in these areas is different from India and North Africa and we still know little about reservoirs, vectors, etc.

Present research in being. Present research is being conducted in the Sudan by NAMRU-3 based in Cairo and in Kenya in the department of insect-borne disease. In the Sudan, work has started on the search for reservoirs and a study of the sandflies which occur and bite man is in progress. In Kenya, work is being done on the epidemiology of the disease with special reference to the importance of termitaries and the role of *P. martini* in the spread of the disease. A trial is in progress to test the value of a live vaccine prepared from a ground squirrel strain of *Leishmania* in the prevention of kala-azar. Some 3,000 people have been included in this scheme.

Research necessary. (i) Techniques of epidemiological research need to be worked out to determine infection past and present in man and animals suitable for bush work far from any developed centre. These include serological, biochemical and intradermal tests such as the leishmanin test. Work is proceeding along these lines at NAMRU-3 in Cairo.

(ii) Basic knowledge of the sandflies of the region, their susceptibility to infection with *Leishmania*, their life history, feeding habits, and their whole ecology is necessary. Little is known about these basic factors.

(iii) The role of other biting insects and direct contact in spread of kala-azar in epidemic conditions.

Until these questions are answered, it will not be possible to know whether the disease will spread right across Africa South of the Sahara especially with development in this area. The rapidity with which kala-azar from being a rarity has become a major problem in the Sudan and East Africa has surprised everyone and has led to calls for action which could be embarrassing.

RABIES

Research Needs in Field of Rabies—Submitted 30 January 1961 by **Dr. Karl Habel,** Chief, Laboratory of Biology of Viruses, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland.

Prophylaxis in man. Although much work has been accomplished in this area through the Expert Committee on Rabies of the W.H.O. several questions require further research for their clarification.

1. Further experimental and field studies of the efficacy of local applications of dried antirabies gamma globulin to the bite wound as emergency treatment. Russian rabiologists have reported good results. Not only efficacy but also safety from the standpoint of anaphylactic reactions need to be investigated on a more sound experimental basis.
2. Further studies in man concerning vaccine and antiserum schedules to produce the greatest degree of protection and reduce the interference of antiserum antibody with vaccine antigen in their combined use.
3. Pre-exposure immunization for high-risk groups is now an established procedure, but the best type of vaccine, schedule of doses, route of inoculation (intradermal vs. subcutaneous), and what to do with non-reactors still need to be determined.
4. A practical tissue culture source of virus for preparation of a killed-virus vaccine would be a great advance since all presently available vaccines are still very crude biological products.
5. Nature of immunity to rabies and immunological mechanisms involved in post-exposure prophylaxis.

Prophylaxis in animals. With the widespread use of the Flury live virus chicken embryo vaccine as an effective vaccine for prophylaxis in canines and bovines, the materials are available. However, efficient and simple tests of the potencies of these vaccines are still not available and are needed. Furthermore, the technics of freeze-drying these products leave much to be desired concerning their stability under field conditions.

Ecology. Much more work is needed to understand the factors responsible for the maintenance of rabies infections in nature, especially in the wild species. The possibility that some animals other than bats may serve as healthy, silent carriers of the virus is always being raised but little evidence has been forthcoming. The infection in bats—known carriers—is not too well understood in relation to such things as the effect of hibernation and external temperatures, physiological stimuli or even if bats represent a source of infection for other species besides man and cattle. The existence of rabies in the local bat populations of many areas of the world is not known because surveys have not been made.

Chemoprophylaxis. Rabies is the one virus infection of man where the exact time of exposure is known and would represent an ideal situation for the use of an antibiotic or chemical agent with antiviral properties. Physiological states of the neuromuscular junction may have significant effects on invasion by rabies virus and should be looked into now that a wide variety of pharmaceuticals are available which alter this end-organ.

Research Problems on Rabies—Excerpts from a letter dated 1 February 1961 from **Dr. P. Lépine,** Institut Pasteur, Paris, France.

The most important research problems in rabies are (in order of decreasing urgency):

1) Investigations on preparation of a rabies vaccine devoid of central nervous system substance and with reduced protein con-

tent. Such vaccine could be obtained either from purification and extraction of rabies virus from infected animal CNS or more probably from virulent fluids of tissue cultured rabies virus on non-nervous cells.

2) A better understanding of rabies immunity after vaccination, especially regarding the time and speed of its onset, its duration with special reference to the evaluation of CNS resistance to rabies infection.

3) Improved diagnostic methods enabling us to rapidly recognize the presence or absence of rabies infection, whether latent or active, in suspect or biting animals.

4) Investigations into the ecology of rabies virus with special reference to natural reservoirs and the survival of rabies infection in wild life of the tropical zone.

These points have been, at least partly, mentioned by the last (fourth) W.H.O. Rabies Experts Committee held in Geneva, December 14-19, 1959, the views of which are expressed in the W.H.O. Technical Series pamphlet No. 201.

If I may express a general opinion regarding problems of tropical medicine, I should point out as number one problem the investigations into the arbor viruses, their ecology, their immunological relations, their mode of transmission and their control.

HYDATID DISEASE

Research Problems on Hydatid Disease—Excerpts from a letter dated 8 February 1961 from **Dr. Calvin W. Schwabe,** Department of Tropical Health, Schools of Public Health and Medicine, American University of Beirut, Beirut, Lebanon.

The following would be among those research problems in connection with hydatid disease which seem to me to be particularly pertinent to control. It should of course be noted that given the proper situation, with adequate governmental organization and an understanding and cooperative population, the disease can be reasonably well controlled and possibly even eradicated from selected areas with present knowledge and techniques alone. The Icelandic experience witnesses to this. However, the proper combination of circumstances does not presently appear to exist anywhere else in the world where hydatid disease is currently a major problem.

My own experience with the disease clearly suggests that major problems of control in many areas are tied very closely to properly motivating the populations concerned to lend their full cooperation. Inasmuch as people, their attitudes toward dogs, their methods of food procurement and processing and the like are so related to hydatid disease control, critical research needs in each local situation are as much sociological as biological. I won't comment at any further length on this aspect of research except to say that funds for extremely important studies of this type are generally difficult to come by. In my opinion, however, many of the failures to date in hydatid disease control, and most efforts have more or less failed, resulted from an underestimation of the sociological factors involved.

Another extremely important area for further research is in the epidemiology of the disease. We know for parts of North America, for example, that a wildlife cycle is important in maintaining unilocular hydatid disease. Knowledge of the presence or absence or importance of possible wildlife cycles for other parts of the world is almost entirely lacking. In East Africa, for instance, the disease appears to be much more important both economically and to the health of certain segments of the population than the very limited published reports suggest. It is not at all clear that the level of infection in domestic ruminants and man in this part of the world is explainable by the known levels of infection in domestic dogs. Some years ago Ortlepp described species of *Echinococcus* other than *E. granulosus* from wild African carnivores, but this work has never been followed up and knowledge of possible wildlife cycles for the disease in Africa is presently lacking. In this connection it should be mentioned that some of the most productive research on hydatid disease in recent years has been the epidemiological studies of Rausch and Vogel, which have cleared up the much argued question of alveolar hydatid disease.

A critically felt need is for an anthelmintic considerably more effective than arecoline hydrobromide for use against the adult stage in dogs under field conditions. Required is a well set up program for the systematic screening and laboratory and field trial of known, new and potential anticestodal drugs. Desirable in this connection would be the development of screening procedures for drugs less costly and time-consuming than those which require infected dogs. Extremely useful would be a laboratory technique to enable one to differentiate between the ova of *E. granulosus* and those of other taeniids of the dog. The only present method to confirm a diagnosis in the dog without autopsy is by the unsure diagnostic use of arecoline hydrobromide as is presently being done in New Zealand.

Of considerable value would be an effective ovacide, both to reduce the risk of infection to the researcher on the disease and to disinfect mass dog treatment sites. A sufficiently non-toxic ovacide would also have use as a dip for dogs following treatment (or even as a wash for vegetables).

Little is known of the bionomics of *E. granulosus* ova. Particularly important to control efforts would be knowledge of their survival under different climatic and environmental conditions. Important, too, would be studies on the modes of dissemination of ova.

A major problem exists in the diagnosis of hydatid disease in man. Intensive immunological work is required, particularly in the area of separation and identification of specific antigens to replace the very crude, relatively non-specific antigens in present use. Related to this and to other problems of importance is all work on the chemistry and metabolism of the hydatid parasite in particular, but of all cestodes in general. To be generally encouraged is work in the entire area of helminth physiology and immunochemistry. Work in these fields lags far behind similar efforts for other groups of infectious agents and few original techniques have evolved.

Less directly related to control, but nevertheless important in lieu of effective control, is the problem of treatment of the infected human. Medical treatment has been ruled out not because of proven inefficacy of available parasiticidal drugs, but solely through lack of studies to assess their efficacy. This work is long overdue, particularly since techniques are presently available for some *in vitro* screening of drugs and also for laboratory trials in experimentally infected mice. Work on the physiology of the parasite is here again important. The availability of effective medical treatment would be of even greater importance than at present when immunologic techniques proceed to the point of development where mass-screening of heavily infected populations for detection of early infections is practical.

There are, of course, as with other diseases, many other significant problems which could be mentioned, but these are those which appear to me to be of particular importance to those concerned with the control of the disease at the present time.

ONCHOCERCIASIS

Research Problems in Connection with Onchocerciasis—Excerpts from a letter dated 15 March 1961 from **Dr. Thomas A. Burch,** National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland.

Probably one of the most important research problems in connection with onchocerciasis is the lack of uniformity in methods and in reporting of findings. It is extremely difficult to compare the status of onchocerciasis in different areas of its distribution since nearly every investigator uses different methods. While nothing should be done to limit development or utilization of new diagnostic tests and modifications, all investigators should be urged to do them in conjunction with rather than in lieu of the usual superficial skin biopsy.

The difficulty of comparing surveys and investigations by different authors is rendered still more difficult when they do not use the same age groups in reporting results. It would be best to follow one of the groupings recommended by the WHO Committee on Vital Statistics, such as -1, 1, 2, 3, 4, 5-9, 10-14, 15-19, 20-24, 25-34, 35-44, etc.

A somewhat similar problem in that it also stems from a lack of sufficient acquaintance with epidemiological literature is the matter of sample selection. The way in which a sample is selected varies, of course, with the purpose. If one merely wants to ascertain if the disease is present, or not (as in 2b below), it makes little difference how it is selected. If it is desired to calculate infection rates or prepare estimates of total numbers of infected persons, it is essential that the sample be representative of the population. Just because the investigator did not select the individuals in the sample does not mean that it is a random sample. In this regard it should be emphasized that patients attending a clinic—no matter what the clinic—cannot possibly be considered representative of the population. Similarly, age and sex specific rates, if based on a sample that is not representative of the general population, can be very misleading.

The problems that I feel should receive attention are:

1. Diagnostic
   a. Development of more sensitive diagnostic tests.
   b. As mentioned above, these should be done and reported in conjunction with rather than in lieu of the usual superficial skin biopsy.
2. Distribution of the infection
   a. I am sure that onchocerciasis will be found in many parts of Central and South America whenever it is sought.
   b. I would suggest that the quickest and simplest way to locate new foci would be by means of the Hetrazan test. More sophisticated sampling and studies could be made after the foci were discovered.
3. Distribution of ocular onchocerciasis
   a. The distribution of the ocular disease is not as extensive as the distribution of the infection.
   b. While it takes an ophthalmologist to adequately evalute the ocular disease, it does not require an eye specialist to ascertain whether the ocular disease is a health problem. I would therefore suggest that preliminary studies could well be done by non-specialized medical personnel with more intensive studies being made in the areas where a health problem is shown to exist.
4. Etiology and pathogenesis of ocular onchocerciasis
   a. This could be approached by doing identical studies on a group of subjects from the same area with ocular disease, and a group without ocular disease, with each individual matched according to age, sex, race, etc.
   b. Similar studies on population samples from onchocerciasis zones with and without ocular disease would also be profitable. (Liberia has a high prevalence of onchocerciasis, but virtually no ocular disease, for example, while in other parts of Africa ocular onchocerciasis is very common.)
5. Immunology of onchocerciasis
6. Determination of vectors in Venezuela and the as yet undiscovered foci in Central and South America
7. Search for possible reservoir hosts
8. Chemotherapy

   There is still no satisfactory treatment. Hetrazan kills the microfilariae but not the adult worms and hence it will not cure the disease. Suramin, on the other hand, kills the adult worms and hence cures the disease. It must be given intravenously and is too toxic to be considered ideally suited for mass therapy. I suggest that other analogs be tested.
9. Control
   a. Our own experience in Guatemala in 1950, and later experience in Africa has demonstrated the feasibility of mass treatment campaigns, and the observations in Kenya that the disease continues to progress to blindness even when the vector is eradicated indicates that even in these areas where vector control is possible mass treatment should be done.
   b. The effectiveness of control measures can best be gauged by the incidence of new cases of onchocerciasis developing in children born after the start of the control campaign.

Suggestions for Further Research Into the Problems of Onchocerciasis—Submitted 10 March 1961 by **Dr. F. C. Rodger,** Consultant Ophthalmologist, Princess Margaret Hospital, Swindon, Wiltshire, England.

1. *Intention.* Out of many varied ideas two lines of enquiry emerge as likely to be important. One is an enquiry into the relationship between the vitamins and onchocerciasis, in particular Vitamins A and B 2. The other is whether or not a tolerance or immunity develops in relation to onchocerciasis. In both instances by "onchocerciasis" I mean ocular and cutaneous infestation.

2. *Projects.*

(1) (Investigation of a possible relationship between Vitamin A and onchocerciasis.) I believe it is possible that in the presence of Vitamin A in excess the adult worms lying free in the subcutaneous tissue are more readily encompassed in nodules. I also believe it is possible that where Vitamin A in excess is present in the diet that the mf. are prevented in some degree from spreading through the subcutaneous tissues. Thus it follows that in areas where there is plenty of Vitamin A, I would expect the density of infection to be light, fewer cases of ocular involvement and very few if any cases of the posterior degenerative lesion (which, I believe, and have presented evidence concerning, is perhaps due to an intoxication more likely where the adult worms lie free and secrete such a toxin into the tissue fluid). The opposite state of affairs is also true. This would explain the increasing number of reports that blindness as a result of onchocerciasis is not found in fertile regions but is serious in unfertile regions.

(2) In the areas in which I have worked Vitamin B 1 has not been on short supply but Vitamin B 2 has been somewhat reduced. Therefore I would think it important to consider a possible relationship between Vitamin A and Vitamin B 2 in connection with the investigations suggested above. One might also, I think, consider whether or not protein metabolism is involved, as when there is a deficiency of Vitamin A and Vitamin B 2 there is usually also a deficiency of the essential amino acids.

3. I have shown in my papers on the subject published in the American Journal of Ophthalmology for the greater part that the collection and counting of mf. volvulus is possible and that it is also possible to inject a number of living or dead mf. (the number being a close approximation) into the eyes of animals and subconjunctivally into the eye of man. By these means I have found that in densely infected cases sub-conjunctival injections of dead mf. do not produce a reaction but that in non-infected or lightly infected cases invasion of the ocular tissues with dead mf. leads to an immediate violent reaction. These important pioneer experiments undoubtedly should be followed up and expanded as they appear to indicate that a degree of tolerance or immunity occurs in these tissues, which of course would explain why out of the millions infected *relatively few* are blinded.

Research Problems on Onchocerciasis—Excerpts from suggestions of 4 February 1961 offered by **Dr. Luis Vargas,** Instituto de Salubridad y Enfermedades Tropicales, Mexico, D.F.

1. Study is needed of the habits of simuliids in relation to vector potentialities.

   a. What is the ideal environment to maintain simuliid vectors in captivity?

   b. What factors prevent unfed captive female simuliids from obtaining a human blood meal?

   c. What factors inhibit copulation between captive simuliids?

2. Standardization of sampling techniques is needed to measure (a) the size, importance, and composition of wild simuliid populations and (b) epidemiological characteristics of the transmission of *Onchocerca*.

3. An easier technique is needed to study the distribution, number, stage, etc., of *Onchocerca* in simuliids.

4. Larvicides with long-lasting effects are needed to control or eradicate simuliid larvae, pupae, or eggs.

5. We need to know the effect of insecticide mist and fogs in the control or eradication of simuliids, i.e., formulae, equipment, cost of operations, schedules of application.

6. What is the path of the microfilariae to the eye and to the nervous system?

7. The production of microfilariae by female worms ought to be studied, i.e., volume, cycles, length of production, fertile periods, copulation characteristics.

8. Research is needed on nutritional requirements of both microfilariae and adult worms in the vertebrate host, including anabolic and catabolic processes and their relation to allergic reactions.

9. We need *in vitro* cultivation and morphological studies of the evolution of microfilariae to the metacyclic stage and thence to the adult worm.

10. We want to know the itinerary of the metacyclic microfilaria of *O. volvulus* from the site of entry into the skin to the site of nodule formation by the adult, with accompanying morphological changes and chronology.

11. What is the life expectancy of metacyclic microfilariae, male worms, female worms, and microfilariae?

12. We want better anti-allergic drugs to prevent undesirable reactions produced when anti-microfilarial drugs are administered, and a more comprehensive mechanism for these reactions.

13. Better means of finding *Onchocerca* adults, free or in nodules, in the vertebrate host are wanted.

14. Better drugs to kill *Onchocerca* in all stages in the vertebate host are needed. Best would be a true prophylactic drug, that is, one that prevents the metacyclic microfilaria from reaching the adult stage.

CHAGAS' DISEASE

Suggestions about Research that may be of Value in the Planning of International Health Programs for the Control of Chagas' Disease—Submitted 5 March 1961 by **Dr. José Lima Pedreira de Freitas,** Professor of Hygiene and Preventive Medicine, Faculdade de Medicina de Ribeirão Préto da Universidade de São Paulo, São Paulo, Brazil.

1. As I have revised in a working document prepared for the Study Group on Chagas' disease, an important question to be investigated on Chagas' disease is an evaluation of the extension of the infection with *Trypanosoma cruzi* in most Latin American countries to afford information about the real importance of this problem. This will be a fundamental step "in the planning of international health programs . . . " because, although data collected in limited areas suggest that this problem is real outstanding, the available informations are very limited and particularly have not been collected in such a way that the conclusions can be securely extended to the populations.

2. Another aspect to be investigated is the question of the pathology determined by *T. cruzi*. Although it has been well proved that in some endemic areas this parasite damages severely the heart and the digestive tract, there is a tendency to consider this as only a regional character of the disease. At the same time, these investigations would contribute to clarify the problem of the chronic myocarditis so frequent in extensive areas of Latin America.

3. Favorable results have been obtained in the fight against the vectors of Chagas' disease through the application of residual insecticides, particularly BHC. There are two main aspects to be considered in the control of Chagas' disease: the persistence of the parasite in the vertebrate in the chronic stage and the autochthonicity of the vectors in large endemic areas.

Then investigations must be carried out on how should be planned the control of these vectors so that more definite results must be obtained. They should aim at a better understanding of the ecology of the different species, with particular reference to those most directly adapted to the human habitation.

Investigations should also be carried out on the habits of those species not so strictly adapted to the human habitation, trying to evaluate their possible role in maintaining *T. cruzi* in nature.

More information is still needed about the best methods of application of residual insecticides against triatomid-bugs, with special reference to concentration and spacing of sprayings.

4. It has been proved that transmission of *T. cruzi* through blood transfusion may occur. In different areas and countries a high percentage of donors infected with this parasite has been demonstrated among blood donors. Two important aspects should be investigated in this field: first, the development of a rapid presumptive serological test for the diagnosis of Chagas' disease to be applied in blood banks. Second, although the data so far collected indicate the value of gentian violet as a prophylactic agent against *T. cruzi* in the blood "in vitro" investigations should be extended for other drugs to be used in this circumstance.

Preliminary Plan of Investigation and Control of Chagas' Disease in the Americas and the Role of International Organizations—Submitted 23 February 1961 by **Dr. Cecilio Romaña,** Ex-Professor of Parasitology, Universidad del Nordeste, Argentina.

If we examine the situation which exists in the various countries of Central and South America with regard to the epidemiological understanding of Chagas' disease and the prophylactic measures undertaken to control the disease, we shall note that a very diverse panorama is presented. Whereas in some countries investigations and studies are quite advanced and control programs can proceed rapidly on a large scale, there are others in which investigation has hardly begun and where the nosological role of the parasitosis is still unknown or in dispute.

Such a varied picture precludes treating the problem in a uniform way for all countries and obliges us to classify the countries provisionally into three groups in accord with the progress of their investigations.

The first group comprises Brazil, Chile, Uruguay, Argentina, and Venezuela. These are countries in which knowledge of the species of domestic vectors of Chagas' disease is now quite complete, in which the geographic distribution is known, in which the nosological importance of the disease has been demonstrated by clinical or epidemiological studies, in which health authorities have formed a consciousness of the seriousness of the problem and, finally, in which there have been attempts at large scale control of the disease or in which programs of systematic control are underway.

The second group comprises Peru, Ecuador, Guatemala and Panama. These are countries in which epidemiological investigations have attracted the interest of national health organizations, in which systematic surveys have been made thanks to the efforts of individual investigators or official research institutes and in which attempts have been made at direct control by means of insecticides.

Finally, the third group comprises Mexico, El Salvador, Honduras, Nicaragua, Costa Rica, Colombia, the Guianas, Bolivia, and Paraguay. These are countries in which studies are poorly advanced, frequently thanks only to the efforts of individual investigators, and in which there has not yet been any demonstration of the true importance of the disease as a human infection. In Mexico, for example, although many species of domestic conenose bugs are known, the number of reported cases is so small as to indicate a manifest disproportion in the epidemiological data which urgently demands clarification. In Bolivia, impressively infested by *T. infestans*, all evidence points to the existence of areas in which the nosological indices for Chagas' disease are as high as any on the continent, but it remains to be proven.

Programs of work on trypanosomiasis in these various countries cannot, in consequence, have the same development nor the same orientation. In the first group, an understanding already exists with regard to the importance of the disease and its danger. Its epidemiology is more or less completely understood; thus it will not be necessary here to undertake preliminary studies and all efforts can be directed to the control of the disease. In these areas, wherever domestic conenoses are encountered, they should be exterminated.

The second group of countries needs to complete its epidemiological investigations in advance of any control program. There already exists, here, among the health authorities, the necessary understanding for anticipating an appreciable amount of cooperation and control efforts which have already been made will help in future programs.

Finally, the third group is the true orphan as far as essential understanding is concerned. Here there is a clear requirement for preliminary epidemiological investigations and, in particular, for a translation into figures of the importance of the disease and its proportionate morbidity. The population must be informed and governments must be made interested in programs of investigation and control, based on demonstrations of the disease's importance.

Methods of Investigation

Methods of investigation of trypanosomiasis cruzi are sufficiently well understood at present to allow the existence of agreement among investigators as well as the establishment of a system of uniform technique.

I personally consider that the first step must be to point out the domestic species and their geographic distribution in the various countries. Conenose collections permit study of the index of infection with *T.* (*S.*) *cruzi*, which is oriented toward the intensity of infection in the domestic environment, for an apparent ratio exists between infection of house-loving conenoses and human infection.

Along with these studies, or separately, but on a more limited scale, the survey of conenose bugs should be followed by an investigation of human infection, using the complement fixation reaction and on the frequency of possible Chagas-derived cardiopathy.

We believe that the method of choice for the survey of cases is the C-F reaction because we have established that it is approximately twice as sensitive as xenodiagnosis in the discovery of cases. Moreover, the technique is simpler.

A standardized antigen should be used in the test. It should be dried and lyophilized so that it does not rapidly lose its properties. A uniform technique should be employed for the test so that results may be compared. A choice must be made between quantitative and qualitative techniques. We believe that the former is sufficient for epidemiological investigations since it is simpler and does not require special apparatus for reading the tests.

