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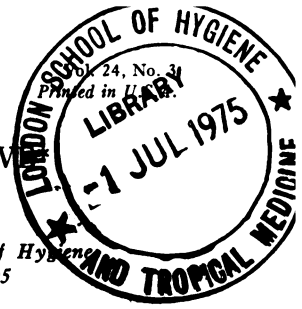

OUR SOCIETY—AN ENTOMOLOGIST'S PERSPECTIVE*

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During the long time that I have earned a living as an entomologist, I have been a member of several scientific societies; however, this is the one in which I have felt most at home. No other society offered the excitement and inspiration that I received at the annual meetings by listening to reports of studies on malaria, yellow fever, and other tropical diseases, especially those given by people engaged in field projects in what to me were exotic tropical countries. Furthermore, these were the workers whom I most admired, and to visit with them, however briefly, was another reason why those annual meetings I could attend were so meaningful.

All of us are fully aware of the difficulties facing some areas of biomedical research. In tropical medicine these are especially acute. The infectious diseases no longer are the killers they once were, and so the emphasis in medical research and training has shifted from them to the metabolic and degenerative diseases. Furthermore, the American Society of Tropical Medicine and Hygiene is an organization whose members pursue their professional activities for the most part in the north temperate region. If infectious diseases are of diminishing importance, it may become especially difficult to justify the existence of an organization, based in North America, whose mission is the study of tropical diseases.

In posing this problem, I make no claim to originality. We have asked these questions before, and if I am only paraphrasing what you have heard in previous speeches and dialogues, I can only say that the future of our Society may depend to a large extent upon continual reexamination of our goals and accomplishments.

What I propose to do, therefore, is briefly to review our origins and some of the major developments in which members of this Society have participated, and then discuss what seems to me are pertinent challenges and missions of the Society in our changing world.

Historical Background

When we attempt to define what we mean by tropical diseases, we find that this is not as easy as it first appears. Physicians are quick to point out that the important diseases of the tropics are the same as they are elsewhere, i.e., tuberculosis, measles, smallpox, malnutrition, and the gamut of chronic diseases. In an address to the American Society of Tropical Medicine in 1933, Dr. Earl B. McKinley tackled this problem with the following statement: "Tropical medicine can not be defined definitely in a geographic sense and we are forced to conclude that this field of medicine includes most of temperate climate medicine plus modifications of these diseases due to special environmental and social conditions, and in addition certain other diseases, which for one reason or another, seem to be so far, more or less limited to tropical environments."[1]

It would be helpful to go back to what seems to be the beginnings of the recognition of the study of tropical diseases as a distinct entity, separate from the standard medical school courses in clinical medicine. Sir Patrick Manson returned to London from China in 1889, and was appointed to the staff of the Seaman's Hospital Society in 1892. In this position, he saw patients suffering from diseases contracted in all parts of the tropics. In 1897 he was appointed Advisor to the Colonial Office. He saw a need for training of physicians in diagnosis and treatment of these unfamiliar maladies, and he was able to persuade the Seaman's Hospital to organize a school for the teaching of tropical medicine. This school was opened in 1899. On 1 August 1924, it was consolidated with the new London School of Hygiene and Public Health.

The origin of our Society goes back to a letter written on 29 January 1903 to a number of prominent Philadelphia physicians by Dr. Thomas A. Fenton, in which the suggestion was made that there should be a society for the study of tropical

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diseases. Following additional correspondence and the formation of an organizing committee, on 25 May 1903, a charter was adopted to incorporate the American Society of Tropical Medicine in the County of Philadelphia. The intention was to have two or three scientific meetings a year in Philadelphia as well as an annual meeting. The first public meeting was held on 9 January 1904 at the University of Pennsylvania, in which Dr. James Carroll delivered an address entitled *A Brief Review of the Etiology of Yellow Fever.*[2] By reading this paper, one can sense the interest and excitement which this speech must have generated in the audience. In view of the regulations which we now observe in animal experimentation, and especially in the use of human volunteers, it is intriguing to hear of the grave responsibilities Carroll was willing to accept in order to complete a crucial experiment. In August 1901 Dr. John Guiteras had infected 7 people by mosquito bites, of whom 3 died. Because of the obvious virulence of these infections, Dr. Carroll was denied permission to inoculate serum from these cases into other volunteers. This, said Carroll, was a great disappointment, because yellow fever patients were becoming very scarce. Also, he was advised that he should not perform additional mosquito bite transmissions. However, because, in Carroll's words, "it was practically impossible to obtain a suitable case otherwise," he proceeded with the experiment anyway, and proved that serum obtained from a mosquito-bite induced case was infectious following passage through a bacterial filter.