Tests should be confided to experienced technicians and performed in reliable institutes, which, fortunately, all of our countries possess. In 1950, when the P.A.S.B. decided to coordinate an international program of serological surveys, the Department of Parasitology of the School of Medicine in São Paulo (Brazil) took charge of the manufacture of antigen, with the collaboration of Dr. Pedreira de Freitas. The technique of the test was standardized by Dr. Muñiz of the Instituto Oswaldo Cruz.

Electrocardiograms may be executed using portable apparatus powered by batteries, which may be commercially obtained, and interpreted in accord with uniform criteria.

Control of the disease

As already stated, the first group of countries ought to begin immediately on control programs on a large scale. I have presented previously in another report the bases which I consider suitable to support the campaign, using simultaneously spraying, improvement of habitation and popular education.

The second and third groups may take advantage of the experience of the first group of countries in order to develop the studies and work which are preliminary to a campaign and also for the training, in them, of technical personnel.

Of course the techniques of control will vary according to the types of habitation, species of conenoses and their sensitivity to the various insecticides. These matters must be established by prior studies.

Role of international organizations

Few endemic diseases offer a more adequate field than Chagas' disease for international health collaboration between Latin-American countries. In effect, Chagas' disease represents a problem intimately associated with the low standard of living in rural communities, poor housing, and sanitary ignorance. It can therefore serve as the basis for a program of general improvement of the primitive customs and habits which are prevalent in rural American areas, in addition to aiding in prevention of the ravages of a serious and often fatal infection. Using these criteria, it is our point of view that the problem should be met by a program of international cooperation utilizing the intervention of the regional organizations for health protection.

On the other hand, antecedents already exist for such cooperation. In 1950, the P.A.S.B. resolved to send a consultant to the various countries of the continent, in fulfillment of the recommendations of the XII Panamerican Sanitary Conference which met in Caracas in 1947 and according to the expressed wish of the IV Congress of Tropical Medicine and Malaria in Washington, 1948.

In reality the first step toward the fulfillment of these recommendations had already been to sponsor the First Round Table Discussion on Chagas' disease, held at Tucuman, Salta, and Jujuy (Argentina) in July of 1949. This conference was attended by representatives of Argentina, Brazil, Bolivia, Chile, Costa Rica, Mexico, Uruguay and Venezuela. The P.A.S.B. submitted an agenda in the form of questions which, once answered, permitted sufficient value judgments to be made so as to consider the time convenient and opportune for the implementation of a continental program on the subject.

The consultant then received instructions which said " . . . the visits to the various countries should have as their object the collection of ample information regarding organization, personnel and segments of the work; extent of the disease and its epidemiological characteristics, methods of control and evaluation of the supply of services and in general all those antecedents which may be useful for an appreciation of the problem."

We then had an opportunity to visit, in the space of four months, 16 countries in which we held conversations with national authorities, effected visits to zones of trypanosomiasis, gave lectures to physicians, hygienists and medical students and promoted programs of investigation and prophylaxis of Chagas' disease. During the tour agreements were signed with various institutes and sanitary organizations—today we could call them "letters of intent"—with the object of coordinating investigative, particularly serological, programs. Detailed reports of this visit, by country, will be found in the archives of the P.A.S.B.

Then, in November of 1946, and also under the auspices of the P.A.S.B., a sanitary agreement was signed in Santiago de Chile in which Article 22 included "a proposal to contribute to the program outlined by the Pan American Sanitary Bureau, by which the signatory countries (Argentina and Chile) are in agreement to intensify epidemiological studies on Chagas' disease and to apply the prophylactic methods which are adjudged most appropriate, maintaining an intimate reciprocation of information on these two aspects in order to tend toward better knowledge of the disease and prevent its greater spread, particularly along frontier zones."

An article very similar in wording to the one I have just presented was included in the protocol adjoined to the agreement on frontier health which was signed in Villavicencio (Colombia) by representatives of Brazil, Colombia, Ecuador, Peru and Venezuela on the 14th of April, 1950.

We consider that other international organizations could collaborate in a continental program on Chagas' disease in the way that the P.A.S.B. has done. In this sense, during our trip of 1950 as temporary consultant of P.A.S.B. we took the initiative of interesting UNICEF in this disease. At that time we depended upon the help of Miss Alice C. Shaffer, chief of the mission in Guatemala, who understood the pediatric importance of the problem.

Moreover, the Cooperative Interamerican Public Health Service (SCISP) has ultimately become interested in Chagas' disease. At least, in the year 1958 we received from Dr. Frederiksen, director of SCISP in Bolivia, a request for collaboration to study the disease and plan a control program in that republic.

Activities still to undergo development

I believe that it is the intention of the World Health Organization, through the Pan American Sanitary Bureau, to take the initiative in developing a program of investigation and control of Chagas' disease on the continent. We should accept it, then, as the international organization which will take charge of directing the project. Naturally, this requires efforts of investigation and control, the development of which should remain in charge of the respective countries. The P.A.S.B. should be free to fulfill the role of promoter, coordinator and provider of exceptional assistance, particularly technical, when necessary.

Promotion, coordination, and assistance could take shape in the following ways:

1. Select the technicians and the institutes to prepare antigens for the serological reactions.
2. Establish regional institutes which will carry out the tests.
3. Coordinate epidemiological studies with work on classification of conenose bugs.
4. Promote the organization of electrocardiograph work.
5. Collaborate in the training of investigators and technicians by means of fellowships and courses.
6. Keep up to date an understanding of the work which is being done in the different countries.
7. Seek the collaboration of other international organizations, either public or private, for improved development of the work.
8. Prepare material for health education (leaflets, films, children's toys, etc.).
9. Promote the improvement of rural dwellings by means of regional studies on this theme.
10. Favor the fight against the disease by promoting studies on new insecticides, better application techniques, etc.
11. Assist in the implementation of pilot programs of disinsection in countries whose own studies are in arrears.
12. Lean toward the protection of cardiac patients in rural zones endemic for Chagas' disease.
13. Hold meetings with governments for the development and coordination of prophylactic work.

In order to maintain this program, we consider that it is necessary to organize a permanent Advisory Committee formed of technical personnel from the various countries, which would meet annually in the various capitals. The executive part of this program would remain controlled by the customary mechanisms which the P.A.S.B. considers necessary. (Translation)

AFRICAN TRYPANOSOMIASIS

Research Needs on African Trypanosomiasis—Submitted 28 February 1961 by **Dr. M. A. de Andrade Silva,** Superior Inspector of Health for Overseas Provinces, Ministério do Ultramar, Lisbon, Portugal.

Human Trypanosomiasis

That which I am about to mention refers specially to the *T. rhodesiense* sleeping sickness.

The principal research needs are those concerning epidemiology, immunology, and therapeutics.

Epidemiology of the disease. It will be necessary to clear important gaps in the knowledge of the problem of epidemiology looking for the reasons which may explain the existence of the disease in certain areas and its absence from others in which the conditions are apparently suitable and similar to those of endemic areas, sometimes nearby. This matter has deserved the best of our attention, ever. In 1952, we already discussed the factors related with the population, trypanosomes, and insect vectors which may influence epidemiology (De Andrade Silva, M. A., 1952).

It is of the utmost importance to enlighten the role of wild animals as reservoirs of this disease. It is known that many wild animals are susceptible to *T. rhodesiense* and that they are easily infected experimentally. (Ashcroft, M.T., Burtt, E., and Fairbairn, H., 1959).

In contrast with the facility of transmitting the infection to several species of wild animals, the available data regarding evidence that game constitutes a reservoir of *T. rhodesiense* trypanosomiasis is limited to the isolation of the etiological agent from a bushbuck in a *G. pallidipes* infested area near Lake Victoria, Kenya (Heisch, R.B., McMahon, J.P. and Manson-Bahr, P.E.C., 1958).

For the last two years we have been trying to isolate *T. rhodesiense* from animals living in an endemic area where both *G. morsitans* and *G. pallidipes* are responsible for the transmission of the disease, without attaining our objective. We wished to concentrate our efforts upon bushbuck (*Tragelaphus scriptus*) and on the suidae (*Potamochoerus koiropotamus* and *Phacochoerus aethiopicus*) as, according to Weitz, B. and Glasgow, J.P. (1956), the first two species are preferably sought by *G. pallidipes* and the last by *G. morsitans*. Many and great are the difficulties which have been encountered to carry out this investigation. However, we shall insist for results to enlighten this matter which we deem of particular importance.

Studies to determine the host preference of each species of *Glossina* have recently been carried out (Weitz, B. and Glasgow, J.P., 1956). We are of the opinion that the results obtained regarding the incidence of blood meals from different hosts depend largely from the availability to the tsetse-fly of the animals in the area and the pattern may substantially vary with the areas. In a paper recently published (De Andrade Silva, M.A., and Marques da Silva, J., 1958) results are mentioned which partially disagree with those of Weitz and Glasgow. Animals which, after these two authors, are rarely or never bitten by tsetse-fly, were found to carry trypanosomes in the blood, and, regarding the *G. austeni*, in the areas where blood slides were taken, it depends upon small antelopes, specially the suni (*Nesotragus livingstonianus*).

Immunology. Some persons are more easily infected than others. Certain individuals, exposed to the infection, seem to be immune to the disease. Cases have been described of persons carrying trypanosomes in their blood without presenting the habitual symptomatology and without being greatly affected in their general condition.

I don't believe that there are "carriers" as such, and in all the cases I have observed the beginning was always acute.

Cases which have been treated, but not cured, becoming chronical may eventually simulate "carriers" because their relapses are less dramatic.

Studies are needed on the resistance of the host to the antigens and, inversely, on the behaviour of trypanosomes in what regards the host's defences. Summarizing, the process of immunity must be studied.

This can also be applied to animal trypanosomiasis, as referred to further on.

Through the studies on immunology it seems possible to discover a test to facilitate diagnosis in those suspected cases where the examinations of both the blood and cerebro-spinal fluid are negative.

Treatment. Curative treatment. Most of the early cases are easily treated with Bayer 205 (Antrypol, Moranyl) and Mel B (Friedheim). We avoid the use of the last drug in these cases on account of its high toxicity.

With one diamidine (pentamidine) we have treated successfully some cases but with Bayer 205 better results have been obtained.

In spite of its toxicity we have depended for many years and we are still depending on Mel B for the treatment of the nervous cases: it is a most valuable drug and many lives have been saved.

Mel B is too toxic, encephalopathy is an accident which is fairly frequent and it is necessary to be careful. The use of it must be confined to hospitalized patients.

As for Mel W (Friedheim) we were not able to try it yet. According to the literature it is less toxic and can be injected intramuscularly. Two advantages over Mel B.

We need less toxic drugs to treat the nervous cases of sleeping sickness which could be given in dispensaries by male nurses or assistants. This independently of the follow-up of the patients based on cerebro-spinal fluid tests.

Prophylactic treatment. As the incidence of the disease is very low among a widely scattered population mass chemoprophylaxis is neither economic nor practicable unless a drug is discovered which can be given by mouth. Chemoprophylaxis proved valuable in controlling epidemic outbreaks in Mozambique and Ruanda-Urundi.

I would suggest that research work should be done to explain how chemical prophylaxis works. The habitual explanation that it depends on the dose of the drug is neither scientific nor satisfactory. It is important to know for how long drugs are retained in the body and also to have knowledge about the mechanism of their action. Does a prophylactic drug prevent the parasites from living in the host or does it keep them in very low number, resulting in a latent infection? Is it possible that a drug can induce the production of antibodies?

Animal Trypanosomiasis

Tolerance of cattle towards trypanosomiasis. The incidence of the *T. brucei* infection is very low in bovines. Certain breeds of cattle are tolerant to *T. congolense* and *T. vivax* infections or to mixed infections by those two parasites.

In the southern areas of Mozambique, infested with *G. brevipalpis* and *G. austeni*, cattle show a high tolerance towards *T. congolense*, *T. vivax*, or mixed infections. As a rule the infected animals recover spontaneously. This in normal feeding conditions and in the absence of another disease (tick-borne diseases or others).

We know that cattle of these areas transferred to a *G. morsitans* area having similar grazing and climatic conditions will die of trypanosomiasis if not treated.

Experimental work carried out in this particular subject lead us to conclude that the local trypanosome strains were less virulent than in *G. morsitans* areas.

Low virulence of trypanosomes which may be the result of cyclical transmission through *G. austeni* and *G. brevipalpis* can explain the behaviour of cattle of these areas towards trypanosomiasis. Premunition can help in this.

As in those above-mentioned areas many thousands head of cattle live in good condition, we consider it of great importance that further research work should continue to ascertain real variances of infection risk of the *T. congolense* and *T. vivax* from those areas to *G. morsitans* areas, as for virulence, pathogenicity and also in the line of immunology.

What we have mentioned in the realms of immunology for human trypanosomiasis is valid for animal trypanosomiasis.

Treatment. Curative treatment. Good drugs are now available but are still very expensive. Owing to repeated and uncontrolled treatment of cattle in tsetse-fly areas the resistant and cross-resistant strains of trypanosomes became a real danger. Treatment cannot be uniform and the same in different areas. It is very important to arrive by trial at schemes of treatment using the drugs of choice, suitable to the areas and according to the risk of infection, local strains of trypanosomes and ecological conditions.

Research work is needed to estimate the risk of infection (also known as trypanosome challenge) and also a better knowledge of the mechanism of drug resistance.

Prophylactic treatment. A prophylactic drug to give protection during a larger period than the ones now in use is badly needed.

Wide use of careless chemoprophylaxis should be avoided, due to the consequences of drug resistance.

A reliable drug having good "sanative" properties and acting as a "stopper" of resistant infections, created by chemoprophylaxis, is not available; this in contrast with the resistance caused by repeated treatment with the same trypanocidal drugs for which we have already at least one drug.

There is great necessity for more basic research work on the mechanism of the action of trypanocidal drugs which may take us to the discovery of better chemoprophylactics.

Tsetse Control

We need more research work on the habits, ecology and biology of the species of *Glossina*, having in mind the improvement of the methods of tsetse control. The known methods are yet very expensive and sometimes uneconomic and I wish to emphasize the need for finding others less expensive and more practical. (C.C.T.A./C.S.A. I.S.C.T.R. 1961)

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Research Problems on African Trypanosomiasis—Excerpts from a letter dated 6 February 1961 from **Dr. T. A. M. Nash**, Tsetse Research Laboratory, School of Veterinary Science, University of Bristol, Bristol, England.

I have recently referred to a number of important research projects in my *Review of the African Trypanosomiasis Problem* (Tropical Diseases Bulletin, vol. 57, no. 10, pp. 973-1003, October, 1960). When briefly referring below to any of these projects I will indicate the page reference so that amplification can be readily obtained.

IMMUNOLOGY

1. General. There is a vast amount of work to be done in the field of immunology. For example, we know virtually nothing about the relative degrees of immunity, or the basic principles involved, for the different species of game and for the West African breeds of dwarf cattle.

2. Cross-immunity studies. Can man's resistance to infection with *T. gambiense* be increased by prior challenge with one of the common species of trypanosome which are non-pathogenic to man, such as *T. brucei, T. vivax, T. congolense* or *T. simiae*? (Among Europeans in Nigeria it is the newcomers, or people who rarely encounter tsetse, who seem to contract the disease, not the specialist doctors and entomologists who have, over many years, been regularly bitten by tsetse heavily infected with the non-pathogenic species referred to. The degree of immunity, if any, acquired in such a fashion in the field, may be sufficient to protect the specialist against the occasional infection with *T. gambiense* which one would expect him to receive; as acquired under field conditions, it obviously cannot afford complete protection as Africans succumb to the much heavier challenge which they encounter when regularly fetching water and washing at the village water-hole.) I think this possibility of a cross-immunity ought to be followed up, as hitherto only some rather desultory studies have been made on the subject. In Rhodesia, the relative susceptibility to infection of the newcomer to an endemic area has been observed, so that the principle suggested may also be applicable to *T. rhodesiense*.

EPIDEMIOLOGY

3. Too little is known about the relative importance of different species of game as reservoirs of animal trypanosomiasis (p. 977, para. 2) and of Rhodesian sleeping sickness (p. 990, paras. 2, 3 and 4 and p. 979, para. 2). With regard to the latter subject, if conditions remain as described by Fairbairn, attempts to isolate *T. rhodesiense* from the different species of game found on the R. Ugalla and at Kimyora in Tanganyika Territory, would be well worthwhile.

4. The gaps in our understanding of the epidemiology of Rhodesian sleeping sickness, indicated by Dr. Apted, should be investigated (p. 991, last para.)

BIOLOGY

5. An investigation into the whole biological complex as outlined on p. 980, para. 1.

ENTOMOLOGY AND TSETSE CONTROL

6. What are the factors which suddenly cause certain tsetse species, such as *G. morsitans* and *G. pallidipes*, to start extending their range into new country? Hitherto, no satisfactory explanation has been found for most of these fly advances, but the results can be disastrous and of great economic importance.

7. Game destruction has often proved to be a very effective and cheap method of tsetse control (pp. 997-998), but its use is abhorrent to many people and the method as practised to date has been most unscientific. However, now that we can identify the host preferences for each species of tsetse (p. 977, last para.—979, 2nd para.), it does seem essential to ascertain the effect on the fly of destroying its first choice of host, and if need be its second. N.B. Such an experiment has been included in the ambitious investigation referred to in para. 5 above, but should be repeated in a simple form for different species of tsetse in different areas.

8. In East Africa, further research is required on Discriminative Clearing (p. 992, last para.). The method often succeeds, but sometimes fails; but we do not know why it succeeds or why it fails.

BIOCHEMICAL

9. Studies on drug resistance and cross-resistance should be intensified, as mass treatment of cattle in areas of fairly high challenge may rapidly produce this phenomenon.

Research Problems on African Trypanosomiasis—Translated excerpts from a letter dated 17 February 1961 from **Dr. M. Vaucel,** Director-General of Overseas Pasteur Institutes, Paris, France.

It is of interest, I think, to observe that present knowledge of matters of diagnosis, therapeusis, epidemiology, and prophylaxis has achieved a level which would permit hope of attainment of decisive results if it were possible to be assured of popular cooperation, governmental interest and necessary funds.

But the political evolution of Africa has supervened at a time when methods of attack, applied with judgment and tenacity, had been procuring results which promised probable eradication. The subsequent political backwaters have been placing at risk the spectacular improvements obtained to date.

It must be hoped that the warnings will be heard by the Governments and that the current active efforts of combat teams will not be relaxed. Otherwise, all that work which did not have immediate application for the benefit of the people would be in vain.

Study of the disease in humans

Repetition of the works of Gallais, Collomb at Marseilles, of those of Neujean at Leopoldville on early damage to the nervous system (culture of spinal fluid, electroencephalography, pneumoelectroencephalography); evaluation of treatment of the attack with a drug which is useful against lesions of the nervous system (such as Mel B but less toxic; with possibility of cure following a single dose at the outset of the disease, avoiding the risk of "evolution");

Study of the chronic disease: allergic disorders, self-limiting disease, evaluation of a nonspecific drug;

Study of humoral disorders and their role: cryoglobulins, macroglobulins;

Study of disorders of a genital nature (testicular damage, abortions and premature births);

Study of pathological anatomy: demyelinating leucoencephalitis (also seen in some viral diseases).

Diagnosis

Complement-fixation reaction: improvement of antigens;

Blood culture: application to individual cases (diagnosis of relapse), evaluation of its use in mass medicine (research on the parasite in suspected individuals who are negative on microscopic examination, most particularly in areas where lomidine has been employed);

Electrophoretic study of serum: specificity of dysglobulinemia and acquisition of immunity?

Laboratory studies

Research on a culture medium which would permit maintenance of the pathogenic trait in an isolated strain: works of Weinman (trehalose), of Trager (tissue culture of tsetse organs);

Acquisition and loss of a gene for human virulence (*T. brucei* and *T. rhodesiense*);

Study of synthetic culture media;

Anaerobic culture of the trypanosome;

Fate of the trypanosome during trypanolytic crises and latent periods in experimentally infected animals;

Study of resistance factors in refractory animals (baboon);

Study of the maintenance of transmissibility of lyophilized cultures by tsetse flies;

Study of the metabolism of the species of trypanosomes (classification);

Study of mechanisms of drug action by radioisotopes.

Epidemiological and entomological studies

Research on a reservoir animal in regions of virulent trypanosomiasis gambiense;

Study of transmissibility by tsetse of trypanosome strains carried in the chronically ill (true reservoirs of the agent);

Eradication of tsetse by spread of insecticides in regions of residual trypanosomiasis;

Differential diagnosis of the species of polymorphic trypanosomes in the salivary glands of the tsetse;

"Dilution" of *T. gambiense* (or *T. rhodesiense*) by *T. brucei* in tsetse feeding successively on man and on infected animals?

Laboratory rearing of tsetse through all the stages.

Summary of the Most Important Research Problems in African Trypanosomiasis—Submitted 6 March 1961 by **Dr. K. C. Willett,** Director, The West African Institute for Trypanosomiasis Research, Kaduna, Northern Nigeria.

Animal trypanosomiasis is included as well as human trypanosomiasis because the greatest medical problem of the trypanosomiases at present is the protein deficiency which results from the prohibition of vast areas to cattle and other domestic animals by the presence of the tsetse fly and trypanosomiasis.

Medical Problems. There is still a serious need for better curative drugs. A highly effective non-toxic drug which could be given in a very short-period regimen would be of great help in clearing whole populations and breaking the cycle of transmissions.

Veterinary Problems

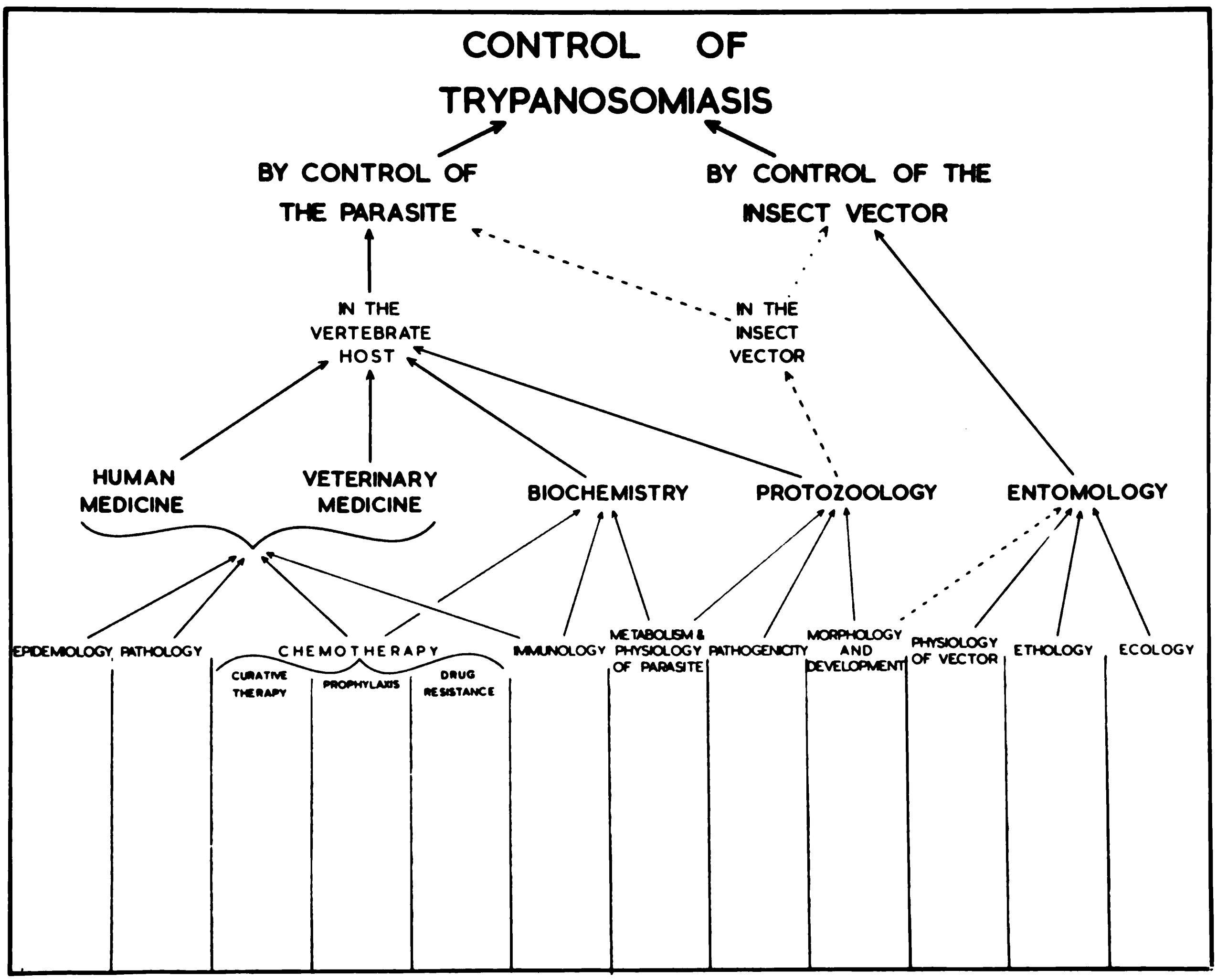
Chemotherapy. There is still a great need for better and less toxic curatives for cattle trypanosomiasis and for safer long-lasting prophylactics. One important aspect of this problem is that of drug resistance: several of the drugs now in use tend to generate cross-resistance to each other and it is of the utmost importance to develop new chemotherapeutic agents which do not suffer from this serious drawback.