The original active membership of the Society was restricted to physicians; scientists could be elected to honorary membership. However, in 1907 a nonmedical scientist slipped into active membership. According to Faust the way out of this dilemma was to amend the by-laws,[3] and at the Sixth Annual Meeting in 1909, Miss Clara Ludlow became the first legal nonmedical active member. I find special pleasure in noting that Miss Ludlow was an entomologist, and no doubt our lady members, who without exception are enthusiastic women's lib activists, will find equal pleasure in the fact that it was a female entomologist who broke the barrier. By 1913 the Society had grown to 121 active, 17 corresponding, and 37 honorary members. In the early years of the Society, the war with Spain, acquisition of tropical colonial possessions, the Panama Canal, and expanding commercial enterprises stimulated great interest in tropical medicine. There was further impetus during World War I. However, these surges of interest were followed by declines, and an ever-recurring question has been whether there was a valid reason for the continuation of our Society. Thus, in his presidential address of 1920, Dr. Henry J. Nicholas said, "I began to feel that my only function might be to conduct the postmortem."[4] He added that "The Society as the only national organization of its kind, is called on to put its affairs in order and go forward." And indeed it has. In spite of times of lagging interest and support, the Society membership has continued to increase from 175 in 1913 to 1,873 in 1974.

Most of the reasons we can think of for the continued existence of our Society have been stated in previous presidential addresses. These include making the tropics safe for foreigners as well as for native residents; protection of tourists and military personnel; sanitation of military bases in tropical areas; greater production in agriculture and industry by maintaining high standards of health and living conditions of the workers, which in turn is to our economic advantage by creating export markets for our products; the prevention of introduction of exotic diseases into the United States; the availability of physicians with a knowledge of tropical medicine for treatment of people succumbing to these diseases after returning to the United States; and treatment and control of the so-called tropical diseases which are endemic within our borders. More research was needed on the early diagnosis and treatment of diseases, and there was an obligation to train physicians and others from the afflicted areas to carry on the work in their own countries. McKinley argued for the validity of purely scientific and altruistic reasons, and urged the Society to shape educational policies and create public opinion.[1] He pointed to the opportunities for the promotion of international understanding and peace.

Now we must ask, have we met these challenges?

In a recent historical summary, Dr. C. B. Philip and I designated the period from 1891 through 1933 as the "Golden Age" of medico-veterinary entomology, as it was during this time that the exciting discoveries of the transmission of disease organisms by arthropods followed one another in

close succession.[5] These were accompanied by other major developments. Some of these, in which members of our Society actively participated are as follows.

In yellow fever, the characterization of the virus; the demonstration that primates other than man are hosts and mosquitoes other than *Aedes aegypti* are vectors; the development of the neutralization test and the viscerotome whereby it became possible to delineate the geographic distribution and host relationships, all of which led to out present understanding of jungle yellow fever; and the development of a vaccine whereby millions of people living in endemic areas were protected.

In malaria, the sorting out of the vector from the nonvector *Anopheles* species, leading to the principle of "species sanitation." In 1926, Samuel T. Darling used this phrase in an article published in Volume 6 of the *American Journal of Tropical Medicine*.[6] He said, "Every malaria problem should first be subject to field studies to determine its specific nature and define its limits." Outstanding achievements in species sanitation were the eradication of *Anopheles gambiae* from Brazil and Upper Egypt, and of *Aedes aegypti* from Hawaii, Guam, and most of Latin America. The appearance of DDT literally shattered the species-oriented antimalarial measures. Here was the weapon that would stop transmission not only in urban areas but also in scattered rural populations, without the necessity of the preliminary survey. Meanwhile, under the impetus of World War II and the wars in Korea and Southeast Asia, great strides were made in the development of more effective antimalarial drugs.

We must not neglect to acknowledge our debt to the many dedicated investigators whose studies have given us our present understanding of filariasis, onchocerciasis, plague, Chagas' disease, African trypanosomiasis, leishmaniasis, relapsing fever, the rickettsioses, and the arboviruses. The prevention of typhus outbreaks in World War II is an achievement that probably can be appreciated only by those who have made the effort to learn how devastating this disease has been in past wars. Time does not permit further recitation of progress in prevention and treatment of other diseases associated especially with the tropics but are not arthropod borne, such as tuberculosis, smallpox, cholera, leprosy, yaws, and those caused by parasitic helminths and protozoa.