Immunology. Active immunization of domestic stock still cannot be regarded as more than a hope for the (probably distant) future, but the discovery of any means of achieving this would be of such enormous value, in terms of money alone, that considerable research effort directed towards it could well be justified.

Biochemical Problems. The above remarks on chemotherapy indicate the need for studies of metabolism and drug action to rationalize drug treatment and elucidate the mechanism of the acquirement of drug resistance.

Entomological Problems. These must be included as they form an important part of the problem of control, in this case by control of the vector rather than the parasite.

The chief method of control in the past was that of bush clearing either partial, based on ecological studies of the tsetse fly, or complete. Now, however, the method is generally too expensive to be economic and emphasis is rapidly shifting to the use of insecticides. The present position is, briefly, that where the fly-habitat is restricted either naturally (e.g., the riverine species) or seasonally by climatic conditions (i.e., the savannah species near the drier limits of their distribution) insecticidal control is not merely practicable but also economic. However, these conditions obtain for only a small fraction of the area of fly-infestation in Africa. Much more ecological and other work is needed if insecticides are to become a practical economic means of control in areas in which the far-ranging savannah species prevent the raising of cattle.



A diagrammatic representation of the scientific disciplines and types of study involved in the "routes" by which all work must converge on the final objective of control of trypanosomiasis. The diagram can also be used, by listing research projects in the appropriate columns at the bottom, to build up a histogram showing roughly the distribution of the total research efforts.

Research Problems on African Trypanosomiasis—Excerpts from a letter dated 6 March 1961 from **Dr. S. G. Wilson,** Veterinary School, Utrecht University, The Netherlands (formerly Chief Veterinary Officer, Ministry of Animal and Forest Resources, Kaduna, Northern Nigeria).

I am restricting myself to the research problems as I am assuming from your letter that you will be collecting from the various Institutes data on the research already in progress. These Institutes are West African Institute of Trypanosome Research (WAITR) in Kaduna, Northern Nigeria, and the East African Trypanosome Research Organization in Uganda (EATRO).

Work at both these Institutes is being severely limited at present through lack of staff and indeed the greatest need at the moment is to recruit new research officers into this particular field. Being a limited and specialized one, it has not attracted the men of high research calibre which is so essential for progress.

Dealing with the most important research problems, I suggest the following list, recognizing that it cannot be complete as I have no access to my own papers and records, which are still at Kaduna.* This list is therefore only tentative and will require modification in the light of other replies which you will no doubt receive.

It is convenient to divide the problem into 3 separate fields on the understanding that each "field" cannot be kept separate in practice and any worker to make a significant contribution must be familiar with the whole problem. The division is merely a matter of convenience and assistance in clarity in presentation.

The three problems are concerned with:

(1) *The Vector*—the tsetse fly

(2) *The Pathogen*—the various species of trypanosomes

(3) *The Host*—the bovine and to a lesser extent sheep, goats and game animals.

Much work has been done in control of the *vector* and it is obvious from current work in Nigeria and Kenya that the old forms of control by bush clearing are largely outdated. Control by insecticides has come to stay as being the most economical and rapid and the only practical method applicable to large areas.

Our problems therefore are:

(a) *Insecticide of choice*, formulation, rate of application—D.D.T. or dieldrin are the two insecticides of choice at the moment but of course a watch should be maintained for any new and more useful compounds.

(b) *Methods of application.*—Types of pumps, frequency of application, use of mist or spray for quick knock-down or residual effect.

(c) *Point of application* to vegetation—this depends on the resting sites of the tsetse which varies with species of tsetse and vegetation zone. *Glossina morsitans* for instance in Nigeria settle on the base of the larger trees within forest clumps in the Soudan zone of vegetation but in the Guinea zone they rest on the underside of the large branches 12′ to 14′ from the ground. The point of application of the insecticide is different in each zone. Different points of application are again required say for *G. palpalis* and *G. pallidipes* in Kenya.

(d) *Cost of application* and economic value of different methods. —A standard method of costing is required.

There is of course the overall problem of *Tsetse Survey* which must precede any reclamation scheme to determine species of tsetse present, total area infested, local concentrations, resting habits and other relevant information. These data should be collected for about 2 years prior to initiation of any scheme so that adequate information is available on movements of fly and seasonal differences.

* Dr. Wilson's letter was written from the Food and Agriculture Organization of the United Nations in Rome where he was temporarily assigned for a few weeks.

The *pathogen* still requires study regarding morphology, identification, pathogenity in relation to vector and host and life cycle both within the host and within the vector.

With regard to the *bovine host* the matters of chief concern relate to

(a) *Chemotherapy*—reaction of pathogen and host to various drugs. Development of *drug resistance* within the host by various species of trypanosomes is also included under this heading.

(b) Immunity developed by the host, i.e.

  (i) *Species resistance*—the dwarf cattle of the West Coast of Africa.

  (ii) *Developed resistance* or immunity following chronic attacks or induced by controlled drug therapy.

The question of immunity in the host has never been properly investigated, chief attention being paid to chemotherapy as the line promising the most fruitful results.

ARTHROPOD-BORNE VIRAL INFECTIONS

Research Problems on Arthropod-Borne Viral Infections—Excerpts from a letter dated 17 February 1961 from **Dr. Ottis R. Causey,** Director, Belem Virus Laboratory, Belem, Brazil.

The Belem Virus Laboratory is a cooperative project of the *Serviço Especial de Saúde Publica* of Brazil and the Rockefeller Foundation, established for the purpose of studying the arthropod-borne viruses (arbor viruses) of the Amazon region. Operations began in the latter part of 1954. By investigating epidemics, placing sentinel animals in the forest, and trapping mosquitoes, wild animals and birds for virus isolation and antibody surveys, considerable information has been acquired concerning the viruses of the region and the vertebrate and invertebrate hosts. More than 1,600 isolations consisting of 795 infections have been studied. A total of 36 different arthropod-borne viruses have been discovered in the region, 23 of which are new to science. Among the old agents isolated are such viruses as those of yellow fever, St. Louis, Eastern equine encephalitis (EEE), Venezuelan equine encephalitis (VEE), Ilheus and others.

From what we know of the viruses in the Amazon it seems logical to assume as a working hypothesis that the Amazon and Orinoco basins are perhaps the seed beds from which most of the arbor viruses of the Americas are distributed. In Brazil there are two regions with almost perfect ecological conditions to serve as the seed bed. One of these is a small area of approximately 300 square kilometers around the city of Belem. The other is a vast area that occupies more than 8,000 square kilometers of the upper Amazon and Negro rivers in Brazil and extends into Venezuela, Colombia and Peru. These areas have been characterized by Koppen (1936, Handbuch der Klimatologie, Vol. 1, Part C) as having humid tropical rain forest climate Af, with the following description: The median temperature of the coolest month is always above 18° C and the rainfall in the driest month is not less than 60 mm. The annual amplitude of the median monthly temperature is not more than 5° C.

In the small Af climate area around Belem, which includes the IAN study area, many viruses have been isolated repeatedly and others at varying intervals, showing a persistence and variety of viral activity over the six-year study period. In the larger Af climate zone on the upper Amazon our information on viral activity is so far limited to antibody studies on about 500 human residents and a few trapped animals. These have shown high rates of antibody for some of the same viruses isolated in the Belem area, indicating the probable presence of these viruses in the region.

Our concept of viral activity in the Amazon region is that of eddies within the enormous forests where favorable ecological conditions are always present somewhere for the reproduction and maintenance of mosquito and vertebrate hosts capable of sustaining the cycle of infection. The epizootic state shifts from place to place as local conditions are modified by the immunization of the susceptible population or the relative abundance of the insect vectors. Infected vectors passing from one enzootic or epizootic region to other areas where a low percentage of immunes exist may spark epizootics such as those of yellow fever that regularly pass at about 10- or 12-year intervals from the Amazon region through central and southern Brazil. The virus once established in other less favorable regions may persist for months or even years, but eventually due to unfavorable seasons or lack of sufficient susceptible hosts the virus is lost and the region remains free of it until another invasion from the seed-bed region is effected. Some viruses like those of group C and yellow fever that apparently do not attack birds are dependent principally upon the movements of the insect vectors or a chance or unnatural passage by man, as the home range of most small susceptible vertebrates is very restricted. It has been demonstrated, however, that the forest mosquito may move rapidly over considerable distances, usually in the direction of prevailing winds. Birds conceivably could facilitate movement of such viruses as EEE, WEE, and St. Louis from seed-bed areas to other tropical and temperate regions. EEE virus has been repeatedly isolated from sentinel animals in the forest near Belem every year since 1954 with the exception of 1958, but neither virus nor antibodies for EEE are found in the forest wild animals. Some of the birds tested have, however, shown EEE antibodies, although no virus has yet been isolated from birds in the Amazon region.

Considerable information could perhaps be gained by virus studies, such as those being conducted at Belem and Trinidad, of Af regions of Venezuela, Colombia and Peru. Simultaneous studies should be made along the flyways of migratory birds, special attention being given to large permanent swampy areas throughout South, Central and North America. As a part of the program, birds should be captured, bled for virus isolation and antibody studies, banded and released.

Important Problems on Arthropod-Borne Viruses—Submitted 28 February 1961 by **Dr. J. A. R. Miles,** Professor of Microbiology, University of Otago Medical School, Dunedin, New Zealand.

There are two distinct possible ways in which the problem of arthropod-borne viruses may be approached. The first approach is strictly academic and this is primarily through the isolation, identification and study of as many types of arthropod-borne virus as possible from all sources regardless of their potential importance in human or veterinary medicine. This comprehensive approach should eventually lead to ideal results, but it is possible that a more selective approach might prove more immediately useful and it is my opinion that it is preferable to devote our main efforts to problems likely to be of human or veterinary importance. It is clear that when one is investigating a disease which, for some clinical or epidemiological reason, one regards as likely to be due to arthropod-borne virus, one may isolate a number of viruses none of which are relevant to the syndrome which led to the initiation of the investigation. The extent to which such viruses are investigated will depend on the inclinations and available resources of the research workers concerned, but I believe that special encouragement should be given to projects designed to increase our understanding of diseases known to be important for either the medical or veterinary professions.

The question of what is an important disease is also a matter of some discussion, and while I would regard a non-fatal disease such as dengue which can cause considerable disruption in its epidemic form as an important problem deserving a high priority, some of my colleagues take the view that diseases which are fatal or which lead to very serious sequelae are considerably more important even though they may only cause small epidemics occasionally, as in the case of Murray Valley encephalitis in Australia and New Guinea.

I am not qualified to speak of research needs on yellow fever which must still be regarded as the queen of arthropod-borne viruses although I am certain that research on this should still be given very high priority. Other than this it would appear to me that the diseases most requiring attention are the arthropod-borne encephalitides, dengue and the dengue-like diseases, the haemorrhagic group of fevers, the syndrome due to West Nile virus, phlebotomus fever, African horse sickness and the other arthropod-borne viruses of very considerable veterinary importance.

Japanese B encephalitis virus is clearly one of enormous importance with its wide distribution from Japan and Far Eastern U.S.S.R. through China and Malaya to Southern India. Although there is a great deal known about the disease in Japan, the situation in tropical areas is far less clear and indeed the disease has only been recognized in a few small areas while it must be probable that it extends throughout the whole region of South East Asia. The epidemiology of this disease in tropical areas requires careful investigation and it is far from clear that ardeid birds are of such importance in other areas as they are in the Tokyo region of Japan. The situation in Indonesia is quite unknown and, if it were politically practicable, it would be of great interest to find out the relation of viruses present there to Japanese B to the north and to Murray Valley virus from New Guinea and Australia.

In the case of dengue we have considerable knowledge of the epidemic disease, but how this virus survives between epidemics particularly in relatively small communities with apparently a high level of immunity in the resident population is quite unknown. So far there is no good evidence of a wild-life cycle and there is no evidence for or against the survival of virus in some latent state in human immune convalescents. In this case it appears to me that our best chance of obtaining results within a reasonable time is through the study of relatively small and isolated island communities in the Pacific and in my opinion the Fiji group of islands in which dengue appears to be endemic would appear to be the most satisfactory area for study. It is of course far from certain that even if the problem were elucidated in such an area that the epidemiology in the more complicated ecological situation of a continental land mass would be the same. I have selected these two particular virus problems as ones in which I am personally interested and which I think are important, but I do not think that necessarily they are over-ridingly more important than the other diseases which I have mentioned listed above.

There are certain general investigations which I think also require attention and not necessarily in relation to any particular virus. W.H.O. has recently emphasised the necessity of obtaining a good assessment of the potential importance of migrating birds and of parasites carried by migrating birds in the distribution of arthropod-borne viruses, and this is particularly emphasised by the appearance of the haemorrhagic syndrome of Kyasanur Forest disease in Southern India in 1955. It appears to me that equally important are entomological studies on the feeding preferences of mosquitoes, on their flight range and on the diurnal variation in their height range and the reasons for such movements. We are very ignorant of the biology of the *Culicoides* and the importance of work on this extremely difficult group is emphasised by the sudden eruption of African horse sickness into Europe and Asia.

My personal experience of working on these viruses in tropical areas is limited to tropical Australia and certain islands in the Pacific, and therefore I have made my remarks particularly relevant to problems in which I am especially interested. I do not pretend to have suggested a comprehensive programme and I am sure that other workers who have been consulted will have covered the other important points.

Research Problems on Arthropod-Borne Viral Infections—Excerpt from a letter dated 14 February 1961 from **Dr. Joseph E. Smadel,** Chief, Laboratory of Virology and Rickettsiology, Division of Biologics Standards, National Institutes of Health, Bethesda, Maryland.

Below is a list of problems which I consider important and which require extensive investigation in the field of arthropod-borne viral infections.

1. Develop and maintain a global system of surveillance (epidemiologic and laboratory) to determine the arbor virus flora in given areas and its importance in man and his domestic animals.

2. Investigate on a continuing basis the effect of man's actions, viz., changes in agricultural practices and introduction of programs for control of vectors of malaria and plague, on the vectors of arthropod-borne viral infections.

3. Develop simple laboratory procedures for rapid identification of arthropod-borne viruses and the infection they produce.

4. Develop immunologic procedures which are safe, effective, and not too burdensome for inducing resistance in man against clinical disease caused by all of the arthropod-borne viruses in his immediate environment.

5. Develop effective chemotherapeutic regimens for patients with arbor virus infections.

Research Problems on Arthropod-Borne Viral Infections—Excerpts from a letter dated 6 February 1961 from **Dr. Kenneth C. Smithburn,** Indianapolis, Indiana.

As to the arthropod-borne viruses in general, studies made to date have been mainly in regions of special interest, and there are vast populated areas in which little or no work has been done. Establishment of regional laboratories is therefore indicated, to give coverage to such areas. Virus-diagnostic services should be extended to all heavily populated regions, and the most modern techniques of virus isolation and immunity surveys should be applied in many as yet unexplored areas. As and when the viruses present are identified, special attention should be given to those for which there is evidence of etiologic relationship to manifest illness in man. Vectors of these must be sought, as well as extra-human hosts. Means by which the viruses are maintained in inter-epidemic periods should be sought, with special attention given to cold-blooded animals, rodents and birds. The role of avian species in transportation of viruses should be investigated, with full awareness that some viruses may be importantly involved in local or long distance bird migrations, and other viruses not at all. Only when some of these, and perhaps other questions, can be answered will it be possible to proceed intelligently toward the search for methods of control.

The foregoing problems are ones which can be studied best or only in the regions to which they pertain. There are other fundamental problems which could be investigated as well outside the tropics. For example, the effect of group-specific immunity on resistance to infection with heterologous viruses of the same group should be investigated. If significant resistance is evoked, studies could be made of the possibility of using one or more viruses which do not cause disease in man as vaccine against antigenically related agents pathogenic for man.

Research Problems on Arthropod-Borne Viral Infections—Excerpts from a letter dated 6 March 1961 from **Dr. R. M. Taylor,** California State Department of Public Health, Viral and Rickettsial Disease Laboratory, Berkeley, California.

I would like to preface my remarks by pointing out some of the recent developments and what we know of the behavioral characteristics of this family of viruses which make further investigation of them singularly important.

A dozen years ago the number of viruses transmitted by arthropods was thought to be quite limited and scarcely more than a score were known, but during the last decade due to improved methods of recognition and concerted effort to search for these viruses, particularly in the tropics, the number has constantly grown, and now approaches 150. While these infections are more common in the tropics, they are by no means limited to this area and not infrequently spread and become established in temperate zones. The spread and distant transplantation of these infections are not limited to the movements of man. Their epidemiology is infinitely more complicated than those infections that are transmitted direct from man to man, and for understanding their behavior in nature a great deal more study is required.

In their basic cycle and their manner of maintenance, lower vertebrates and certain arthropods are principally involved. Infection of man is usually fortuitous, tangential and dead-end. To understand how these agents are maintained it is essential to know what lower vertebrates are involved in their cycle and what arthropods are responsible for their transmission. To anticipate their distant spread, and perhaps do something to circumvent it, it is essential to know where they exist at present and the areas which by virtue of favorable biological environment are receptive to invasion.

To obtain this information, international cooperation is clearly essential. Fortunately some steps in this direction have been taken. There have been three meetings with international representation to consider and formulate recommendations on international cooperation and research on the arthropod-borne viruses. The first was held in Lisbon in September 1958 in conjunction with the International Congresses of Tropical Medicine and Malaria, the second and the third in Geneva in November 1958 and in September 1960, respectively. The latter two were sponsored by the WHO. There was also a WHO "Scientific Group on Research on Birds as Disseminators of Arthropod-borne Viruses" which met in Geneva, March 9-14, 1959.

Part of the recommendations of the two earlier meetings, the one in Lisbon and the Scientific Group on Virus Research that met in Geneva in November 1958, have been activated by an American group, sometimes referred to as the Gould House Group, which was assembled by the Rockefeller Foundation in October 1959. This group decided that the most pressing needs were: first, exchange of information; second, creating a supply of serological reagents for the identification of viruses; third, a central reference laboratory; fourth, recruitment and training of personnel; fifth, collective interest, cooperation and coordination among investigators; and sixth, ecological problems associated with the arthropod-borne viruses. A "Summary of Actions of the 1959 Gould House Meeting on Arthropod-borne Virus Investigations" may be obtained from the Rockefeller Foundation.

For the exchange of information a subcommittee was appointed and has undertaken the issuing of a Newsletter at suitable intervals for circulation among those actively engaged in the investigation of arthropod-borne viruses, and the assembling of a catalog to include unpublished or "new" viruses, as well as the "old" published arthropod-borne viruses for purposes of comparison. Two issues of the Newsletter have now appeared and the third is to come out next month. More than sixty viruses have now been registered and it is hoped to complete the registration of all the presently known arthropod-borne viruses within the next few months. So far this program has been limited to Americans as sort of "trial run" but with the hope that it would eventually become internationalized under the auspices of the WHO.

The accomplishments of this American group were presented to the WHO Study Group on Arthropod-borne Viruses that met in Geneva last September and were approved, and the internationalization of the Newsletter, as well as the catalog, recommended. This WHO Study Group also considered the various problems associated with arthropod-borne viruses and made recommendations for an international program of cooperative investigation. Since the writer participated at this meeting and is in accord with the recommendations offered, he can do no better than refer to this report in answering your letter on the problems associated with arthropod-borne viruses. The report of this Study Group may be obtained from the WHO.

However, the program for meeting these problems as outlined in the report is still largely on paper. The WHO is doing all it can but its resources are limited. The Rockefeller Foundation paid the expenses of the meeting of the Gould House Group and has extended an invitation for another meeting in Atlanta at the CDC next month. The Rockefeller Foundation has also supported the issuing of the Newsletter and the assembling of the arthropod-borne virus catalog. Henceforth, the Newsletter will be issued from the CDC. But for the full realization of the program, moral support and collaboration of other agencies will be required.

Research Problems on Arthropod-Borne Viral Infections—Excerpts from a letter dated 17 February 1961 from **Dr. Max Theiler,** Director, The Rockefeller Foundation Virus Laboratories, New York, N. Y.

Recent work has indicated that there are a great number of arthropod-borne viruses which may be of importance as a cause of human infections. A great deal of this information has come from a limited number of laboratories situated in the tropics. Many of these infections appear to be exceedingly abundant and have a fairly wide distribution. From the available information, it seems likely that some of these infections are not of great medical importance because the infections, as a rule, either produce very mild clinical signs or are asymptomatic.

The great majority (possibly all) of arthropod-borne viral infections of man and his domestic animals are maintained in nature involving wild vertebrates and arthropods. In no instance (including yellow fever), do we have complete knowledge of the wild hosts and vectors which are responsible for maintaining the virus in nature.

Efforts designed to fill in the lacunae in our knowledge should, in my view, be planned on the following lines.

1. The isolations and identification of the arthropod-borne viruses in various parts of the world which cause infection in man and his domestic animals. This to be combined with extensive antibody surveys in the region to determine the incidence of the various infections. This information would give an idea of the importance of the various agents as a cause of human morbidity.

2. Studies in the epidemiology of the various agents found to be present in a region. It is only after this information is available that the public health official is in a position to envisage control methods.

The gaps in our knowledge are enormous due partly to the large number of distinct arbor viruses which are known to infect man. No less than 50 distinct arbor viruses have been isolated from man. The number is continually increasing. Until we have more knowledge concerning which of these infections are of importance as a cause of human disease, it is premature to think of control or prophylactic measures.

Important Current Research Problems on Arthropod-Borne Viral Infections—Submitted 25 March 1961 by **Dr. Telford H. Work,** Chief, Virus and Rickettsia Section, Communicable Disease Center, U.S. Public Health Service, Atlanta, Georgia.

Ten years' exploration for isolation, characterization, and identification of arthropod-borne viruses, many of them causing newly recognized diseases, was guided and stimulated largely by the Rockefeller Foundation through laboratories in Egypt, India, Trinidad, South Africa, Brazil, and California. Development of this research field was augmented by simultaneous efforts of the British and Latin Americans in yellow fever laboratories in East and West Africa, Colombia, and Brazil, as well as Europeans in Central European and USSR laboratories dealing primarily with the expanding recognition of disease due to viruses of the tick-borne RSS virus complex. Equally significant were the USPHS studies of the encephalitides by Communicable Disease Center laboratories and field stations and the Rocky Mountain Laboratory. The matrix on which this research has been woven are the contributions of RF yellow fever research since 1915 and work on the encephalitides by Meyer, Howitt, Hammon, Reeves, Sabin and Japanese workers from 1931 until the present time. All this has brought this field of infectious disease research to a position of general acceptance as important, particularly in tropical medicine because of the greater prevalence, activity, and variety of mosquito-borne viruses in causing newly recognized and described diseases in tropical areas.

The discovery in tropical India of Kyasanur Forest disease, caused by a virus antigenically very closely identified with the RSS complex of tick-borne viruses, previously recognized only in the etiology of central nervous disease and hemorrhagic fever in the temperate palearctic region of the old world; and the isolation in tropical countries of eastern equine encephalitis (EEE), western equine encephalitis (WEE), and St. Louis encephalitis (SLE) viruses, etiologic agents of epidemic and epizootic encephalitis in temperate North America, have dissolved the geographically limited outlook toward research encompassed by what was formerly referred to as investigation of the "tropical viruses." Therefore, it should be accepted that any research on arthropod-borne viruses is indissolubly included in what increasingly we are coming to call medicine in the tropics.

If this concept is accepted, then there appear to be five general spheres encompassing the most important research problems in connection with the arthropod-borne viral infections. These are:

1. Establishment and development of additional foreign field laboratories to support exploration for additional arthropod-borne viruses and evaluation of resulting disease in areas which have not been studied adequately or at all previously.

2. Collaborative international research on specific but broadly based biological problems such as reservoir maintenance and dissemination which have been defined by scientific evidence accumulating from intensive local efforts and isolated observations.

3. Controlled laboratory and clinical studies of the pathogenesis and parasitic nature of certain of the arthropod-borne virus infections, particularly those known to cause variable pathological manifestations or severe systemic disease.

4. Precise physical, chemical and biological characterization and analysis of specific arthropod-borne viruses, particularly those involved in the most variable and complex parasitic cycles as well as those causing most severe or debilitating disease.

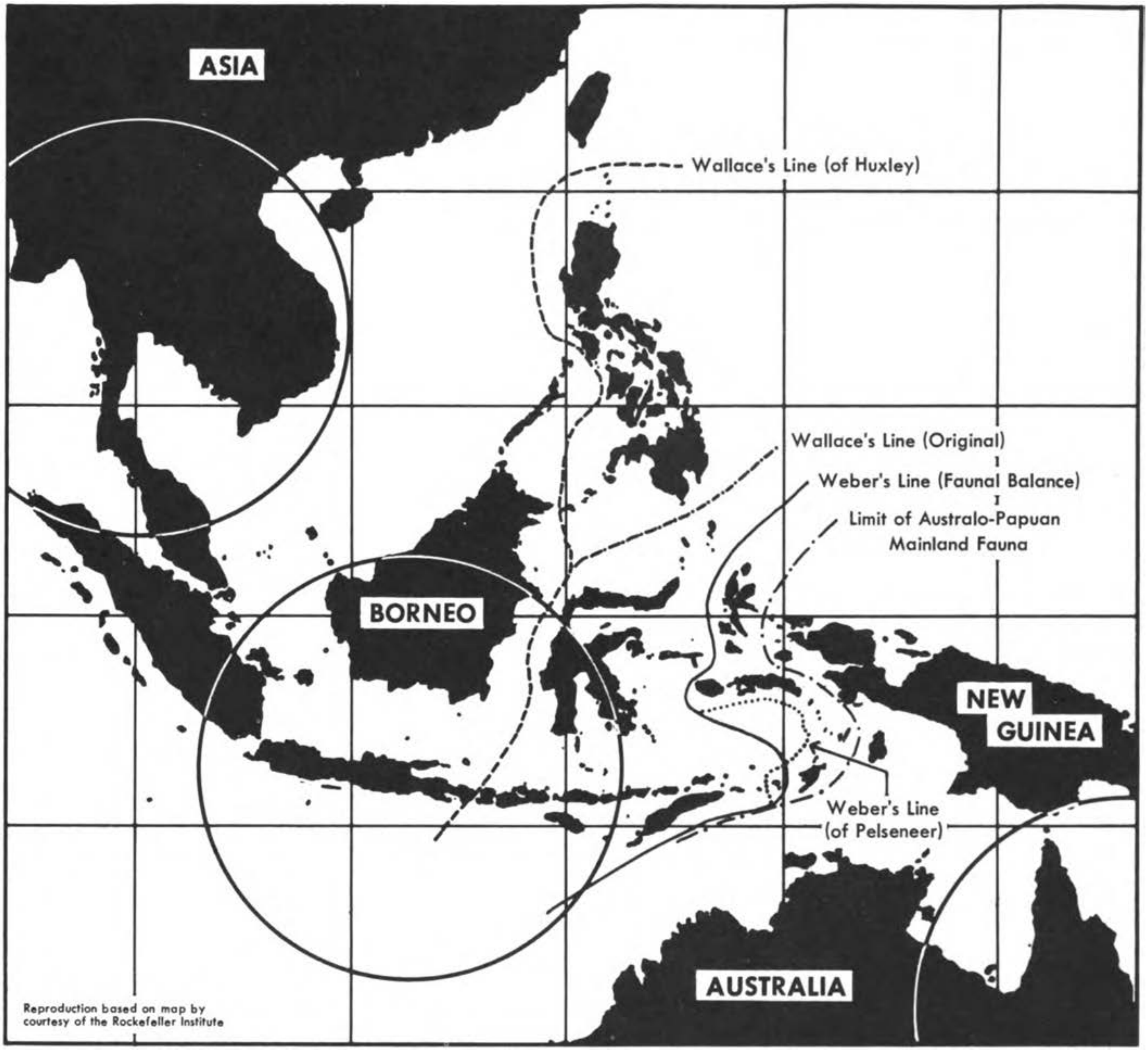
5. Based on the accumulating knowledge from research in the previous four fields, development and testing of environmental and immunological means of prevention of exposure and infection, biological control of parasite maintenance and transmission, and medical therapy of disease resulting from infection.

To even begin to accomplish much of significance in any or all of the above mentioned fields adds up to an enormous scientific demand. As rich as it is in scientific competence and manpower, particularly in the field of virology and medical science which the United States has led with pre-eminence for sixty years, the bodies are too few to significantly, let alone adequately, grasp the scientific challenge and opportunity which looms before us. So perhaps a sixth sphere should be designated as orientation and research training. It is unfortunate that effort in this direction in the past five years has been in inverse relation to the advances and achievements of research on arthropod-borne viruses.

It would be impossible to list in this document the most important research problems in this field which have become apparent from close association with research on arthropod-borne viruses abroad and in the USA during the past nine years. Therefore, it might be useful to briefly mention one or several under each heading which appear to me to be important and feasible to investigate now or with appropriate facility and personnel development in the near future.

1. Establishment and development of additional foreign field laboratories to support exploration for additional arthropod-borne viruses and evaluation of resulting disease in areas which have not been studied adequately or at all previously.

Selection of sites for the initial exploratory efforts of the Rockefeller Foundation arthropod-borne virus research programs were not necessarily the most ideal for maximum productivity in variety of viruses, ecological opportunity, or relative importance in causation of human disease. What is significant is that each of



Accessibility of Arbor Virus Field Investigations in Australasia to Laboratories Based in Bangkok, Brisbane, and Surabaja

the efforts paid off appreciably in scientific accomplishment, and each in a different way reflecting interests and talents of the investigators as much as local circumstances. If other efforts referred to above are to proceed towards more comprehensive and definitive objectives, it will be necessary to fill in gaps in our knowledge of geographical distribution and occurrence, expand the number of recognized arthropod-borne viruses to a majority and evaluate spectra of host and vector variability in relation to different climatic, ecological, and geographical factors. This can only be done by establishment of additional field stations and activities—almost all of at least a semi-permanent nature—with facilities capable of accumulating the basic elements of the knowledge delineated above. While continued support and expansion of laboratory and field activities already in existence is essential, there are certain big areas of the tropical world in which establishment of new facilities and efforts should be fostered and supported.

The Upper Amazon, Central Africa (Old French Africa and the Congo) and Australasia are three such areas. The Upper Amazon studies can be approached from one or several directions: (1) a field activity through Leticia, Colombia, that country's port on the Amazon which is in direct air connection with Bogota; (2) a field laboratory in Iquitos, Peru, which is in frequent contact by ocean vessels and almost daily by air with Lima; (3) a field activity of a more primitive nature along the Upper Amazon based on laboratory facilities elsewhere in Brazil. These efforts can deal with such questions as whether the C group viruses are active in the upper Amazon jungle, whether they are the same or significantly different from those already described at Belem in the Lower Amazon, what other arthropod-borne viruses are active in the area, what effect altitudinal changes on the eastern side of the Andes has on the activity, distribution and genetic variation in arthropod-borne viruses already known which certainly must exist there.

In Central Africa arthropod-borne virus disease, other than yellow fever, must certainly be as important as it has been shown to be in East and South Africa. Although political stability of vast portions of this area seems, for the moment, to be untenable, there are possibly some localities of old French Africa which might be selected at least for preliminary probing from some laboratory based in some other non-prejudicial locality in Africa like Liberia. Special attention should be directed to tick-borne viruses to determine whether there are foci of RSS virus complex agents established in this tropical region as they have been found in tropical India and Malaya.

The third, and, in some respects, most intriguing unexplored region for arthropod-borne virus research is Australasia, particularly that part straddling Wallace's Line. Here perhaps would be found a generating site for different, but related, arthropod-borne viruses or a key to biological host and vector factors which influence genetic variation of such closely related agents as Japanese B encephalitis virus which ranges northward into Oceania, Asia, and westward into India while closely related Murray Valley encephalitis virus ranges eastward and southward into New Guinea and Australia.

The richness of two faunas in this area provides challenges any biologically oriented virologist would find hard to resist. From a document I prepared previously on this area, I am attaching a map which shows the accessibility of the Australasian region from laboratories based in Bangkok, Brisbane, and Surabaja. The circles have a radius of 700 miles which, in my opinion, is a workable range for such studies from a working laboratory in proximity to adequate communications. It would seem that Surabaja is the most strategically located. With the University of California already contracted to develop an American type medical school there, such an additional research effort in tropical medicine is not beyond the realm of practicability.

2. Collaborative international research on specific but broadly based biological problems such as reservoir maintenance and dissemination which have been defined by scientific evidence accumulating from intensive local effort and isolated observations.

Isolation of more than half a dozen different arthropod-borne viruses, repeatedly, in nature from different species of wild birds on more than a hundred recorded occasions has implicated birds in several facets of the ecology of these agents. One is the long-distance dissemination for periodic re-introduction in ecologies which cannot maintain virus or to establish new permanent foci. This remains in the realm of speculation until an enormous effort is accomplished to amass a significant amount of positive or negative data.

At present there appear to be two areas where this might be possible: India and the Caribbean-Atlantic Coast region. The Kutch area in northwestern India, which is a cross roads for birds migrating between Asia and Europe to East Africa and tropical India is now in its third year of surveillance by a minimal but important field effort. It is minimal because of small support—the WHO grants $1000/year—and insufficient understanding and interest by those who could provide better basic and laboratory support. More specimens could be collected and more of them worked up with participation of additional people and other laboratories capable of adequate examination of the specimens.

The possibility of evaluating the role of migrating birds in the long-distance transport and dissemination of an arthropod-borne virus which causes infection and disease in temperate and tropical areas is most favorable in the Caribbean-Atlantic Coast region. This is the virus of eastern equine encephalitis which has repeatedly been isolated from migrating and other wild birds in many different localities.

To accomplish the necessary amount of data over a long period of time an extensive collaborative effort will be necessary. To obtain comparable information from a number of different localities will require training of personnel, establishment and development of additional laboratories competent to deal with arthropod-borne viruses, provision of common antigens and antisera for use in comparable tests, dissemination of information, including standard protocols and techniques for field collections as well as laboratory tests, and two-way liaison through a recognized acceptable sponsor.

No single agency can ever have sufficient personnel or laboratory capacity to undertake such an enormous task. On the other hand, a cooperative chain of a dozen or more laboratories, each working on local arthropod-borne virus problems, working together using acceptable standard techniques simultaneously during the migration season for several years could provide an accumulation of significant information as to where and when the virus appeared, in what species, at what intensity, in which direction it proceeded and what the dynamics and serological status of the wild avian population were as the season progressed. On a large enough scale, the information we need to answer this question should become available. What is required is (1) support for training personnel, zoologists as well as virologists, (2) support for establishment and/or development of local laboratories where arthropod-borne virus problems require it, and (3) support of the big program when the time is right.

We are directing what resources we can toward this end here. It is realized that the cooperative program is some years off because of insufficient personnel, generally accepted standard procedures, and lack of laboratory capacity in certain strategic localities in such places as the Carolinas, Mexico, and much of Central America.

3. Controlled laboratory and clinical studies of the pathogenesis and parasitic nature of certain of the arthropod-borne virus infections, particularly those known to cause variable pathological manifestations or severe systemic disease.

The range of pathogenicity and virulence encountered in arthropod-borne virus infections and disease is perplexing not only to those dealing with clinical manifestations in human patients in epidemics or as sporadic cases, but also to those interested in characterizing biological features of these viruses which elicit a variety of host responses which are not clearly applicable to antigenic differences. For instance, in the RSS virus complex the two most widely distributed members—Russian spring-summer encephalitis and diphasic meningo-encephalitis—invariably cause central nervous system disease in man. Louping ill has low infectivity for man and langat from Malaya is not known to have ever produced human disease nor to be of special infectivity for man. Omsk hemorrhagic fever and Kyasanur Forest disease viruses are highly infectious to man, being responsible for innumerable laboratory infections, and cause a systemic infection which results in hemorrhagic disease unassociated with any specific involvement of the central nervous system.

A parallel situation exists with the group B Japanese B—West Nile virus complex where St. Louis and Japanese B encephalitis viruses cause specific acute CNS disease in only a small percentage of persons infected, while West Nile virus, which is highly infectious to man, produces a self-limited febrile illness, often with skin rash, in a high percentage of persons infected. Disease from Ilheus virus of this complex is rare and nondescript although antibody studies have shown substantial incidence of infection in certain human populations.

Knowledge now emerging is showing similar variability in the group B dengue virus complex and the group A Chikungunya complex.

The clinical importance of uncovering the mechanism of these differences is obvious. Therein lie possible clues to controlled development of attenuated strains for preventive vaccines. Perhaps most important would be a clearer understanding of steps in the pathogenesis of each type toward production of particular disease syndromes which would aid in early treatment of what now are therapeutically frustrating illnesses.

Some of these viruses appear to have an important toxic factor associated with them which causes generalized systemic symptoms. Characterization of this factor and possible isolation of it raises the possibility of producing a palliative antitoxin like those available for the toxic bacterial infections. The influence of fever on the course and outcome of arthropod-borne virus disease has not been critically evaluated when temperature control may be of considerable importance in such infections.

We now have new techniques which make these problems amenable to laboratory investigation. Fluorescent antibody, ferritin electronmicroscopy, differential tissue culture, and ultra centrifugation as well as new biochemical procedures should be intensively applied to these specific problems.

4. Precise physical, chemical and biological characterization and analysis of specific arthropod-borne viruses, particularly those involved in the most variable and complex parasitic cycles as well as those causing most severe or debilitating disease.

Unfortunately, most efforts by those competent to carry out investigations in this sphere have been directed towards additional means for distinguishing antigenic similarities and differences between an increasing number of newly isolated arthropod-borne viruses. This is perhaps the usual preoccupation with the necessary descriptive side of a new field of science. But it is important that a taxonomy and classification be thought of as only a means, not an end, of scientific study. Support, in the name of tropical medicine, of studies which use the physical, chemical, and biological approach to determine what elements or characteristics of specific arthropod-borne viruses cause them to invade certain types of cells, persist in particular vectors, produce specific antibody or other host response, and, perhaps, to be amenable to inhibition or change to a virulent state would not only be worthwhile, but at this time might broaden the range and objectives of this research field toward a more stimulating and productive future.

There seem to be plenty of nucleic acid biochemists, phage microbiologists and microgeneticists who are ultrafiltering ideas which grew out of such biologically stimulated concepts as Beadle's and Tatum's *Neurospora* work that might be attracted to as challenging problems biologically derived from the current accomplishments of arthropod-borne virus investigations.

Because there is such a comparative dearth of effort in this sphere at present, it is difficult to outline specific lines of approach other than to say that a scientific agency or authority in a position to influence or direct support of scientific activity on viruses of importance in tropical medicine might selectively emphasize this sphere.

5. Based on the accumulating knowledge from research in the previous four fields, development and testing of environmental and immunological means of prevention of exposure and infection, biological control of parasite maintenance and transmission, and medical therapy of disease resulting from infection.

Activity in this sphere parallels that which has gone before relative to other tropical disease problems. It concerns the application and elaboration of an armamentarium of accepted methodologies of vaccine production (17D for yellow fever), environmental control (mosquito abatement and tick control) and chemical studies (diagnosis and supportive therapy). More attention might be given to mechanisms of host resistance but much remains to be done in all avenues of this sphere because of the great number and variety of arthropod-borne viruses, diseases and complexities in their natural history.

Attenuated viruses for Venezuelan equine encephalitis, dengue, and Japanese B are now in existence. Other vaccines of a killed type and combinations of regimes are also available. Worthy research efforts can be made toward adequate human and field trials.

The problem of culicine mosquito control—the outdoor resting mosquitoes implicated in transmission of most mosquito-borne viruses—contrasts strikingly with that of house-resting anopheline control for prevention of malaria. This will require a multifaceted research approach because of the dispersal and variety of habits of culicine mosquitoes.

Palliation of the acute clinical course of arthropod-borne virus disease, whether an encephalitis or hemorrhagic fever, often influences the extent of residua. Little is known clinically about any but a few of the arthropod-borne virus diseases and these can perhaps best be studied in epidemic outbreaks or tropical foci of infection by specially trained clinicians associated with good virological diagnostic facilities.

Japanese B encephalitis, Kyasanur Forest disease, West Nile fever and dengue occur annually in clearly defined localities. Perhaps such clinical research efforts could be directed there.

Conclusion. This has been a cursory statement of general and particular research problems dealing with arthropod-borne virus infection and disease in man which are within the purview of investigation of medical problems in the tropics. The largest problem remains, however, that of a minimum corps of adequately trained scientists and physicians to undertake research on these problems. Only a token force exists today and the nature of virology with the broader and more complex understanding of sister disciplines required to intelligently approach such research problems require time for training and provision of fairly elaborate laboratory facilities. This, therefore, is not only a sizable challenge in terms of global distribution of problems and paucity of personnel, but an expensive one which, perhaps, only the United States can financially afford. It appears that this important factor alone might influence selection of fields of research in tropical medicine which the National Research Council might choose to emphasize.

DISEASES OF DOMESTIC ANIMALS

Research Problems in Animal Diseases in the Region of Africa South of the Sahara—Excerpts from a letter dated 2 March 1961 (revised 22 January 1962) from **Dr. W. G. Beaton,** Director, Inter-african Bureau for Animal Health (I.B.A.H.), Commission for Technical Cooperation in Africa South of the Sahara (C.C.T.A.), Muguga, Kenya.

In taking Africa South of the Sahara as a region, it must be borne in mind that the subjects referred to are of varying importance to individual countries within the region and, therefore, do not provide a general picture of Africa as a whole, e.g., rinderpest is virtually confined to Africa north of the Equator and foot-and-mouth disease is only of economic importance to East and South Africa, where high yielding breeds of cattle have been established.

The order of mention indicates a measure of priority in Africa as a whole.

Trypanosomiasis. For a great proportion of Africa, the presence of infected tsetse flies is the greatest deterrent to full productivity of the economic domestic animal species. Research, additional to that being undertaken, is required in the following fields: Insecticides and manner of application, in respect of the tsetse fly; chemotherapy, new formulations and field trials in the sterilisation of animals infected with trypanosomes.

Pilot projects are indicated in areas of high meat/game concentrations regarding utilisation for human protein supplementation of surplus animals to confirm assertions that such tsetse areas are more profitably suited to game-animal production than to domestic animal production, while still conserving the aesthetic, educational and cultural values of a wild-life concentration.

Helminthiasis. Internal parasitic infections of the domestic animals account for the greatest total loss of production of food of animal origin. Still too little is known of control measures by establishment of immunity or in the use of anthelmintics for general use by the millions of small herd and flock owners.

Tick-borne diseases. Control of these infections lies in the effective use of acaricides and the elimination of resistance by the tick to the basic chemical. The most economical and efficient means of application is still a matter for research but the basic problem is a study of the factors which cause the development of resistance. Chemoprophylaxis and chemotherapy in the development of premunition and total resistance is a field in which interesting work, already in progress, might with advantage be supplemented.

Contagious bovine pleuropneumonia. The fundamental factors responsible for the establishment of an immunity by the susceptible animal species are little understood, nor the nature of the resistance in an immune individual of a susceptible species. Upon a greater knowledge of these points depends the emergence of effective vaccine evolved on logical lines. Little exact is known on the epizootiology of the disease and control depends largely on an infallible test to detect incipient or latent infection.

Rinderpest. The control of rinderpest in domestic animals in an enzootic country is largely a question of the degree of application of known procedures with the recognized adequate prophylactics, but the maintenance of the situation by coverage of the annual increase is a heavy financial burden. Research is called for on the question of reservoirs of infection during the inter-epizootic periods, be these domestic or feral.

Rinderpest has been referred to as the saviour of areas where cattle are of very high incidence but this expression of opinion is no longer tenable in the face of reduced resistance to annual take-off. Unfortunately, parallel research to that of disease control has not taken place on the manner of absorption of surplus stock. Except in limited quantities, a market does not exist for the teeming millions of cattle, sheep and goats, available annually in Africa. The market is controlled by three factors.

(a) Internally—Inadequate per capita income to purchase meat to include it as a regular item of diet at all income levels of the population.

(b) Externally—The general ban, based on inadequate data, in the importation of stock from a rinderpest area, however, sporadically infected, to a rinderpest free zone of Africa.

(c) Inter-territorially—The economic distribution of meat is not well understood and surplus and famine in respect of this commodity can exist almost next door to each other.

These points lead up to the research required in the field of persistence of the virus and the detection of infection, in carcases.

The potential for infection of susceptible cattle from this source may well be exaggerated but the control measures applied are justified in the absence of precise knowledge. In the meantime, much surplus cannot be utilised where urgently required.

Foot-and-mouth disease. Africa, unenviably, is infected with three distinct types of the virus of this disease, unknown elsewhere, in addition to the three classical types. Control by vaccination is thereby rendered more difficult than elsewhere, even if vaccines against these types were available. A foot-and-mouth disease research station exists in Kenya, the only one in Africa. Much more fundamental research could be carried out and vaccines be produced if more research workers were available.

Biological reference centre. Already the lack of a reference centre for the collection and storage of normal sera, antisera, and virus and microbial types, or at least their cataloguing, is becoming felt. Research is indicated on the actual and potential needs and the means of providing the same.

Streptothricosis—bovine cutaneous. Simple inexpensive prophylactic and curative measures to reduce the incidence of this disease are called for. The disease is of serious and economic importance and nothing is known of any practical and economic method of control.

Rabies. Research in aspects of this disease of particular reference to Africa is required in the following:

(a) Role of wild life reservoirs and transmitters.
(b) Confirmation of the "carrier" non-clinical reservoir.
(c) Rapid methods of laboratory diagnosis.
(d) Prophylactic protection of humans at risk.

African swine fever. Much brilliant research is being carried out in Africa on this disease. No prophylactic biological agent is as yet known and little encouragement has been received that future research in this direction will be successful. The expansion of this African disease to other countries, which has occurred fortunately only to a very limited extent, is another indication of the necessity for preparedness on the part of even disease-free countries.