Perhaps one of the most notable contributions to international cooperation and peace is the active part taken by many members of this Society in the world-wide malaria eradication campaign. In 1959, President Eisenhower declared, "We are embarking with other nations in an all-out five-year campaign to blot out this curse forever. We invite the Soviets to join with us in this great work of humanity." Soper said that "here we have the concept of malaria eradication emerging at the highest international levels. It is ranked among the great works of peace."[7] Examples such as this should reassure us that tropical medicine indeed has had a significant impact on the affairs of man beyond direct health benefits. This is the *American* Society of Tropical Medicine and Hygiene, and by this we mean *all* of the Americas. Our annual meetings have always been an opportunity for exchange of ideas and for strengthening personal friendships between collaborators from all countries in the Western Hemisphere. Through its strong support of international congresses, our Society has furthered the cause of international exchange on a world wide basis. We regret that our colleagues from the People's Republic of China were unable to accept our invitation to participate in this meeting; hopefully this will become a reality at some future date, and that this will be possible with colleagues from other countries as well.

The importance of tourism is indicated in a statement by Velimiroc that in 1970 this was a 15 billion dollar industry.[8] It is obvious that there should be adequate briefing of American tourists prior to journeys into tropical and poorly sanitated areas. For many years, our Society has been engaged in such instruction through its *Health Hints for the Tropics*. Perhaps this pamphlet should have been required reading for the approximately 170 physicians and scientists who suffered from diarrhea while attending the Eighth International Congress of Tropical Medicine and Malaria.

The Continuing Problem

Certainly, in meeting the challenges that were raised, the Society has justified its existence. But again we must ask: Has the progress in the control of tropical diseases reached a point where a society such as ours no longer is relevant to current needs, and should schools of medicine and of public health in the United States abandon

all interest in this field? Let us examine some of the continuing problems. First there are the conventional ones.

In his annual report for 1972, the Director General of the World Health Organization stated that in so far as the developing countries are concerned, the infectious diseases made up from 5 to 9 of the 10 most important public health problems.[9] Although, as noted in the Thirteenth Report of the WHO Expert Committee on Malaria,[10] over three-fourths of the people who formerly lived in malarious zones are now free of the risk of infection, the remaining fourth represents a problem of no mean proportions. Dr. H. Mahler points out that malaria continues to kill over a million infants and small children every year.[11] Technical difficulties in eradication include insecticide and drug resistance, and outdoor biting and resting habits of the anopheline vectors. However, Lepes believes that these represent less than 5% of the total problem.[12] He states that total insecticide coverage is essential to eradication, and that this was prevented in many areas because of administrative and operational difficulties, or for lack of financial support.

Unquestionably the use of DDT as a residual insecticide inside houses remains the most effective weapon against malaria in most parts of the world. It is, I believe, a mistake to relegate the resourcefulness of the anophelines to a very minor factor in the ability of malaria to persist. For example, in parts of Colombia and Venezuela where the man-biting population of *A. nunez-tovari* maintains malaria transmission, Elliot has shown that this mosquito actually enters houses, obtains a blood meal and then leaves without acquiring a lethal dose of DDT.[13] In both northern Luzon and in Palawan, during the course of our studies of filariasis, Dr. Cabrera and I obtained mosquitoes for dissection by trapping near houses with a cow- or carabao-baited stable trap. In these traps we caught *Anopheles minimus flavirostris*. This mosquito enters houses to feed on man during the middle of the night. The houses near which traps were set presumably had been sprayed with DDT as a part of routine malaria eradication practices. Our conclusions were that *A. minimus flavirostris* was the important vector of *Wuchereria bancrofti* in these areas, because a proportion of the specimens taken from the traps were shown by dissection on the day of capture to be carrying infective third-stage larvae. These mosquitoes could only have become infected by feeding on the sleeping inhabitants of the DDT-treated houses from which they escaped and survived long enough for the filarial worms to mature.

The problems caused by failure to achieve eradication as promised within certain time limits have made more difficult the continued funding of these programs by governments whose limited resources permit inadequate support for all health activities. We now have seen a retreat from the all-out eradication campaign. To quote Lepes:[12] "The relatively slow progress of malaria eradication programs is expected to continue for some time and it will be in proportion to the pace of the development of the health services in the countries in question as well as their overall development. . . . In order to apply an ecological approach to malaria control, well-trained personnel, conversant with the intricacies of the life cycle of the parasite, the host-parasite relationship and the man-mosquito contact, will be required." One could use these statements to describe species sanitation. And so, we have gone through a complete cycle; we are back to the principle established by Watson, Darling and other pioneer malariologists. What this means is that again we are confronted with the necessity of understanding the ecological factors which permit malaria to exist in an area, as a basis for the most effective control.

I shall not attempt to do more than remind you of the continuing problems due to other classic enemies: the zoonotic foci of yellow fever, the possibility of a wandering or stable yellow fever endemicity in rural areas dependent only on man as the vertebrate host (see Monath et al.[14]), the outbreaks of dengue, the permanent avian reservoirs of the arboviruses and occasional devastating epizootics in equines and epidemics in man, the threat of spotted fever in our parks and suburbs, the impact of urbanization on the rising prevalence of filariasis in Southeast Asia, the complexities of control of onchocerciasis, trachoma and its possible relationships to the aridlands fly densities, the resurgence of African trypanosomiasis and the impact of nagana of protein deficiencies, schistosomiasis, the diarrheal diseases and malnutrition. All of these are vastly complicated, and require the collaboration of experts in several disciplines.