General. This very abridged survey of the most important requirements in research in animal disease in Africa covers only the major problems. The impression must not be given that none of these problems is under examination. In fact, all of them are being tackled to some degree but the intensity of action must necessarily be relaxed in the next decade or so, until adequate qualified replacement becomes available, to fill the vacuum being created at present by the exodus of the great proportion of the existing research staff, who feel that security of person and career are greater elsewhere. The extent of future research will to a great extent depend upon the appreciation of research, which will be shown by politicians in practice by adequate provision of funds for the purpose.

As the current major diseases come under control following investigation and research, new infections become major.

An intensive veterinary research service is an expensive facility but can be economic, if shared by countries extending over an adequate area with similar problems.

Research Problems in Zoonoses and Other Animal Diseases—Submitted 27 February 1961 by **Dr. Martin Kaplan,** Chief, Veterinary Public Health and **Dr. M. Abdussalam,** Veterinary Public Health Office, Division of Communicable Diseases, World Health Organization, Geneva, Switzerland.

The following is a list of the important problems in this field prepared in consultation with Dr. Kaplan. This list does not include zoonoses like yellow fever, plague, schistosomiases, leishmaniases, etc., which we believe would be dealt with separately by specialists on these diseases. Important animal diseases other than zoonoses are only briefly enumerated as, we believe, this list is being prepared primarily from the point of view of human health.

General

1. Microbiological, serological, parasitological and other techniques of diagnosis, manufacture of biologicals and epidemiological investigations suited to conditions in the tropics (warmth, humidity, long distances, slow transport, etc.).

2. Assessment of the importance of different zoonoses by careful epidemiological surveys.

Special problems in the zoonoses and other animal diseases

An attempt has been made to list the more important problems in this field in the tropics omitting those which are receiving adequate attention in the temperate regions of the world, e.g., rabies, with the exception of ecology in wild animals which is a local matter.

a) *Brucellosis.* More reliable methods of diagnosis in sheep and goats and swine. Immunization of these animals and of man. Bacteriology of *Brucella* species. Therapy of human brucellosis.

b) *Rabies.* Ecology of stray dogs and wild life hosts.

c) *Leptospirosis.* Study of serotypes prevalent in different areas. Ecological cycles in rodents and other hosts. Vaccination of man and domestic animals. Simplified diagnostic procedures.

d) *Toxoplasmosis.* Epidemiology with emphasis on transmission and host spectrum. Diagnostic tests and therapeutic procedures.

e) *Hydatidosis.* Extent of prevalence and local epidemiological factors including those of a socio-economic nature, and the ecology of the animal reservoirs (wild life cycles). Anthelmintic and immunological procedures against the adult tapeworm. Action of chemicals on the egg.

f) *Bovine tuberculosis.* Extent of prevalence in different areas with different types of animal husbandry. Incidence of tuberculosis of animal origin in man. Mycobacteria occurring in man and animals. Nonspecific sensitivity to tuberculin.

g) *Trematode infections other than schistosomiases.* Prevalence and public health importance of such trematode infections as clonorchiasis, fascioliasis, fasciolopsiasis, heterophyiasis, opisthorchiasis and paragonimiasis. Diagnostic and therapeutic procedures. Study of life cycles and control of intermediate hosts where indicated.

h) *Taeniasis and cysticercosis.* Prevalence in man and food animals. Methods of detection of cysticerci. Diagnosis and therapy in man.

i) *Myiasis.* Biology and ecology of the flies involved. Factors leading to infection. Prevention and eradication procedures.

j) *Arbor virus infections.* Ecology, reservoirs and vectors of various encephalitides. Rift Valley fever and Wesselsbron fever. Simpler diagnostic and survey procedures. Vaccination and control of vectors and reservoirs.

k) *Food-borne infections.* Investigation and delineation of the causes of various types of food-borne infections and intoxications.

l) *Animal diseases other than zoonoses.* Research on the following diseases of economic importance is needed: rinderpest, foot-and-mouth disease, African horse sickness, contagious pleuropneumonia, black-quarter, pasteurellosis, East Coast fever and other haemosporidia, trypanosomiases and other parasitic diseases.

Research Problems on Animal Diseases in Iran—Excerpts from a letter dated 24 April 1961 from **Dr. A. Rafyi,** Director General, Institut d'Etat des Serums et Vaccins Razi, Tehran, Iran.

Most of our researches deal with production of biologics for human and animal diseases. Besides, we do some routine work for diagnosis of bacterial, viral and parasitic diseases in which some of them have a great public importance, such as brucellosis, tuberculosis, leptospirosis, Q fever, tick-borne diseases.

1. *Leptospirosis.* By serological tests with 5 different serotypes of leptospires (*pomona, grippotyphosa, hyos, canicola, icterohaemorrhagiae*) we found a lot of positive sera among sheep, cattle and camels around Teheran and the northern part of Iran (Mazanderan), and last year we were able to isolate *L. grippotyphosa* (*L. bovis*) from cattle, sheep and man around Hessarak. And now we are continuing the serological work with 10 different serotypes of leptospires to know the prevalence and the spread of the disease in different parts of the country.

2. *Q. fever.* By serological work we proved the existence of this disease among sheep, goats, calves and camels in Iran. For the screening test, we use a stained antigen of *Coxiella burnettii* which is modified by us for rapid slide and capillary agglutination test. We continue our serological work on this problem and are trying to isolate the organism.

3. *Tick-borne diseases.* The most important researches are made on borreliosis and Q fever, in which we feed and inject the different ticks onto laboratory animals for isolation of organism.

Besides, there are some other diseases, such as listeriosis, tularemia, toxoplasmosis, psittacosis, neorickettsiosis (enzootic abortion in ewes), etc., which are suspected in Iran and some of them have public health importance in which, if we have specialized personnel and materials, we will be able to do some researches on these subjects which seem very important.

Regarding some other research problems still remaining in this part of the world, I would like to bring to your attention that the viral diseases, mainly encephalitis in humans and animals transmitted by Arthropoda have not been studied seriously in this region.

RESEARCH NEEDS IN HUMAN AND ANIMAL TROPICAL BIOMETEOROLOGY

Research needs in the Field of Tropical Climatology—Excerpts from a letter dated 20 December 1961 from **Dr. G. E. Burch,** Tulane University School of Medicine, New Orleans, Louisiana.

Some of the suggestions that I might give would not be applicable in every situation since the interest in research varies with the individual and his capacities as well as with the available facilities. However, it seems to me that the following fields need to be investigated.

1. There is a need to investigate various aspects of acclimatization, particularly the influence of air conditioning on changes in acclimatization as well as on resistance to hot and humid environments. Air conditioning is beneficial provided one can remain in air-conditioned environments most of the time but what happens physiologically in normal and sick people when the air conditioning is not available needs study. The general problem of acclimatization needs continued investigation and the roles of the cardiovascular system, the skin and sweat glands as well as the central nervous system, the over-all regulator, need further elucidation.

2. There is a need to investigate the psychological aspects of the influence of hot and humid environments in tropical climates on man. There are many conflicting opinions in the medical field concerning the problems of alcoholism, the ability to perform physically and mentally and the variations in capacity to work efficiently over long periods of time in tropical climates. These aspects have never been investigated adequately and need study.

3. There is a need to study the influence of tropical climates on disease in man. Practically all of the fundamental investigations have been either on animals or on normal man. It is well known that many acute diseases are reversible if the physician is able to tide his patient through the acute phase of illness. This is a particularly important problem in aged people and a hot and humid environment when air conditioning is not available may make the difference between success and failure in treatment. There is a need, therefore, to study the reactions of the abnormal physiologic states in man to tropical climates. Furthermore, sick people cannot adjust to stress, including that due to climate, well. There is a need to learn more about the mechanisms of poor adjustment.

4. There have been many reports in the literature concerning the relative efficiencies of the Negro or "black" man over the white man in tropical climates. The consensus of opinion and certainly most of the physiologic studies indicate that the Negro is able to cope more effectively with tropical climates than the white man. Whether this is related to racial or genetic factors or to problems of training and acclimatization has not been fully evaluated and this type of investigation should be undertaken not only for normal people but for people with various types of diseases. The cardiovascular system in particular needs this kind of investigation.

5. There is a need to investigate the influence of tropical climates upon the incidence of various diseases. As we know, the incidence of disease varies geographically and although the need for geographic pathologic investigation is well recognized, this has been and continues to be neglected. The National Research Council will have a symposium in Washington in January, 1962, to consider the problems of geographic pathology. This consideration should not be limited to diseases peculiar to the tropics such as parasitic diseases but should include diseases found the world over such as angina pectoris, arteriosclerosis, hypertension, cerebrovascular accidents, peptic ulcer and many others. The incidence of cardiovascular diseases among Negroes living in the tropics is quite different from that of the Negro and the white man living in the temperate zones; the role of tropical climate *per se* has never been adequately evaluated.

6. The influence of tropical climates on nutrition and growth and on the anthropologic developments and variations in man's build needs investigation. It is generally stated that the ratio of body mass to surface area is low for people living in tropical environments as compared to that of people living in cooler areas of the world. The truth of this and the degree of its relationship to climate, independent of diseases and other factors, are not known. These and other growth and developmental aspects of infants and children as well as adults need to be investigated.

I might add that these suggestions apply to man in all stages of life, including fetal life. Many other problems might be considered based upon the above comments; one's imagination could carry him on into numerous fields of needed investigation but I hope the basic comments will be adequate.

Some Thoughts on Needed Research in Tropical Climatology to Promote the Health and Working Capacity of Tropical Populations—Submitted 3 January 1962 by **Surgeon Captain F. P. Ellis,** Royal Navy, Office of the British Naval Staff, Washington, D. C.

There is probably no aspect of tropical medicine today which is more neglected by medical men in their teaching, practice or research than medical climatology. "Medical" rather than "tropical" is suggested in discussion of the effects on health and working capacity of the hot-wet, hot-dry and intermediate climates which comprise the "tropical" climates, for, just as many of the diseases with which the tropical medicine expert is concerned occur north or south of the Tropics of Cancer or Capricorn, so do many of the more severe environmental situations which face the climatologist whose interest lies in the upper reaches of the temperature scale. Too strict a geographical denotation of the area of interest is misleading. Furthermore, medical climatology can be defined with some precision as the study of the effects of climate on the health, comfort and efficiency, and the physiological and psychological mechanisms of man with which we are by definition concerned here, rather than the effects of climate on his culture, economy, industry, politics, agriculture, animal husbandry, etc., which must all be considered if the more comprehensive term tropical climatology be employed. The emphasis "medical" also might serve to remind medical men that they have a responsibility here which has been somewhat neglected in recent years, in contrast with the interest which has been shown by geographers, meteorologists, physicists, and engineers, etc., who, whilst they are the physician's logical collaborators in any broad consideration of these matters, have rather had the field to themselves, and for this reason can only be forgiven if at times they have tended to trespass into medical territory.

Until World War II, although the literature had abounded with references to the adverse or helpful effects of climate on military operations or economic development since the time of Hippocrates, and particularly since Fahrenheit's thermometer appeared on the scene, the majority of scientific studies on man in hot environments had been made on persons who lived and worked in temperate latitudes. We may view this with some surprise and concern in the light of the suggestive evidence marshalled by several observers, notably Huntington (1924) and Markham (1947), which supports a direct relationship between prevailing climatic conditions and economic and cultural development. A recent survey by a Study Group of the Council on Foreign Relations (Lee, 1957) led to the conclusion that "there is a striking coincidence between the factor of tropicality and the lack of progress . . . that is denominated a state of underdevelopment" although "tropicality is not the exclusive crucial factor in underdevelopment" and "Far more, and more searching, research than has been carried out to date is needed to separate folklore and inference from established fact." Most of the studies on man undertaken before World War II were of an *ad hoc* nature, designed to answer such practical questions as those relating to the effects of extreme warmth on the output or efficiency of workers in the "hot" industries or in coal or gold mines, or, with the advent of air-conditioning, to assist in the definition of the optimum conditions which the architect and engineer should aim to achieve in homes, offices, stores and other places where people congregate together for work or play. Some valuable studies in the tropics or subtropics on these lines were indeed also undertaken in the Netherlands Indies, South Africa, South America, India and Australia, but it is probably fair to say there was no well sponsored systematic scientific approach in any country.

World War II provided for both the contestants a sharp reminder of the need to know more about human limitations in hot environments and how to combat or bolster these, in the desert and jungle and in the confined spaces of tanks and other vehicles, aircraft, surface ships and submarines. This led to much research both in the laboratory and in the field, of necessity nearly always "applied" rather than "basic" research, conducted with the compelling need to provide general staffs with adequate working answers to urgent operational problems as soon as possible. The work which was started in those stimulating times, and the problems which were defined then and in the immediate post-war years, have determined the pattern of much that has been done since by the Commonwealth countries or in the United States of America with certain notable exceptions, such as the investigations by C. H. Wyndham and his colleagues on the Bantu in South African mines, by J. S. Weiner, A. R. Lind and their colleagues in British mines, by W. S. S. Ladell in Nigeria, and by C. S. Leithead in the Persian Gulf tanker fleet. It would seem that recently only Wyndham and Ladell have reported significant studies on indigenous races living in hot climates.

Probably one of the most systematic attempts to evaluate the hot-climate problems of any one particular community is to be found in the joint evaluation by the Admiralty and the Medical Research Council of the environment between-decks in British warships in tropical waters and of its effect on the efficiency and welfare of ships' crews, which was undertaken with some urgency when a major portion of the British Fleet was diverted to Eastern waters in 1943 and 1944. As with the other war-time studies, the programme was conceived hastily and planned, of necessity, to produce quick answers which would help to win the war at sea, and indeed many of these practical answers were forthcoming well before the war ended in 1945. The war-time studies in the Eastern and British Pacific Fleets and in London and at Cambridge were designed to identify the characteristics of the ship-board thermal environment, to show where possible its effect on the health and efficiency of the sailors and to record, under controlled conditions in the laboratory, the physiological responses and the skilled or semi-skilled performance of naval ratings exposed to the range of air temperatures, humidities, air speeds, clothing and work loads which had been observed in the Fleet. The far-sighted decision after the War to continue to expand these laboratory studies, which commenced with "artificially-acclimatised" naval ratings in England as subjects, at Singapore on "tropically-acclimatised" men enabled the completion of this somewhat ambitious project in 1953 to meet the requirements of the Admiralty for the time being; and a series of investigations, to show the effects of variations in upper-deck temperature on the incidence of the main disease groups in the ships of the Royal Navy and the levels of warmth at which optimum comfort could be attained between-decks, were added to studies made by the physiologists and the psychologists. A preliminary comparative evaluation in the laboratory of indigenous Indians, Malays, and Chinese was included in the work at Singapore and it was hoped that the logical expansion of the programme would be to examine the reactions to climate of the people of Malaya in some detail. The authorities decided otherwise however; the laboratory was closed down, and a golden opportunity was lost. The main findings of this ten-year study were summarised recently in the British Journal of Industrial Medicine (Ellis, 1960) and the detailed results of the physiological work were published earlier this year by the Medical Research Council in Special Report No. 298 (Macpherson, 1960). Despite the limited scope of these naval studies—for example, the important effects of solar heat radiation, as opposed to long-wavelength radiation, were not considered at all for it was the population between-decks which was the primary concern of the investigators—the concluding chapter of Report 298 reveals only too clearly that many questions are left unanswered. There are glaring omissions. The biochemical phenomena evoked by heat stress were hardly studied at all, for a biochemist was never a full-time member of the group, the biochemical findings which are reported being the result of collaboration with the University of Malaya. The endocrine responses were never determined; and both these weaknesses are common to work in this field generally.

One impression gained from the Singapore comparative studies, if confirmed, could have an important bearing on the matters under discussion here. This was that, provided the nutritional status is similar and the subjects are in an equal state of health, training and acclimatisation, there are not very great differences between the various ethnological groups of the human race in their responses to work at high temperatures. Support for this assumption may also be derived from a comparison of data reported for Africans in Africa by Ladell and Wyndham with the data obtained by exposing artificially-acclimatised naval ratings to work at high temperatures in London in 1944 and 1945. Another useful piece of information, which was indicated by the limited range of measurements made, is that the responses of "artificially-acclimatised" naval ratings in a temperate country are not greatly different from those of "naturally-acclimatised" ratings in the tropics, and very similar to those of "artificially-acclimatised" ratings in the tropics (that is to say ratings artificially-acclimatised to temperatures higher than the ambient temperatures). This finding is directly relevant to the application of the results of work in climatological centers in temperate latitudes to meet the needs of tropical communities, if it can be confirmed by measurements of a more extended range of physiological and biochemical values than have been attempted up to the present. Thus, although up to now only a few of the effects of a few of the possible combinations and permutations of the several important variables which comprise the thermal environment have been examined with any precision, it is comforting to know that, with the above important proviso, the findings which apply to Caucasians reared in temperate latitudes may well be applicable to indigenous tropical peoples. But, this must be confirmed!

The above lines of thought suggest that, as far as laboratory work is concerned, the health and working capacity of tropical populations, whether indigenous or transitory, can be promoted by laboratory studies in temperate latitudes if the facilities for doing this type of work are available there but are not available to the tropical community under study, provided that appropriate field teams are established in the tropics to live with, and to define, the problems, and to apply or confirm in the natural living or working environments the techniques or lessons learnt in the base laboratory. This is important. The plant for carrying out controlled-climate studies on an adequate scale is costly and requires constant maintenance and a team to operate and use it fairly continuously to justify the financial outlay and full-time employment of skilled scientific and technical personnel who are in short supply; a reliable pool of volunteers to act as subjects for the work is essential; and the facility with which one can obtain consultant advice from a wide variety of scientific disciplines is of paramount importance.

It is worth noting that a reasonably comprehensive approach, even to the limited problems created by environmental warmth in this naval community of relatively young men living in ships, required the application of a remarkable number of disciplines. Initially the investigators were mostly physicians, some with a leaning towards physiology or psychology; but, as the studies continued non-medical physiologists, psychologists, statisticians, biochemists, biophysicists, anthropologists, environmental hygienists, engineers, and a psychiatrist all entered the act; whilst naval medical officers, whose primary role lay in carrying out surveys in the fleet, also participated in the laboratory work throughout.

It may be that no problems of more than passing interest will be defined by field survey, although this would be surprising; but, even so, it is important to know this for it will save useless thought and effort elsewhere. If problem areas are identified, their economic importance and their impact on health will require careful assessment before priorities for further study and resolution can be accorded, for it is likely that the latter may at times prove costly.

There would seem to be no adequate alternative to field survey as the first step! The situation is changing so rapidly in many tropical or subtropical countries that the views of the expert who was there ten years ago, or even five years ago, may be quite misleading on important issues. Not only are housing conditions greatly improved in urban areas where conditions were formerly appalling, but industry is moving in on a considerable scale, and experience in temperate latitudes has shown that it is in association with industrial development that climatic stress may be most prominent and its study most rewarding. It may be that what is considered necessary for the health and welfare of a transient person is not so necessary for the indigene, for example, air-conditioning; or it may be that equally successful results are attainable with careful construction of buildings and careful positioning of fans of sound design at an infinitely smaller cost, so that whereas the former (air-conditioning) might be prohibitively expensive the latter can be afforded.

A great deal more is to be learnt of the phenomena of acclimatisation to heat, and this knowledge is needed for the good of tropical peoples as well as for those living at the high or low latitudes. Very little is known of the process of acclimatisation after the first 14 or 21 days of exposure to unaccustomed warmth for Caucasians. Even that knowledge is only based at present on measurements of body temperature, heart rate, sweat output and of a few sweat components; but, one experiment at Singapore on a group of young men indicated that physiological adaptation was not yet complete after exposure for five months for four hours a day, six days a week to standard work in a hot environment. Very little has been written about the psychological adaptation which accompanies physiological adaptation although there are many clinical descriptions of what happens when it fails to occur. Studies over periods of years rather than days are needed to fill in the gaps, and these will not be easy to contrive.

Again, with Caucasian subjects, most laboratory studies on men working at high temperatures have only lasted for two to four hours each day. There is a paucity of information about more prolonged or repeated exposures within the same 24-hour period or about continuous exposure. Yet we know the duration of exposure is one of the vital variables to weigh in the balance in assessing any environmental situation.

Surveys of the thermal environment in work places and living quarters might be supported in suitable communities by "comfort surveys" to identify the optimum conditions of temperature, humidity and air speed. For most sedentary occupations it is the writer's view that these conditions, if ascertained carefully, will usually provide the optimum thermal environment for efficient work also, and a comfort index is a far more precise index in warm climates than it is in temperate zones.

The possibility of relating sickness incidence to the mean monthly temperature, an approach which proved very useful in the Royal Navy, might also be explored in the case of certain communities, e.g., employees of oil companies, which are under reasonable medical supervision with a view to detecting the causes of ill health which are aggravated by heat and assessing their effect on the total economy of the operation. In the Eastern and British Pacific Fleets in World War II, skin diseases provoked by life in a hot moist atmosphere caused more attendances at the sick bay than any other group of diseases and the attendances were twice as numerous in ships as in establishments on shore where the average air temperature was about 7° F less than it was between-decks in the ships. This provided not only a useful yardstick for assessing climatic stress, but also indisputable proof of its adverse effects on working efficiency. Although some features of the syndrome which has been described as "tropical fatigue" (Macpherson, 1949) or "hot-climate fatigue" (Ellis, 1952, 1953) were discernible in practically every member of some ships' companies of the wartime fleet in the tropics, this was, strangely enough, not apparent from scrutiny of the routine sickness returns, for when all are affected such states tend to be accepted as unavoidable features of the overall situation and are not reported. They are readily recognized by the trained observer who is a newcomer to the community, however, and a preliminary survey by questionnaire may be useful in helping one to decide whether there is a serious problem or not. Other observers have reported similar pictures in communities indigenous to the tropics who have had to live and work in warm and humid conditions for prolonged periods of time. The "fatigue" case should not usually be sought in the psychiatric clinic along with the true psychotics and neurotics, for, although the severe case will be found there at times, the typical individual with mild but significant hot-climate fatigue is neither a psychotic nor a neurotic and usually avoids the doctor if possible.

In those industrial situations where heat stress leads frequently to incapacitation careful study of these cases and the circumstances under which they occur will often be of economic and scientific value, and could be helpful in the revision of the nomenclature and classification of heat illnesses which is occupying the thoughts of another committee of the Academy's Division of Medical Sciences at the present time. There is still much to be learned about the acute incapacitating heat illnesses and too many preventable deaths due to this occur every year.

There have been few worth-while studies of women of any race in warm environments, although Tillet's studies on girls "used to attending ovens" published as long ago as 1764 suggests that women may be more tolerant than men. Very little is known about the reactions to heat stress in the very young or the very old, although Burch's elegant observations at Tulane can leave us with little doubt that it is certainly bad for those in whom cardiovascular disease is present. The infant is surely vulnerable to heat stress too. Do we know how vulnerable? Does life in a warm climate accelerate aging, or does it assist one to grow old elegantly and at ease? Is it a good thing to retire in the tropics? After all, man is said to be a tropical animal!

The Guide of the American Society of Heating and Ventilating Engineers (1960) tells us that little is known of the thermal requirements of the unconscious person in the operating theatre, and these requirements, when they are identified, may well be different in the tropics or in the antarctic from the requirements in Washington, D. C.! It has even been suggested that the anesthetised person may be a "poikilotherm"! Has enough attention been paid to the environmental requirements of the operating room team? Recent correspondence in the *Lancet* certainly raises doubts on this score!

Despite all the thought which has been given to the matter, there is no really satisfactory index or scale for assessing the effects of the wide variety of combinations of air temperature, humidity, air speed, radiant heat, clothing, work rate and duration of exposure which may be encountered in the tropical, or any other, thermal environment. The effective temperature scales, the predicted four-hour sweat rate, the wet-bulb globe thermometer index, the heat stress index and the time honoured wet-bulb temperature all have their particular applications, but there is a pressing need for someone to review just what these applications are and to warn against the misuse of these various systems of measurement, as the American Society of Heating and Ventilating Engineers advised on the use of effective temperature some thirty years ago. Such a review should indicate also, in terms of each index recommended for use, optimum and limiting environmental conditions for various common types of activity at work or in the home. Some such review is almost an essential preliminary to any broad survey of the thermal environment in the tropics, if there is to be any hope that different groups of investigators will "speak the same climatological language", just as it was necessary for Bedford (1946) to advise on standardized procedures for measuring environmental warmth in the Royal Navy in 1944.

This list of a few problem areas which would repay study, whether in the tropics or elsewhere, could be prolonged. It is hoped that sufficient has been said to indicate that the needs for further climatological research are real and that it is of increasing economic importance to assess these needs in relation to the other research requirements of tropical medicine for they have been overlooked sadly in the past. We may be underestimating the contributions which a well-planned and well-supported effort in climatological research might make to the development of the tropics during the next century. In his timely Presidential Address "Empire into Commonwealth" before the Royal Society of Tropical Medicine and Hygiene on the 12th October, Sir George McRobert (1961) laid emphasis on the need to use the resources available for the promotion of tropical health primarily in preventive rather than in therapeutic medicine; and his main thesis was "that a high proportion of money available for aid in the health field from British sources should be spent on British-based research, and that most of the remainder should be directed into the field of health education", not invested in exporting costly heart-lung machines and electronmicroscopes! It is submitted that this generalization holds for tropical climatology too, although the balance may change later with greater emphasis on education and less on research as the facts revealed by the latter are absorbed into the former. Sir George suggested that two kinds of research worker were needed, "high-power workers in temperate climates and well-trained competent workers in the tropics." This also applies to tropical climatology, except that we would like to see the high-power worker resident in the tropics as well, for this is where the problems must be identified and eventually where their solutions must be applied. Today there are several finely equipped government-sponsored laboratories for carrying out "tropical" climatological research in the United Kingdom and the United States of America, but their resources are devoted almost entirely to the problems of the armed forces. Presumably, they could be diverted, or programmes could be modified, to meet the needs of the civilian tropical population as well as those of the military if, after an adequate examination of the problem, this was considered to be in the national interest. This cart is well ahead of the horse at present, however. The first step should surely be the evaluation of the problems which are climatic in origin in the tropics by survey teams, and from a consideration of their reports, the relative priorities, the breadth of support required and the need for more extended study and for base and field laboratory facilities, etc., can be determined.

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Research Needs in Tropical Climatology—Excerpts from a letter dated 30 December 1961 from **Dr. J. C. D. Hutchinson,** The Ian Clunies Ross Animal Research Laboratory, Parramatta, N. S. W., Australia.

My suggestions for research related to the health and working capacity of tropical populations must necessarily be mainly indirect because I am personally concerned with research on farm animals, not with medical research. Since the greatest bar to improvement of health and working capacity is poverty, such suggestions are, I hope, relevant to your enquiry.

1. It has been recognized for many years that Zebu cattle are better adapted to the tropics than the European breeds. Yet comparatively little progress has been made in identifying those physiological characteristics which differ between the two types

of animal. Recent work in this country has shown that the difference may extend beyond heat regulation to adaptation in making the best use of the low nitrogen pastures of the tropics. Obviously more systematic studies in this field are necessary. The differences in physiology between the various breeds of Zebu do not seem to have been studied at all. Of particular importance is the difference between the larger Zebu breeds and the small cattle of the wet tropics, such as West African Shorthorn and Sinhala, which do not seem to be properly Zebus at all.

2. Perhaps the most important determinant of working efficiency is the availability of power. It seems that for many years this may be partly animal power in the tropics. For even where internal combustion engines can be locally manufactured, there may still be exchange difficulties in importing sufficient petroleum to operate them. So far, there seems to be no investigation on the efficiency of work of animals in hot climates, analogous to the many studies which have been made on man. Yet even casual observation of the methods of working animals in the tropics leads one to think that they are not efficient. For instance, cattle and buffaloes, whose heat regulation even in heat adapted breeds is not outstanding, may be seen working in the middle of the day exposed to solar radiation, when a comparatively primitive sunshade could improve their thermal environment. Likewise, donkeys may be seen in the subtropics carrying loads which must effectively prevent evaporation of sweat.

3. For many years there has been speculation on the anatomical and physiological effects on man of residence for a number of generations in hot climates; but little definite information has been obtained. In the Antipodes there is an immigrant population of nearly common origin and common current economic and nutritional status, living in an extraordinary variety of climates. It would seem that this is the best material available for such studies of possible divergence of human population resident in varying climates, yet so far no use has been made of it.

Research Needs in Tropical Climatology—Translated excerpts from a letter dated 29 December 1961 from **Dr. Georges E. Lambert,** Directeur Général Adjoint de PROHUZA (Centre d'Études et d'Informations des Problèmes Humains dans les Zones Arides), Paris, France.

We have been working for three years on the different aspects of human adaptation to desert and subdesert regions. These investigations have been carried out concurrently on Europeans and on natives. I think we are now able to hold some reasonable ideas concerning the orientation of future research, particularly with regard to the hot and dry climates.

I. *With regard to the translocated European*, a longitudinal study lasting six months has provided us with a certain number of original results.

E.E.G. The electroencephalograms of our subjects showed a notable electroclinical dissociation throughout their stay in the Sahara. The entire electrical activity of the cortex was considerably diminished in subjects who were quite wide awake, resembling very nearly pre-sleep and even sleep records, in spite of irrefutable clinical alertness. It would seem that these results are independent of the environmental temperature but are linked to the impoverishment of sensorial perceptions and to the meagerness of the psychosociological situation.

Upon returning to a temperate climate, the E.E.G. immediately became normal.

It seems to me that these electroencephalographic data are extremely important. They could explain the apathy, general slowness and disinterest which is constantly encountered behind the professionally correct but automatic behavior of people remaining for long periods in desert regions.

I ought to make clear that electroencephalograms from natives (nomads) showed normal tracings, as did those from Europeans during two acute survival experiences. Verification of normal E.E.G.'s in the nomads is essential from the standpoint of capacity for work.

Central temperature. In the European and in the native we have recorded a lowering of the central temperature on awakening, all the more important because the atmospheric temperature was higher. This is manifestly a matter of adaptation which resembles, simply, that seen in the camel and which would certainly merit being studied much more intensely.

In the same vein, during alternating sequences of daytime work and nighttime work, the nycthemeral difference in temperatures is weakest during the hottest period. It is almost nil during the month of August when the atmospheric temperature rises to 50° C.

Curiously, the variations in differences in nycthemeral temperatures during work correlate closely with the results of the myokinetic test of Mira.

Reaction time (electronic chronoscope). Visual and auditory reaction times, as measured by the electronic chronoscope, have been clearly shown to deteriorate with heat, the deterioration appearing above 34° C and becoming practically proportional to the elevation in temperature.

On the other hand, all the other tests which we have applied have been subjected to a continuous study, not yet finished after eight months. The results in no way demonstrate deterioration by the intense heat. This leads me to consideration of the electroencephalogram: the electrical activity in subjects engaging in simple and precise activities requiring a weak level of alertness does not deteriorate. However, more complex and intellectual activities are sensitive to temperature and perhaps also to sensorial deprivation.

Electrocardiogram. This has shown us modifications of the T-wave which seem equally associated with the atmospheric temperature and the degree of adaptation and with modifications of the S-T segment of the same order.

On the biological level, a study of hydromineral balances has confirmed what we had already seen with B. Metz and M. Hasselman. However, on the nutritional level it seems rather certain that our subjects have effected an important buildup in nitrogen and potassium, accompanied, without weight changes, by a significant disappearance of lipids.

On the clinical level, the most important fact (based on the observation of several thousands of workers in the Sahara) is the elevated number of cases of renal lithiasis in young patients. In fact, at the present time I find myself unable to define what "potable water" should be when one must consume more than ten liters per day of it.

On the statistical level, the corollary of the action of climate is to be found in an analysis of the frequency of work accidents in industry, in the different seasons and according to the time of day. The frequency is maximum during the hot season but, contrary to what one might expect, the daily frequency is not maximum during the hottest hours but during the morning shift (4:00 a.m. to 12:00 noon). This is the shift during which all the biological rhythms are disrupted (nycthemeral rhythm, alternation of day and night, alternation of coolness and heat, altering the mealtime, bad night preceding the work shift). The variation in accidents is analogous in natives. However, an additional accident period must be added during the Ramadan (traditional fasting period).

II. *With regard to natives:*

On the clinical and pathological levels, the populations of the desert regions of the Sahara present a very banal pathology. Aside from trachoma and, in some few regions, bilharziasis, the rich symptomatology of the humid regions of the tropics does not exist. In spite of the chronic state of poor nutrition there is no true malnutrition.

But this chronic hyponutrition poses a problem when groups of Saharians are put to work. In effect, if it is compatible with the traditional life it should be counterbalanced by extra energy and protein in the event of physical work. This supplement is not merely a matter of supplying the energy necessary for the execution of a job, for an important ponderal and muscular debt must be paid up which may require several months to get in balance. In the petroleum fields we have observed that the mean alimentary consumption by native workers surpassed 5,000 kg.-cal./day, whereas European workers under analogous conditions consumed less than 4,000. The difference must be sought in the considerable protein anabolism in the natives; at the end of a six-month period this is translated into a weight increase of several kilos. This is an important fact in the calculation of the energetic cost of alimentary rations.

On the electrolytic level, the several balances which we were able to effect were quite normal, but at a cost of a very weak level of input and output. This is truly a question of adaptation, for the intake of electrolytes (overly mineralized waters, overly salted food) leads quickly to physiological upsets just as does loss of electrolytes (in the case of diarrhea or vomiting).

This balance becomes a very fine equilibrium which does not depend on any reserve and which is compatible with restricted hydric and alimentary input. The result of all this is that there are some very great possibilities for *light continuous efforts* and an almost total impossibility for strong but brief efforts.

This fact seems to me to be fundamental if the creation of work for tropical populations is to be envisaged.

On the metabolic level, we have not been able to carry out any valid experimentation. However, it seems that the resting metabolism of the nomads is rather low because of their particular mode of life and above all because of their particular mode of thought. One of the survival experiments which we have performed, comparing Europeans and nomads, has shown us that this survival experiment was very easy for the latter, above all because of the meditative attitude which they were able to adopt when faced with the situation.

There should be an opportunity, I believe, to study in depth all the metabolic data of the populations of the tropics, as well as to study their mechanical performance in different types of effort.

On the psychometric level, we have tested a large section of Saharian and tropical population. It would not appear that obstacles to their going to work could result from any incapacity in these populations, even though success in the tests is quite variable from one region to another.

I have dwelt at length on these reflections which were born out of the studies of these last three years. On the level of research which is needed, it would be, I believe, very important to undertake research on *differential (or comparative) physiology* between the dry regions and the humid regions, the humidity factor being more severe than the heat factor, other things remaining equal.

Nutritional studies must be done at length (we have hardly begun them in a socio-economic study of oases in the northern Sahara). They are linked with *metabolic* studies at rest and at work.

The field of *perception* must be studied in depth and configuration.

In fact we are ignorant of almost all of the biology of tropical populations. In point of fact, our research program for 1962 includes some fundamental biological research of the population of the western Sahara. From the standpoint of methodology, it seems to me that all such research ought to be strictly aware of the economic and social context of these populations. The equilibrium at which they have arrived empirically is perfectly adapted but very fragile. We have the example of numerous impetuous actions which succeeded in destroying it when the basic principles were not known.

Unfortunately I have not had time to edit a program of research for you. I trust that you will be able to extract some elements of one from the above reflections.

Research Needs in Tropical Climatology—Submitted by **Dr. D. H. K. Lee**, Occupational Health Research Facility, U. S. Public Health Service, Cincinnati, Ohio.

Further action required, as reported to UNESCO Symposium on Arid Zone Problems, May, 1960

Deficiencies in knowledge of human adaptations

The present state of knowledge is particularly unsatisfactory in the following respects:

Lack of ability to deal quantitatively with variable and transient heat flows characteristic of natural conditions

Absence of a quantitative index of thermal conditions permitting prediction of net effects of given conditions

Inadequate measures of mental performance, especially under natural conditions

Inadequate measures of submaximal physical performance, especially under natural conditions

Insufficient information on the impedance to physical performance offered by various aspects of terrain

Inability to measure the importance of psychological attitudes in adaptation and performance under natural conditions

Uncertainty on the short-term effects of nutritional state upon work capacity and performance

Lack of clear evidence on the various effects of isolation upon performance

Uncertainty on the relationship between austere conditions, personality traits and performance

Deficiencies in knowledge of animal adaptations

The present state of knowledge is particularly unsatisfactory in the following respects, some of which parallel those noted for human adaptations:

Absence of quantitative indices of thermal effects permitting prediction of welfare, performance, and production under given conditions

Lack of clear indications of optimum production targets for given animals under various conditions

Insufficient data on the possible association between efficiency of food utilization and heat tolerance in a given species, breed or strain

Uncertainty as to optimum feeding practices for conservation of performance under conditions of periodic starvation

Insufficient evidence on effects of chronic water deprivation

Scant knowledge of the range of variation in heat tolerance and similar functions within representative breeds

Deficiencies in application of knowledge of arid zone problems

No comprehensive survey has been made to determine the relative distribution of problems in human and animal adaptation under various types of arid zone occupancy or economy, or of the relative importance of the various problems.

Similarly, few estimates have been made of the changes that occur in the nature or distribution of problems following changes in the economy of a region.

Few estimates are available of the economic cost that would result from failing to solve various problems in human and animal ecology.

Much more attention needs to be given to educating local inhabitants in the application of existing knowledge to important practical problems.

Too little attention has been given to examining the various problems in a total ecological context.

Problems reported in "Climatology. Reviews of Research," Arid Zone Series X, UNESCO, p. 1-3, 1958

Development of a method for directly measuring skin wetness

Formulation of convective properties of naturally occurring turbulent air flows in relation to the size and surface of an interposed body

Clarification of the factors determining the net heat load resulting from incident solar and thermal radiation

Codification of radiative properties of sky, terrain, trees, and buildings in relation to type

Perfection of a system for obtaining an index of the thermal strain resulting from the simultaneous operation of several variables

Codification of the impedance offered to locomotion by terrain types

Elucidation of the carcinogenic effect of sunlight

Determination of the relationship between wind speed and impedance to locomotion

Analysis of time trends in physiological responses to changes in environmental stress

Analysis of interval effects upon responses to environmental stress

Determination of the physiological and psychological significance of variability in environmental conditions

Elucidation of the effect of weather changes on bodily function

Establishment of the time course of changes in heat transfer following a change in clothing cover

Clarification of the physics of heat transfer through damp clothing

Establishment of quantitative expressions for the effect on heat transfer of perflation through large openings

Clarification of the relationship of porosity to water vapour transfer in fabrics made from synthetic fibres

Establishment of equations for total effect of clothing changes upon heat transfer, including interactions between effects on different channels

Establishment of cooling efficiency in relation to rate of air movement for various clothing systems and ambient conditions

Determination of the relationships between the properties of animal coats and rate of heat transfer

Clarification of the physics of sweat distribution in animal coats in relation to efficiency of cooling

Design of a simple, effective, and trouble-free evaporative cooling system, especially for roofs

Codification of the thermal properties of construction materials

Improved design of analogue computers for heat transfer problems

Research Needs in the Field of Tropical Climatology—Excerpts from a letter dated 2 January 1962 from **Dr. W. V. Macfarlane,** Department of Physiology, John Curtin School of Medical Research, Australian National University, Canberra, A.C.T., Australia.

The basic question which I should like to see answered in relation to tropical man is whether there are biochemical and physiological differences which have been selected by natural processes to differentiate tropical races or groups from those living in cool climates. If one assumes that the human species originated in the tropics it still holds that most physiology is known for temperate climate groups and the primary human physiology is still obscure. If I had considerable resources, I think several sorts of experiments could usefully be undertaken.

(1) Comparisons within racial groups distributed over a wide range of latitudes. Such groups would be Europeans and aboriginals in Australia, Bantu in Africa and American Indians in North or South America. If anthropological aid were called in for the adequate identification of racial homogeneity, I think that the answers could be quite useful.

(2) Responses of different racial groups to migration either from the Equator towards the Pole or in the opposite direction. These events need to be followed rather carefully in time with observations in the first two weeks, at the end of the month and after one or two years at least.

The types of observation which could be most relevant would almost certainly vary with the background of the investigator. I have always taken the point of view that the peculiarity of living in the tropics is the high water turnover for evaporative cooling and that all functions associated with water intake, distribution and elimination are relevant to tropical living. Metabolic functions are, however, closely related to the same phenomenon. A depression of heat production is clearly useful when the external heat load is high. These two linked phenomena, evaporative cooling and reduced heat production, seem to have consequences in both biochemical and physiological aspects of mammalian life in the tropics. The types of measurement that I think would be most valuable for the study suggested are:

(a) Estimation of water turnover and the distribution of water in the intracellular, extracellular and gut spaces of the body. This should be done for all age groups from the newborn to the aged and for pregnant and lactating women.

With the water studies (mainly revolving around deuterium or tritium measurements), body composition can be approximated. The significance of fat in desert animals seems quite considerable, but probably among tropical peoples where food supply is not intermittent fat is of small importance.

(b) Sodium and potassium content, turnover and distribution in the body. Some vegetarian groups of human beings in the tropics have high potassium intakes and low sodium. The relation between nutrition, water evaporation, and small amounts of sodium is a very interesting problem. The part undertaken by sodium in the water and sweat movements in the tropics requires further quantitation.

(c) Renal studies on the control of water and salt in both dry and humid tropics are very few still for man.

(d) Endocrine consequences of hot environments. The concentration in the blood, the daily output and the turnover of thyroxin and triiodothyronine in tropical peoples are still largely unknown.

The apparent depression in the output of cortisol by mammals exposed to hot environments has importance in metabolism but the full significance of this is not yet worked out. Blood levels of cortisol and similar adrenal steroids, together with studies on the turnover of such steroids near the Equator, would be very valuable.

The reproductive efficiency and milk production of adapted and unadapted races living in hot environments is still very largely obscure. I reported a reduction in the conception of white people living about 20° from the Equator in Australia but the cause of such reduction during summer is not known.

If adequate facilities are available for the measurement of pituitary hormones, particularly TSH, ACTH, FSH and LH, these could yield some of the most useful data on endocrine aspects of adaptation.

(e) Biochemical and intermediate metabolism studies on adapted groups would ultimately be necessary for analysis of any differences found.

(f) The nervous system is intimately involved with nearly all aspects of the adaptive process. Some phases of nervous activity that could be studied are:

(1) Autonomic functions in circulatory redistribution, particularly to skin and kidney. With these the central control of sweating and the nature of the change in output of sweat on acclimatisation as well as failure of sweating in those not acclimatising are also relevant.

(2) The central regulation of fluid and food intake as well as of activity in relation to the hot environment is clearly of great survival value, but the exact information from the body that leads to the homeostatic regulation could do with a good deal more investigation.

(3) Habituation to heat appears to be a function of spinal cord interneurones and the nature of this elementary type of learning is important for the understanding of changes in response of those exposed to strong and continuous stimulation.

Most of the simpler forms of tests of efficiency and of exercise tolerance or heat tolerance have been worked over fairly thoroughly.

Suggestions for Needed Research in the Field of Tropical Climatology Especially as Related to the Health and Working Capacity of Tropical Populations—Submitted by **Dr. R. K. Macpherson,** School of Public Health and Tropical Medicine, The University, Sydney, New South Wales, Australia.

When considering the preparation of a list of suggestions for needed research in the field of tropical climatology, one is immediately confronted with the difficulty of deciding what should be included and what should be excluded. If time had permitted, guidance on the scope of the subject would have been sought, but in the circumstances it appears that it would be better to err on the side of inclusion rather than exclusion.

GENERAL ASPECTS. It is thought that the term "climatology" should properly be interpreted in the widest sense as embracing all matters arising out of, as well as those directly attributable to, the effects of hot climates on the health and productivity of the people concerned. On the other hand, it is thought justifiable to exclude from consideration "tropical diseases" in the usually accepted sense of the term.

Difficulty, however, arises in defining the limits of research. Fundamental research merges imperceptibly into *ad hoc* research and this, in its turn, becomes difficult to distinguish from attempts to provide solutions to pressing problems from the resources of recent technological advances. Indeed, the devising of means for the application of modern technological methods in underdeveloped or backward countries may be of itself an important subject for research.

In order to keep the scope of the subject within manageable proportions, one is tempted to restrict it to matters which directly affect man, and avoid reference to those affecting plants and animals, of which the effect on man is indirect. This, however, is not possible. Improvement of the nutritional status of a tropical people may be the most important factor in improving its health and productivity, and the solution to this problem may be found only in the solution of other problems related to the effect of tropical climates on food crops and domestic animals. Increasing crop yields and the breeding of domestic animals suitable for the tropics may then become research subjects of the greatest importance in the present context, and even plant and animal genetics may, therefore, qualify for a place in the list of topics.

Faced, as scientists are in some tropical countries, with the problem of matching the food supply to a population increasing at a rate which has been described as explosive, it seems ill-advised to concentrate all efforts on increasing the food supply or national productivity and not to attempt at the same time to restrict the rate of growth of the population. Therefore, problems of population control may justifiably be included among the topics for research.

There is a diversity of needs for research within the tropics and a topic of dominating importance in one area may be insignificant in another. In the arid areas the dominating climatological problem is the absence of an adequate water supply, and it may appear essential perhaps to devote intensive study to the provision of fresh water from sea water or non-potable brackish water. This problem has no counterpart in areas of adequate rainfall.

Requirements for research in the hot arid zones differ from those in the warm moist areas in many other respects. The moderate temperatures encountered in equatorial climates, for example the northeastern seaboard of Australia, do not urgently demand the devising of methods for the reduction of indoor temperatures in order to render the area habitable to the same extent that they are required in the hot dry areas of Central Australia or in the countries bordering the Persian Gulf.

An important dichotomy of interests also occurs when consideration is given to the contrasting problems of an emergent indigenous people living in the tropics and those of a sophisticated westernized community in the same circumstances. It will at once be plain that the problems awaiting solution before the density of the white population in the northern parts of Australia can be increased, are very different from those of immediate concern in the neighbouring countries of New Guinea, or even of Indonesia, with their existing high level of population.

In the first case, the emphasis is on improving standards of living conditions so that they match those of the more climatically hospitable and more densely populated parts of the country and on countering the psychological effects of isolation. These problems would have little relevance in the second case.

A dichotomy of emphasis, however, may be more apparent than real. In all tropical areas, whether they are "hot wet" or "hot dry", the provision of housing which provides adequate protection of the inhabitants from the stress of the environment is one of the most pressing needs. It is often customary to consider this under two separate headings, "housing for Europeans" and "native housing". It is true that the immediate needs of providing high-density urban housing for an indigenous population of low income status may be very different from those involved in providing houses for a high income group, but the differences are largely those imposed by costs. The fundamental scientific problems for solution are the same in both cases, viz., problems of minimizing heat gain and heat transmission, and results in the form of improved materials and techniques and reduction in costs are as important in the one as in the other.

Even the distinction between "hot-wet" and "hot-dry" building research is largely artificial. Though the ultimate results, the type of building designed, may be very different, both branches of building design have a common basis of scientific enquiry.

Indeed, the same fundamental research or the same technological advance may often be used to subserve different ends in different circumstances. Improved techniques for the utilization of solar energy in the tropics can be used to provide domestic air conditioning in an American community with a high standard of living, or provide the basic means of cooking in an Indian village.

The results of one form of enquiry may also have widespread and apparently often unrelated effects. If solar energy could largely supplant dung as a source of domestic heat in India, the dung could be used as a fertilizer with an increase in crops and consequently in the nutritional status of the people.

There would appear to be good grounds, therefore, for including the development of techniques for the utilization of solar energy as a proper subject for research in the present context.

Reference has already been made to the necessity for improving the standard of nutrition in many tropical areas, and the need for increasing the total calorific intake and the amount of high-grade protein in the diet is obvious. Views on other aspects of diet in tropical countries rest on less certain grounds—for example, the extent to which calorific requirements vary with environmental temperature is debatable, and there are special aspects such as vitamin, salt and water requirements which might repay further study. The special case of those inland primitive peoples whose sodium chloride is largely diluted with, or contaminated by, wood ash presents an interesting physiological problem.

Enough has been said in general terms to indicate the breadth of the problem and its great diversity. Indeed, so great is the area covered that it is impossible for any worker or group of workers to do more than cultivate a small area determined by their own interests or the existence of specific local problems.

SPECIAL SUBJECTS. For the reasons just given, it may, therefore, be of help to append a list of those problems which are of special interest to this laboratory, with some notes on each.

Thermal comfort levels. The determination of the levels of thermal comfort for the inhabitants of various parts of Australia and New Guinea and the determination of upper desirable and upper tolerable levels of warmth for acclimatized Australians has been undertaken to provide basic information for air-conditioning design and as a guide in regulating conditions of employment in industry.

The thermal reactions of special social groups. The special reactions of hot environments on infants, women, the aged and the infirm is considered of interest for two reasons. The first is that most information on this matter refers to healthy, young, adult males; the second is that it is on these groups that the stress of exposure to hot conditions specially falls.

The reactions of the skin to sunlight and heat. Special interest is lent to this study by the finding of the high incidence of skin disorders, including dysidroses, in tropical Australia and the existing high incidence of neoplasms of the skin, including basal-cell carcinomata and melanomata, among outdoor workers, especially those with fair complexions.

Building design. The general unsatisfactory nature of buildings, especially houses, at present being constructed in the tropics, has made this of special local importance.

Control of indoor environment. This includes not only air conditioning but problems of ventilation and methods of cooling by evaporative coolers and other non-conventional methods. Special difficulties arise from the restriction in available power supplies in some areas.

Clothing. The physiological properties of textiles and their laundering characteristics are important in this country both from the point of view of the user and that of the chief supplier of the world's wool.

Fluid balance. The requirements for water and salt and the effect of the restriction of intake on ability to work and renal function are important physiological problems in all hot countries, made more difficult to cope with by the existence among the population generally of misinformed convictions.

Fertility. The effect of hot climates on fertility is of special significance in this country, both in its application to man and to domestic animals.

Acclimatization. Acclimatization to heat provides not only intrinsic interest but affects a number of matters of practical importance in a country in which people may move by air over large distances.

Radiant heat exchange. The measurement of heat exchange by radiation, especially solar heat gain, is of special interest in Australia on account of the large group in the population who are engaged in agricultural and other outdoor occupations.

Comparative studies. The Australian aborigines present valuable opportunities for the study of the comparative effects of both heat and cold.

Mental health. There is good evidence that much of the invalidism occurring in very hot areas in this country is related to tropical neurasthenia.

Sociological problems. These deal with the effects of climate on the composition, the rate of growth of the population and its distribution in Northern Australia.

Entomology. Recently growing attention has been directed in this country to one of the traditional scourges of the outback—*Musca sorbens*, the bush fly.

It is of interest to note that, in general, the topics set out above all arise out of specific needs in this country. In this connection, it must also be added that requests for advice on, or the examination of, individual problems have succeeded in the past, and probably will continue to do so in the future, in diverting attention from more fundamental and fruitful lines of enquiry.

It is not for a moment suggested that substantial work has been done or is in progress in the subjects listed. It is confidently hoped, however, that, in the course of time and with the growth of this laboratory, work will be done on most of the topics which have been set out in this section.

Research Needs in the Field of Tropical Climatology—Excerpts from a letter dated 9 January 1962 from **Dr. Bernard Metz,** Laboratory of Applied Physiology, Faculty of Medicine, University of Strasbourg, Strasbourg, France.

First of all, I would like to make one point which may look odd but seems to be of some practical importance. During a short stay in Dakar last year, I visited two factories—one shoe factory and one textile mill. While my interest was centered on the problems related to climatic physiology, I came progressively to the conclusion that the true problems were rather of a "cultural" nature. For instance, most of the workers arrived quite irregularly to work since there was a lack of watches or clocks in their settlements, and also since being on time was not of major concern to them. Furthermore, there was a feeding problem, especially for those doing shift-work, since the wives were not able to fix lunch-boxes to carry along nor were they ready to prepare food outside the ancestral time schedule of their meals at home. In that tropical area, with a rainy season, another feature has quite an important practical bearing. The dwellings not being water-tight, many workers must stay at home to fight the water infiltrations on very rainy days, which completely disturbs the production of the factories. Finally, the incentives to work must be considered remembering that any individual worker has to take care of a much larger family than in western countries. Polygamy has something to do with it, but the situation arises also from the fact that family dependence is much closer than in our societies; when a man has a good job, many relatives come from far away, sometimes from several hundred miles, so that not infrequently one salary provides a living for twenty-five persons. When there is some bonus system, any increase of the income will simply mean that more people will gather around the privileged worker.

Strictly climatic problems are of importance when industrial production involves hot or wet processes which can add to environmental heat and humidity. In these cases straightforward application of the knowledge acquired for environmental control in similar industries located in temperate areas seems to be sufficient.

During our investigations in the Sahara, we gained the impression, which should be supported by appropriate research in the coming years, that the adaptation of the native tribesmen consists mainly in water economy much more than in tolerance to heat. This would be quite logical in traditional desert life conditions. This means that these people may rely mainly on reducing heat production from muscular work and delaying water intake until they are already dehydrated.

In the Sahara we have also come across a peculiar aspect of nutritional problems connected with health and working capacity of native populations. In the oil field areas where about 20,000 native people are presently employed, there is a sudden shift from local foods to French foods. This means that instead of eating dates and couscous and drinking camel's milk they shift to French bread, fried potatoes and canned meat products. Soon the situation will be that native manpower will feel a need for western food while there will be an overproduction of local food. This seems to be most likely to occur in the case of dates.

After these comments about some practical aspects, I must say that those topics which we are trying to study look a little bit academic:

a) assessment and prediction of tolerance to heat;
b) diurnal rhythm as related to thermal environment;
c) optimal thermal environment for sleep in relation to outdoor climate;
d) metabolic and culinary aspects of nutrition in hot-dry and warm-wet climates.

We hope to be able to tackle at least some of them next summer. We had lastly an interesting joint research project with Cyril Wyndham in the Sahara last September on the question of assessing the respective level of acclimatization of 15 Europeans and 15 natives (Chaamba tribesmen) both living in Hassi-Messaoud, near Ouargla in the Sahara.

Research Needs in Tropical Climatology—Recommendations submitted by **Dr. C. H. Wyndham,** Applied Physiology Laboratory, Transvaal and Orange Free State Chamber of Mines, Johannesburg, Republic of South Africa.

Mental reactions

Comfort. In the hot, humid tropics the upper limits of air conditions for comfort might be exceeded during the night as well as during the day. In the typical hot, dry climate of a desert similar effective temperatures which are excessive during the day are usually followed by nights which are cool. It can be expected that the climatic conditions in hot, humid tropics would, in long term, have a more severe effect on inhabitants with respect to discomfort, disturbances of the psyche, lowering of morale and fall-off in performance of work. As far as is known no quantitative studies have been made to determine the relative effects of these two different climatic conditions on human reactions. As a background to such an evaluation certain basic information on comfort is required. Surveys are needed to establish the comfort zone of families living in various regions of the tropics and subtropics. The studies should be designed to provide information of the following points also:

Day comfort. (1) The influence on the upper limit of comfort should be examined of the level of metabolism, exposure to direct sunlight and the amount of clothing. (2) No information exists on the rate at which individuals moving from temperate regions adjust to a new level of thermal comfort in the tropics; it cannot be assumed that the rate of adaptation of comfort is in any way associated with the physiological reactions in acclimatization. (3) The question needs to be examined of the relative effects in the monsoon regions of the world of unrelenting discomfort during the day for prolonged periods before the rains come on psychic disturbances, morale and human performance, compared to the effects of intermittent discomfort in the short, dry spells—when the discomfort might be more severe—which are relieved by cooler periods during heavy rains. Hearsay opinion of residents in hot, humid tropical areas such as Cape York Peninsula of Australia has it that the hot, dry spell is disliked more than the "wet," intermittently hotter, weather of the monsoon months.

Night comfort. (1) There appear to be virtually no populations surveys until that of the writer's in Cape York Peninsula which led to another recently completed by Macpherson near Darwin, to establish the upper limits of comfort at night in hot, humid, tropical areas. There is need to carry out similar surveys in other tropical and subtropical regions to examine a possible relationship between severity of climate and upper limit of night comfort. (2) Any such survey should examine the interrelationships between night effective temperatures and amount of bedclothing, discomfort, presence of sweating and disturbance of sleep. (3) At night more than half of the body, lying on a bed, is shielded from the effects of air movement. This affects the relative influence of air movement on comfort. Still air at night is, therefore, called "oppressive" at effective temperatures which during the day are labeled as comfortable. The relative effects of air movement at high relative humidities on comfort at night, as expressed by the effective temperature scale needs special study.

Human performance in heat. Laboratory studies on human performance in hot conditions show that there is a deterioration in performance somewhere between 81° and 86° F effective temperature. The tasks used in laboratory hot rooms are synthetic compared with those in industrial work and the social-psychological relationships of the subjects of the experiments are quite artificial. However, a validation of Mackworth's and of Pepler's main conclusions has been made recently in the writer's laboratory. The study was carried out in an ordinary working place in a mine on a normal task, shoveling rock in a "development end," in a situation where the air conditions could be altered at will.

Similar studies are needed in other practical work situations to validate further the conclusions reached in laboratory studies. Hot industries in the tropics provide an admirable situation for such studies and also to examine the possible effects of heat on work performance of men in various states of "natural" acclimatization, acquired from residence in various tropical and subtropical regions.

The following proposals are made which might be helpful in planning such experiments:

(1) Industrial tasks should be chosen in which performance can be measured simply and accurately; certain plant operations can be monitored by suitable electronic recording apparatus so that errors in reading signals and in decision taking can be recorded continuously.

(2) Suitable apparatus should be installed near the workmen for recording the various heat stress factors. These are dry bulb temperature, wet bulb temperature (or relative humidity), mean radiant temperature (the temperature inside a 6-inch, blackened, copper sphere), and air movement. These should be recorded continuously and calibrated regularly.

(3) Weekly means and variances in performance should be expressed in relation to mean effective temperatures and their variances. In addition the daily variation in performance should be examined in relation to the diurnal variation in effective temperature. By these means a probable relationship between air conditions and work performance could be tested.

(4) An attempt should be made to select for these studies tasks which require different levels of muscular effort and intellectual activity. A 10 per cent decrease in muscular effort in industry or in military tasks can probably be offset by increased mechanisation. A similar fall in the decision-making capacity of industrial executives or of military commanders could lead to both disastrous and costly mistakes.

The above proposals are directed towards industrial and military activities in the tropics. An equal, and perhaps more important, research effort should be put into the assessment of the effects of living in tropical climates on the rate of physical and intellectual growth of children who are of the second and third generation in tropical regions. This probable effect could be tested by choosing schools in temperate and tropical areas which are closely matched and carrying out appropriate anthropological, mental and sociological studies.

There is another important field of research. The effects of heat on work performance are usually expressed in relation to effective temperatures of the air conditions. No comprehensive study has yet been made to examine the question of whether the effective temperature scale gives correct weighting to the relative effects of the various heat stress parameters on human performance. The effective temperature scale is essentially a measure of temperature sensation; the Predicted 4-Hour Sweat Rate Index is used for assessing physiological reactions to various conditions of work and heat. It is quite possible that a new scale or index is needed in order to give correct relative weighting to the effect of the various heat stress parameters on human performance.

Disturbance of the psyche in heat. The clinical features of tropical "fatigue" or "neurasthenia" are not specific to heat but also occur under other stress situations such as isolation from familiar surroundings, the individual being given more responsibility than he can carry, etc. In the tropics there are many new and unfamiliar factors which add to these stresses. Boredom, monotony, domestics and social stresses are all more common than in the home environ.

It might well be that the seed of discontent is well sown if the mental soil is weak; a well-adjusted person might rise above the adverse circumstances of the tropics. It is not clear whether individuals of the former calibre form the major proportions of those who break down in tropical climates. Heat might, on the other hand, be a specific factor, and this is suggested in the comment made by experienced medical opinion in the tropics that certain personality types do not "thrive" in tropical climates whereas others do; the latter are, in turn, miserable and cold in temperate regions. On this clinical assessment it appears probable that certain personalities cannot stand up to air conditions which are near the limit of comfort. It is a challenge to the psychiatrist to define accurately this type of personality. Also the possibility should be examined of these individuals having a lower threshold of air conditions at which discomfort appears than the average for the population. Considerable costs in transport and frustration to the individual might be saved if a test with a high predictive capacity could be developed which could be employed to prevent those persons with a high probability of manifesting psychic disturbances in tropical climates from going there.

In addition to the general sociological factors in the tropics which contribute to these psychic disturbances and the question of the individual's threshold, the part played by two additional factors needs to be considered. One is that these disturbances are rare in hot, dry climates but are more common in hot, humid conditions. This suggests that cool nights make bearable the heat of the desert day, whereas the relentless discomfort by day and night, possibly with loss of sleep also, in the hot, humid tropics finally causes a breakdown of the psyche. The other is the effect of skin diseases. The impact on the individual's morale of month after month of one furuncle after another or of a chronic intertrigo is quite disproportionate to the extent and seriousness of the local lesion.

In the writer's opinion it is a mistake to characterise this syndrome as one of "fatigue." It is in fact a state of mild psychoneurosis with certain specific and certain general contributory causes. One of the most difficult problems is to distinguish unequivocally the effects due to climate from those due to the other contributory factors which can also cause these psychic disturbances and lead to a lowering of the individual's morale. One approach to this problem is to make an intensive study by competent psychiatrists of individuals with the clinical condition. Another is to examine the attitudes of communities in tropical regions by means of a survey on a random selection of inhabitants in order to give expression, in a quantitative way, to changes in morale at various seasons of the year. The following information might be sought in such a survey: (a) the volume of complaints, (b) the number of resignations, (c) the number of applications for sick leave, (d) the rate of wanton destruction of public property, (e) the time taken for standard tasks, (f) the accident rate, (g) the quality of workmanship, (h) the incidence of psychosomatic complaints and of neuroses, (i) the number and quality of spontaneously organised social events and the attendance at them. By suitable statistical analysis of the answers to these questions on, say, a weekly or monthly basis from personnel executives of industrial companies operating in the tropics it should be feasible to examine the possible correlation between this index of the community morale and the air conditions, expressed as effective temperatures.

Results of a social-psychological study of this nature would need to be assessed with respect to a "base line" of morale of the community. This would not be simple. Social relations in a community are dynamic and it can be conjectured that in an isolated, self-contained community they would be more delicately poised than in or near a town. Surveys of this nature need therefore to be carried out by experienced social-psychologists, possibly working in association with medical officers who have experience in tropical regions.

Physiological reactions

The prediction of physiological reaction to heat. The need for a method of predicting the relative effects on the physiological reactions of man of the four heat stress parameters of an air condition and also the effects of metabolism and amount of clothing is met most successfully by the British physiologists' Predicted 4-Hourly Sweat Rate Index (P4SR). Recent studies at Singapore have validated the relative weightings given to the various heat stress factors. This is also supported by the writer's 1953 study over a limited range of air conditions and by Lind and Hellon recently.

The P4SR index can be recommended for immediate use, on present evidence, in industrial situations and in the tropics for assessing the relative heat stress of various conditions of heat and work. The index cannot be used, however, for the purpose it is claimed, which is to predict the actual physiological reactions of men working under hot conditions. This is due to the fact that a different regression line is needed for each new population of heart rate, or sweat rate, or rectal temperature plotted against P4SR values. Race, sex and the state of acclimatization all affect the intercept of the regression lines on the "y" axis and also its slope. Hence, if it is necessary to predict these physiological reactions for a particular industrial or tropical population, a "calibration" must first be made of these reactions against P4SR values before the index can be used in a general way to predict actual sweat losses, etc. To extend the usefulness of the index, an intensive effort should be put into obtaining the appropriate regression lines for sample populations in different parts of the tropics and subtropics. This study should include samples of the indigenous populations and also "expatriates" from temperate regions at various stages of the residence. This would be a means also of obtaining data on the "natural" state of acclimatization to heat of peoples in tropical regions. This subject will be dealt with more fully in a later section.

Tolerable limits of air conditions and rate of work. It is the considered opinion of the writer that it is not possible to predict with any confidence, based on statistical probability, the limits of air conditions and rates of metabolism at which the populations at risk in various industries and in different parts of the tropics are liable to suffer heat collapse and/or heat stroke.

The limits of "tolerable" air conditions for a specific rate of work were given by Eichna *et al.*, the writer, and the British physiologists but they apply only to the specially selected, trained and highly acclimatised men used in the experiments. They do not apply to ordinary run-of-the-mill workmen in hot industries or residents in the tropics. Recognition of this point is contained in the statement of Weiner, *et al.*, "It was of course appreciated . . . that '*all* men serving in the Navy are not as fit or as young as' the subjects who took part in the experiments . . . an Effective Temperature of 86° F would be safer *in practice* as the upper limit to which men could reasonably be exposed daily." The previous limit given was 90° F Effective Temperature. A second important criticism of present "tolerable" limits is that the criteria of tolerability are somewhat loosely defined. The Fort Knox "excessive" limit is based upon conditions which "rapidly lead to total disability in *most* men with excessive, often disturbing, physiologic changes." The British criterion is "a situation in which an *increasing number* of fit, acclimatized men find the conditions beyond their endurance." Nor is the objective criteria of "excessive" conditions proposed by the Fort Knox workers of a rectal temperature above 102° F and heart rate of 150 beats/min. unequivocal. Bantu mine workers worked with these physiological reactions without the excessive reactions observed by the Fort Knox team. A third criticism is that the sample populations studied are too small for reliable, statistical estimates to be made of the probability of men from similar populations in various combinations of work and air conditions either reaching a heat stroke level of body temperature or of collapsing. The industrial executive sending men to work in a hot mine, for example, or the military commander detailing troops to fight in a tropical area is not satisfied with the loose terms, that "some men" or "an increasing number of men" will become incapacitated, which is the substance of the present tolerable limits. They want the statistical probability of the population at risk suffering from heat collapse and/or heat stroke at the air conditions they will work or fight. They want these probabilities in the same precise statistical terms which they are accusomed to deal with in assessing sickness and accident rates. On present data this cannot be done.

Studies in the writer's laboratory were made of rectal temperatures of large samples, 100 men, in a standard condition of work and heat, to compare two methods of acclimatization. The curve of distribution of rectal temperatures about the mean is skew. It is skew towards the right, or more dangerous, temperatures. The writer's laboratory has worked out techniques of estimating the probable risk in precise statistical terms of the population from which the sample came reaching a rectal temperature of, say, 106° F at which there is a high probability of heat stroke occurring if the temperature persists. Rectal temperature reactions at hourly intervals are needed on samples of 20 to 30 men at each work rate and air condition combination in order to make these estimates. This is being done in the writer's laboratory for the 250,000 labour-force of Bantu who are distributed underground with respect to wet bulb temperatures as follows:

100,000 working actively in wet bulb temperatures above 80° F
60,000 working actively in wet bulb temperatures above 85° F
30,000 working actively in wet bulb temperatures above 90° F
4,000 working actively in wet bulb temperatures above 93° F

It is the opinion of the writer that a judgment of various methods of acclimatizing men, and of their "natural state" of acclimatization can only be made by means of this, or a similar, technique for estimating heat stroke risks. It was shown in the writer's laboratory, for example, that the temperature responses in a "standard" condition of work in heat after two different methods of acclimatization were not significantly different when based on the conventional statistical analysis of means and standard deviations by a "t" test. Yet when the skewness is taken into account, a third degree polynomial was fitted and its upper 95 per cent confidence limit extrapolated in order to estimate the risk of heat stroke, the risk was 1/million after one method and 4/1,000 after the other (despite their not being significantly different, using conventional statistical techniques). This analysis is contained in a publication entitled "The temperature responses after two methods of acclimatization." C. H. Wyndham *et al.*, Arbeitsphysiologie, 18:112, 1960.

It is strongly urged therefore that a new approach be made to the question of tolerable limits of air conditions and that they be based on rigid statistical criteria of heat stroke risks as above, and that samples of men at risk in the tropics and industry "in their natural state of acclimatization" be studied in order to make these assessments. A portable, low-cost climatic tent has been developed by the writer's laboratory for this purpose and is suitable for hot, humid climates.

Another approach is to tackle the problem as an epidemiological one and collect data on the numbers of men exposed to air conditions at which there is a risk of heat collapse and heat stroke and, also, the actual incidence of heat collapse and heat stroke, as they occur over a period of 2-3 years, at various air conditions. By this means the probable mortality and morbidity rates, in cases per thousand per annum, can be worked out. This has been done in the writer's laboratory. The curves apply only to the Bantu in their particular state of acclimatization after the laboratory's methods which are used on some 180,000 men per annum. Schikele in her classic survey in 1947 of heat stroke apparently had data on air conditions at which heat stroke occurred but not that of the numbers of servicemen at risk at the various air conditions in training camps and could not therefore work out the curves of mortality and morbidity for heat strokes.

It should be pointed out that a similar epidemiological approach could be employed to relate the rates of psychic disturbances and of skin diseases due to heat, to some index of the air conditions such as effective temperatures in order to give precise expression to the air conditions at which these conditions increase significantly. The institution of such surveys in hospitals where large groups of service men are aggregated in tropical areas, such as Aden, would prove useful.

"Desirable" limits of work in heat. It has been contended with some justification that while it is most important for industrial executives and military commanders to know precisely the risks of heat collapse and heat stroke to which they will expose their men at various rates of work and air conditions in order to take appropriate preventative measures, men would not voluntarily work to those limits except under high motivation. This might come from financial incentives or from the individual's concept of his duty during wartime. It is therefore important to look for other limits which are lower than those which expose men to heat collapse and heat stroke but which are based on sound physiological principles. This would replace the confusing array of physiological criteria for work in heat one finds in the literature, none of which appear to have a sound basis, but all have adherents who cling tenaciously to them. Thus Muller *et al.* at the Max Planck Institute at Dortmund contend that a heart rate of 120 beats/min. marks the limit of work in heat; Bruner of Institut für Flugmedezin, Bad Godesberg, combines a heart rate of 115 beats/min. with a rectal temperature of 100.9° F; the British physiologists accept a rectal temperature of 101.0° F. The reasons given why men should not be allowed to work with physiological reactions above these levels are as various as they are unsound, being based, for example, in the case of the British physiologists on motivational factors, namely, conditions which men "will not endure." In Muller's case, it is a situation where the heart rate continues to rise above 120 beats/min. Bruner's basis for his criteria is not apparent.

This position needs to be examined afresh in order to obtain agreement amongst climatic and exercise physiologists on a sound basis for this limit. The first step in this direction should be an examination of the problem by an *ad hoc* committee (possibly the group who are sending in recommendations) plus Dr. W. S. S. Ladell, who has had considerable experience of tropical physiology during his years at Lagos, Nigeria. For the purpose of this discussion three possible criteria are put forward. One is an epidemiological study to establish whether living in tropical areas shortens the lifespan and whether certain diseases can be shown to be specifically contributory to this effect. In this survey one would exclude tropical infections. The second possible criterion is the air conditions at the upper limit of the thermoregulatory zone for various rates of work. Above this limit rectal temperature, for a specific rate of work, rises to a new level so that one can contend that the body's two thermoregulatory mechanisms, evaporation of sweat and tissue heat conductance, have reached the physiological limit of temperature regulation. This approach has scientific elegance and has been employed in the writer's laboratory since 1953 to establish "desirable" air condition limits of work for both acclimatized and unacclimatized Bantu workers in mines. Lind (1960) has recently adopted the same criteria for British coal miners. On present work these limits can only be specified for two of the four environmental heat stress parameters, i.e., air which is nearly saturated with water vapour and wind velocity over a narrow range. The Predicted 4-Hour Sweat Rate Index should be examined to see whether it can be used for this purpose; if its predictive capacity is as good as the writer feels it is, then it should be possible to estimate rectal temperatures for various air conditions and plot them in a way which will allow one to determine the upper limit of thermoregulatory zone for various combinations of work and air condition. The third possibility is that by plotting heart rates and sweat rates against rectal temperatures on a sample of acclimatized men from a large series of experiments over a wide range of heat stress conditions, one can establish the characteristic form of the curve for these relationships. This has been done with data from the writer's laboratory and shows that the relationship is linear for both sweat rate and heart rate with rise in rectal temperatures between 99° and 102° F. With further rise in rectal temperature above the latter level, heart rates and sweat rates reach their maximum values (from which it can be inferred that evaporation and tissue conductance of heat are near "saturation" point) and the curve tends towards an asymptote. Moreover, the scatter of individual sweat rate and heart rate values above the means becomes very great. The interrelationships of these physiological reactions at which sweat rates and heart rates reach their maximum values when plotted against rectal temperatures has important practical significance as the limit of physiological regulation. Above this limit rectal temperature can be expected to rise sharply and the circulatory system to be liable to heat collapse.

Physiological criteria for "desirable" limits are the subject of much contention among climatic physiologists. There is need therefore for a full discussion of the problem and for carefully directed research work.

Acclimatization. The mechanisms of acclimatization, especially the role of the adrenal cortex and of volume pressor receptors in the regulation by the kidney of Na and Cl excretion, continue to provide material for academic research of an esoteric nature. Of more immediate practical significance, however, is the fact that very little is known of the range of acclimatization of peoples in various states of "natural" acclimatization in different tropical and subtropical regions of the globe. Nor is it clear how much one can increase the state of acclimatization by hot room procedures, or how men subjected to these artificial methods of acclimatization compare with individuals living normally in tropical climates. Nor is there much knowledge of the part played by sex and race in adaption to heat. Differences in surface areas, in the ratio of surface area/gross body weight, in the ratio of surface area distributed between the trunk and the extremities might all influence the natural state of heat reaction of individuals of different sex and race. On the other hand, the temperatures and humidities at which men live might play a predominant role in their reactions to heat and might overshadow differences in anthropometry. Also there might be important genetic factors in heat acclimatization which would be evident in men who have lived a nomadic hunting existence in hot climates, such as the Kalahari Bushmen, Arab tribes in the Sahara and Australian aborigines. None of these factors in their relation to the state of acclimatization have been worked out fully.

Some research work has been done on this subject, of which Paul Baker's is outstanding. The writer's laboratory has also been engaged on this problem. Samples of male and female Caucasians in their natural state of acclimatization to the climate of Johannesburg have been studied at a standard heat and work load. Other groups studied under the same heat stress conditions are highly acclimatized male Caucasians, acclimatized and unacclimatized Bantu males; nomadic hunter Bushmen in the Kalahari desert, Australian aborigines and Caucasian Australians in Cape York Peninsula of Australia, Chaamba Arabs and newly recruited French servicemen at Hassi Messaoud in the Sahara desert. Comparisons are based on rectal temperature, sweat rate and heart rate reactions in an air condition of 90° F (saturated with water vapour) and a work rate of 1.0 litres oxygen intake/minute. The criteria used for the comparison are not only the conventional "t" test of significance of difference of the means and standard deviations of the measurements but also the risks of reaching a heat stroke level of rectal temperature which, as explained earlier, has been found to be a much more sensitive method of comparing different methods of acclimatization and is also a better method of comparing the natural states of acclimatization of different populations. The studies were made in a portable, low-cost climatic tent designed in the laboratory. A limited number of anthropometric measurements were made in order to test the relationship between temperature reactions and surface areas, ratios of surface areas/body weight, etc.

It is of paramount importance to obtain data on the natural state of acclimatization of peoples in various parts of the tropical and subtropical world. This study should include both the indigenous peoples and also Caucasian "expatriates" from temperate regions and various stages of their residence in tropical parts. By this means a comprehensive picture could be built up of the influence of race and of local climate on man's natural state of acclimatization. A survey of heat adaptation of this nature on a world-wide scale is of great importance because the tropical areas of the world could, if developed to their full industrial and agricultural potential, sustain much bigger populations than at present. In view of the predicted population explosion towards the end of the century, great priority should be given to this question. It is indeed surprising that so much more emphasis has been given to studies of cold adaptation on a world-wide scale by peripatetic physiology teams such as Hammel's and that numerous international conferences and symposia have been held on the subject, whereas by contrast the problems of heat adaptation have attracted much less attention. If one excludes military considerations, this great disproportion of interest and actual research effort would appear to be unfortunate. The peaceful, industrial and agricultural development of tropical areas is probably going to be one of the Western world's biggest challenges in the next half century.

There are in addition a number of *ad hoc* problems which warrant consideration. They relate to the rate at which acclimatization is acquired by different methods. Would one or two days of work in severe heat in a temperate climate before transporting men by air to the tropics reduce the risks of heat collapse and heat stroke on arrival? What in fact is the best method of acclimatizing large numbers of men transported from temperate to hot, humid climates? Can one recognise by means of a man's rectal temperature reaction to a standard stress of work in heat the relatively heat intolerant cases?

Heat illness. Knowledge of the causal mechanisms of some forms of heat illness, especially heat exhaustion, is in a most unsatisfactory state. The acute forms, such as heat collapse, prickly heat leading to loss of heat regulation and hyperpyrexia, and heat stroke, can seriously interfere with the operational efficiency of large groups of men moved suddenly to tropical areas without prior and adequate acclimatization. The more chronic forms, heat exhaustion, tropical anhidrotic asthenia, and mycotic and staphycoccal infections of the skin lead to a loss of initiative and lowering of morale in inhabitants of tropical regions. A state of chronic, mild, ill health is a common background factor in indivduals showing the psychic disturbances characterized as tropical "fatigue." A serious, intensive and concerted research effort is needed on this subject in any research programme concerned with "the health and working capacity of tropical populations." The present inadequate state of knowledge in this field of research is probably best exemplified by the confusion caused by the British physiologists' attempt to separate heat illnesses into a complex series of syndromes in their proposed new classification. Some of the syndromes are classified according to causal mechanisms, others according to contributory factors and so on. This is confusion, worse confounded. It reminds one of confusion about the "typhoid states" before Osler and Welch separated typhus from typhoid on a proper clinical and bacteriological evaluation of the two conditions.

Some of the specific issues upon which knowledge is needed are the following:

Skin disorders. Much is known of the pathophysiology and causal mechanisms of prickly heat. It leads to temporary, but severe, disablement in new arrivals in the tropics, especially if they expose themselves to large doses of ultraviolet radiation from the sun. Mycotic infections, furuncles and infected wounds all have a markedly higher incidence in the tropics than in temperate regions. Certain local factors have been implicated but their causal association has not been clearly established. These factors include a continuously moist skin, trauma to skin from the rub of wet clothes, the electrolyte content of sweat, etc. While these factors might play an important contributory part, the predominant clinical fact remains that individuals vary greatly in their susceptibility to these skin infections. Little is known of the reasons for certain skins having a specific sensitivity to skin disorders in the tropics, except in a crude general way. The development of test procedures for recognising those individuals with a greater susceptibility than average of developing skin disorders in the tropics, as with the question of psychic disturbances, would prevent these potential casualties from being recruited for service in the tropics.

Circulatory disorders—heat syncope. Heat collapse is the commonest cause of incapacitation in unacclimatized individuals on first exposure to the hot, humid tropics. The adjustment of the circulation during acclimatization has as one of its most important results the resistance to syncope. The circulatory adjustments, heart rate, stroke volume, right heart filling pressure, blood volume, peripheral blood flow, venous tone, etc., have not been studied in the same detail that the vasovagal collapse in haemorrhage has and hence the circulatory mechanism which triggers off syncope in heat is not known precisely. There is need, therefore, for an intensive study of the circulatory system during exposure to heat up to the point at which syncope occurs. This might throw light on ways and means whereby syncope could be prevented. It might be that a drug which acts primarily on the venomotor system might prevent syncope without at the same time causing vasoconstriction of arterioles in skin which would interfere with tissue conductance of heat.

Disorders of water and electrolyte metabolism—heat exhaustion and tropical anhidrotic asthenia. Ladell has recently summarised the probable parts played by water and electrolyte metabolism in the intracellular and extracellular fluid spaces in heat exhaustion and the probable role of the adrenal cortex in these alterations through its influence on Na and Cl excretion by the kidney. Provocative as these ideas are, they must at present be regarded merely as speculations. There is urgent need for careful studies on heat exhaustion of the sort that Bass and his colleagues made on acclimatization in order to evaluate the interrelationships between salt balance, water balance and changes in the intracellular and extracellular spaces. Such studies would form the basis for preventative measures with regard to salt and water intake in subjects who are liable to heat exhaustion because of the nature of their work in tropical climates. It would also give guidance as to correct treatment. Even less appears to be known about the salt and water balances in tropical anhidrotic asthenia and this condition also therefore requires urgent study.

Heat stroke. There are two areas of ignorance which are of some practical importance. The first concerns the length of time the body temperature can be raised to various levels before irreversible changes occur in the body which lead to death. These changes are of two kinds. In one the circulatory system goes into profound shock and none of the present anti-shock measures cause the blood pressure to rise; the other is specific heat damage to cerebral tissue—patients die with a good circulation but in deep coma or wild delirium. It might be that permanent damage occurs within 30 minues at a rectal temperature of 110° F but only after 120 minutes at 107° F. Such knowledge would guide the urgency with which cooling must be started and the type of cooling that should be used. The other area of ignorance is the role of the circulatory system in the damage to vital tissues. Some heat stroke deaths are essentially circulatory in that blood pressure cannot be raised by known methods. Lesser degrees of circulatory collapse, for the period it takes to transport the case to hospital, might be responsible for tissue damage. Evidence of this is seen in jaundice during recovery and in lower nephron nephrosis about a week after the accident which sometimes leads to renal failure and death. These subjects require intensive study both as a guide to immediate treatment of the case on recognition and subsequent hospital treatment.

The classification of heat illnesses is being revised currently and proposals in this regard have been discussed since 1956. The whole question of diagnosis, classification, study of mechanisms, and treatment needs to be examined by a panel of medical physiologists who have had experience in this field.

Assessing the relative severity of tropical climates

Relevant meteorological data. Meteorological handbooks generally summarise climate data for various localities in the following way: Dry bulb temperatures are given for each month of the year as (a) mean monthly temperature, (b) average daily maximum and minimum, (c) average highest and lowest for the month, (d) absolute maximum and minimum. Relative humidities are given for either 1400 or 1500 hours and for either 0700 or 0800 hours. Mean monthly rainfall is also usually presented. Summaries are available at major meteorological stations of surface wind forces and directions at 0900 and 1500 hours and for the night; and of mean daily duration of sunshine.

These data are useful for comparing in a broad and rather crude way the climates of different areas. They are, however, of very limited value when attempting to estimate the frequency with which certain critical levels of dry bulb and wet bulb temperatures are exceeded either singly or in particular combinations of these measurements. In judging the effect of a climate on man or in comparing one climate with another it is important to have such an estimate. As the climatic data are at present summarised they cannot be used for this purpose. The limitation could be overcome if the meteorological data contained some estimate of the daily variation in the measurements. Averages alone can be misleading. Two localities might be classified as similar on the ground that the "average daily maximum temperatures" are the same. One climate might have wide daily variations in maximum values, including a number of very high temperature compared to another area where the daily maximum is at a relatively constant level. The reactions of men living in these two areas can be expected to be very different.

It is indeed surprising that meteorological data is not expressed in terms of means and standard deviations from the means. The standard deviation is a measure of the range and frequency of the variability of the climatic element about its mean. It is certainly not possible to make such an estimate from either the average highest or lowest temperatures for the month, or from the absolute maximum or minimum temperatures, although attempts have been made to do so based on certain assumptions about the distribution of temperatures about the mean. In fact, from the biologist's viewpoint, such single extreme values are of little use. However, from means and standard deviations, assuming a normal distribution of temperature about the mean (or deriving an appropriate mathematical model to take account of any consistent skewness), one could estimate, with reasonable accuracy for the month in question the level of air temperature or relative humidity, with respect to the mean, above which 16.6 per cent of observations could be expected to lie. This would be based on the level corresponding to one standard deviation from the mean. Similarly one could estimate from two standard deviations the level of these climatic elements above which only 2.5 per cent of the observations might lie, and so on. Alternately, a particular level of air temperature could be taken to represent a critical value above which discomfort would be experienced by the majority of inhabitants. By a mathematical manipulation of the means and standard deviations it would be possible to assess the number of occasions on which this critical level would be exceeded either on a monthly basis or per annum. It is not difficult to see how considerably the usefulness of meteorological data could thus be enhanced for the biologist.

An even more serious limitation from the biologist's point of view is the usual method of reporting relative humidity. The "average daily humidity" for each month is given for 0800 or 0900 hours and for 1400 or 1500 hours. The wet bulb temperature at the time of the maximum dry bulb temperature, calculated from the relative humidity at, say, 1500 hours, would be higher than the true figure in many instances, because the coincidence of the maximum dry bulb temperature occurring at 1400 or 1500 hours would be rare. An even more serious difficulty is that the only other relative humidity given in meteorological tables is for 0800 or 0900 hours. These values would most certainly not be associated with the "average minimum dry bulb temperatures." In summer months, when these data are most important to the physiologist, the dry bulb temperature tends to rise sharply after sunrise and relative humidity alters rapidly also. The judgment of night comfort must be made on the minimum dry bulb temperature and its associated relative humidity and these data certainly cannot be obtained from the meteorological tables in their present form.

Some of these criticisms are emphasized when climatological data, as presented in summary form in meteorological handbooks, are examined in an attempt to estimate the frequency of discomfort and other adverse human reactions in tropical areas. As an exercise in this regard, the writer in a report on problems of tropical living took the mean daily maximum temperatures and the corresponding relative humidities at 1500 hours for Cairns and Weipa in the Cape York Peninsula area and Darwin. All of these towns are in the hot, humid tropics of Australia. Wet bulb temperatures were calculated from the mean daily maximum temperatures and corresponding relative humidities at 1500 hours. From these data effective temperatures were worked out for still air conditions on the basic nomogram. On this basis these towns have four to six months of the year when the effective temperatures are above 84° F on the average. This estimate grossly exaggerates the true position. A detailed examination of the meteorological observations from these three towns was made and dry bulb and wet bulb temperatures were extracted for the hottest hour of each day. These values were converted to effective temperatures for still air. A completely different situation was then revealed. An effective temperature of 84° F was exceeded on only 7 occasions over the summer months at Cairns and Weipa and on 36 occasions at Darwin. Use of meteorological tables grossly overestimates the severity of conditions. The error lies in the use of the relative humidity at 1500 hours to calculate the wet bulb temperature at the time of the mean maximum daily temperature. In its present form, therefore, it is not possible to use meteorological data, as summarised in the handbooks, for a reliable assessment of the frequency of adverse human reactions in a tropical or subtropical climate. There appears to be no alternative for the biologist but to examine the actual meteorological records and abstract from them relevant data.

Consideration has to be given next to what data needs to be extracted from the raw records. In order to assess the extent of heat stress during the day one must know the average dry bulb temperature, and the associated relative humidity, for the minimum period that it is considered will produce adverse human reactions, physiological and psychological. The air condition of the hottest hour of the day is a reasonable compromise to adopt for this purpose until scientific evidence is forthcoming for accepting either a shorter or a longer time interval. From an examination of the daily meteorological records for a number of years at Weipa, Cairns and Darwin, it was noted that spikes of temperature of short duration, of the order of 15 to 30 minutes, may exceed the average for the hottest hour by 1 to 3° F. These peaks are generally reported in the daily maximum returns made to the government meteorological services and from them the average figures are computed. It is the opinion of the writer that such short spikes of high temperature are of less importance in quantitating man's reactions than is the average temperature for the hottest hour of the day. The hottest hour may, unfortunately, be at any period between 1100 to 1700 hours. Hence there is no shortcut to examining either the thermograph and hygrograph records for each day or the hourly wet and dry bulb recording (where they are taken hourly), and extracting the average temperature and humidity for the hottest hour of the day. In addition to temperature and humidity measurements, the degree of heat stress during the day is assessed. Data required for assessing heat stress during the day are: (a) the average dry bulb temperature for the hottest hour of the day, (b) the average relative humidity for the hottest hour of the day, (c) the wind force over the period 1100 to 1700 hours, (d) the presence of solar radiation, or preferably the average black globe temperature in direct sunlight, for the hottest hour of the day.

For assessing heat stress at night three different times of the night need to be examined because of differences in activity and dress. The first is the period of the evening meal when presumably dress will conform to some minimum conventional standard and when the increase in metabolism due to the specific dynamic action of the protein in the evening meal are both calculated to add to the heat stress of the climate. The second is the period about midnight when the family has retired and needs to be free from extraneous stimuli and irritations in order to fall asleep. The third is time of the lowest dry bulb temperature, in order to determine whether discomfort, which might be experienced in the earlier part of the night, falls to a level at which restful sleep is possible even for a limited period. The meteorological data required for this assessment are: (a) dry bulb temperature and associated relative humidity for the hours 2000 and 2400 and at the time of the lowest dry bulb temperature in the 24 hours, (b) the force of the wind and its direction.

Frequency of adverse human reactions in tropical climates. It is proposed that one logical way of assessing the severity of the climate for man of a tropical area and of comparing one region with another is to determine the frequency with which adverse human reaction can be expected. The effective temperatures at which such adverse human reactions as discomfort, skin disorders, decrease in work performance, and acute heat incapacitation are liable to occur must be specified, precisely. Then the meteorological data from the particular tropical region needs to be examined and the number of occasions on which these critical effective temperatures are exceeded must be determined. As an exercise in this subject, the writer made such an estimate for the towns of Cairns and Darwin in the tropical regions of Australia and also the mission station at Weipa on Cape York Peninsula. The frequency with which the critical air conditions are exceeded at which adverse human reactions occur is given in the following tables. The tables contain also the effective temperatures at which in the writer's view, based on current information, discomfort, etc., will occur in men who are adjusted to living in the hot, humid tropics.

Frequency of adverse human reactions for minimal velocity

		Weipa	*Cairns*	*Darwin*
Skin disorders	(78°F E.T.)	208	150	223
Discomfort	(80°F E.T.)	122	75	200
Decrease in performance	(83°F E.T.)	10	13	100
Acute heat incapacitation				
(i) New recruits in sun	(78°F)	208	150	223
New recruits in shade	(80°F)	122	75	200
(ii) Old hands in sun	(81°F)	75	54	175
Old hands in shade	(85°F)	0	4	10

Frequency of discomfort at night

	2000 hours	*2400 hours*	*Coolest period*
Weipa	80	40	10
Cairns	68	33	6
Darwin	170	150	120

General. Discussion is needed on the various methods in use for assessing the severity of tropical climates (the above is given as one possible approach) by a panel of physiologists and meteorologists experienced in this field. Consideration should be given to use of computers for reducing the raw data for this purpose.

Ventilation and air conditioning of buildings in the tropics. In towns in the hot, humid tropics such as Darwin in Australia, there are approximately 200 days and 120 nights in the summer when the air conditions with still air are uncomfortable even for individuals adapted to the climate. Consideration in building design has therefore to be given to the question of whether this degree of stress can be relieved sufficiently by providing good ventilation in the hotter hours of the day and night or whether the use of air conditioners is essential.

Air movement. During the hotter part of the day there is generally adequate natural convection to provide 100-150 feet/minute air movement indoors, provided that houses are sited in such a way as to make maximum use of prevailing winds, and that free air flow is allowed for by replacing walls by louvres. The number of uncomfortable days at Darwin would be reduced from 200 to 140 if 150 feet/minute of air movement could be provided by natural or artificial means.

At night, however, the situation is quite different. The proportion of calm periods at night is high in the summer and may rise to 50 per cent in some months. Providing a wind velocity of 150 feet/minute reduces the number of uncomfortable nights from 120 to about 60 at Darwin. Ceiling fans in living rooms and bedrooms in the hot humid tropics should be regarded as an essential, not a luxury, item if air conditioning is not possible.

Consideration should be given to improving present methods of providing air movement. Is the ceiling fan the final answer? The question of the desirable air velocity at night needs to be investigated as half the body is shielded from the air movement. High velocities may be more acceptable, but in hirsute individuals this can cause unpleasant side effects.

Air conditioning. One of the important issues in building design for the tropics is whether air conditioning of working and living spaces is essential or desirable. The costs to the relevant authority of air conditioning all houses, administrative buildings, parts of process plants, workshops, etc., would be considerable. The first issue is therefore to decide if it would be desirable to do so. All of the evidence from the scientific literature on comfort and from current surveys points to the fact that the "set point" of man's upper limit of comfort is very labile, being lower in peoples living in temperate regions than in tropical areas. Furthermore, the readjustment of the "set point" appears to occur over a relatively short space of time, altering in a matter of days. Air conditioning of working and living spaces might introduce factors that would interfere with the "natural" state of adjustment in comfort sensation. If a major proportion of the waking time is spent in air-conditioned spaces, then the "natural" adjustment in comfort sensation to a tropical climate might be lost and a new "set point" of comfort might be established that is adjusted to the "artificial" indoor air conditions. This might be a serious disadvantage in that every time the "artificially conditioned" person goes out from the air-conditioned space into the tropical climate he or she would then experience the air conditions outdoors as much too hot. By contrast the person who has remained "naturally adjusted" to the tropical climate would experience the same air condition as comfortable or, at the most, as merely warm. The person living in an air-conditioned space would therefore be perpetually in the position of the newly arrived recruit as far as the adjustment of the sensation of comfort to the tropical climate is concerned. A continual reminder throughout the summer months every time one goes out of doors that the tropical climate is much too hot might very well have the reverse effect on the individual's morale to that anticipated by the advocates of air conditioning of all working and living spaces. On balance, therefore, the writer would not recommend the indiscriminate introduction of air conditioning into living and working spaces in the tropics.

The problem of air conditioning of bedrooms also requires careful consideration. Use of air movement reduces the number of uncomfortable nights. There is, however, an additional factor that should be borne in mind. Most of the uncomfortable nights follow days which are also above the comfort limit. The combined effect of day and night discomfort on morale, human productivity, etc., can be expected to be more severe than in situations where either day or night discomfort are experienced separately. Unfortunately there are no objective data on this important practical question. It is urged that a field study be undertaken in which the introduction of bedroom air conditioning can be tested for its effect on the morale of individuals in a community. Methods for doing so have been outlined earlier: the study should be done before and after the installation of the units with appropriate intervals to allow for acclimatization to the new conditions.

General recommendations

To implement these various ideas it is proposed that an *ad hoc* committee of scientists experienced in tropical biometeorology be constituted with the following terms of reference:

(a) To discuss the various recommended research problems on health and work capacity of tropical populations and allocate some order of priority to them;

(b) To consider the possibility of organizing this research on an international basis by asking certain laboratories to undertake projects and to aid them financially and also to constitute teams of research workers from different laboratories for field research in the tropics;

(c) To examine the question of the finance needed and from what sources it could be obtained.

In planning its program of research this committee should give priority to field studies. Once funds have become available, it should organize a field team to make a survey of the feasibility of carrying out the research in the tropics.