The Entomologist's Role in Tropical Medicine

Each of you will be thinking of the contribution his own specialty has to offer to the solution of these problems in tropical public health, and at this point I shall indulge in some bias by emphasizing the entomologist's role. Certainly we will agree that one of the distinctive features of tropical disease is that many of them are transmitted by arthropods.

Basically, the ultimate objective of medical entomology is to seek out and destroy the vectors of disease. It would appear obvious that the first step in this activity would be to establish criteria whereby the proved and potential vector species can be distinguished from the nonvectors. Taxonomists of necessity deal with dead museum specimens, but also they are aware of the fact that these specimens are representatives of living populations. The concept of the biological species has led to the application of genetical and experimental procedures in attempts to establish the specific identity of populations which have no or at best only ill-defined morphological characters. The classic example of the practical value of such work is seen in the *Anopheles maculipennis* group in Europe. Hackett's delightful book on malaria in Europe,[15] in which the studies on this group are summarized, should be required reading for the membership in this Society. A more recent example is *Anopheles gambiae*. Our more complete understanding of the epidemiology of malaria and filariasis must take into account the involvement of each of five populations whose existence has been revealed especially by cross-breeding experiments.

Experimental cross-breeding between mosquito populations from different geographic localities or ecological environments has also shown that there are a number of so-called mating types, i.e., closely related populations with varying degrees of incompatibility. An interesting phenomenon of non-reciprocal fertility occurs between populations of the *Culex pipiens* group. This is considered to be caused by cytoplasmic factors for sterility,[16, 17] or by infectious agents.[18] A similar type of non-reciprocal fertility occurs between certain species of the *Aedes scutellaris* group in the South Pacific. This multiplicity of mating types emphasizes the fact that we are dealing with dynamic populations which may be going their separate evolutionary pathways and are adapting to environmental pressures and responding to genetic alterations. Such changes may profoundly affect the vector potential of certain of these populations.

Recognition of species and subspecific populations permits the perusal of investigations on vector biology which are essential to a complete knowledge of the epidemiology of the disease in a given area. These include studies on mating habits, host preferences, oviposition behavior, larval habitats, flight patterns, adult longevity, population densities, and natural infection rates with pathogenic organisms. In these studies there have been many improvements in techniques and in interpretation of data, including trapping, identification of blood meals, age-grading of natural populations, and in detection of disease agents.

In the final phases of the entomological activities, i.e., vector and disease control, we find one of our greatest challenges. Difficulties surrounding the use of the organochlorine, organophosphorus, and carbamate compounds as pesticides have stimulated the search for alternate methods of vector control. In a recent publication, a National Academy of Science Study Group asserts that mosquito control is now in a state of crisis.[19] For some years there have been intensive efforts to develop genetic and biological control procedures, including liberation of sterile hybrid or cytoplasmically incompatible males, or of males sterilized by irradiation or chemicals; also the cultivation and application of infectious agents, among which are viruses, bacteria, fungi, and helminths; and the liberation of predators or competitors. We all are aware of the spectacular success in the release of sterilized males for the control of the screwworm fly; however, to date, so far as I am aware, although some of the methods referred to above show a degree of promise, none is available for practical control of mosquito pests or vectors, nor indeed for most other medically important arthropods. Meanwhile we must fall back on our older, more conventional measures of chemical pesticides and environmental sanitation. In so doing, however, we must be fully aware of the side effects of each control program. Marsh alteration by drainage or impounding may not always be an alternative to pesticides; both may destroy shrimp and other aquatic animals and plants which may be vital to local industry and recreational activities. This

brings us again to the point that requires special emphasis; to be economical, effective, and with a minimum of undesirable side effects, these must be based upon an intimate knowledge of the biology, not only of the target species, but also of the non-target organisms within the area to be treated.

From these conventional and familiar enemies we should move on to a consideration of what at first glance may appear to be peripheral to the responsibilities of our Society. These, however, threaten to overwhelm all others and, because preventive medicine and public health are accused of contributing to these problems, we can not ignore them. We are being reminded constantly that the ever-increasing numbers of people will eventually lead to economic and social chaos. Without effective voluntary population control, this job will be done by war, pestilence, and famine. That we already have reached this stage in some parts of the globe is evident from what we see happening in Southeast Asia and the countries immediately south of the Sahara Desert. Do we have an effective answer to the question that often is put to us: Which is more humane, to permit an infant to die quickly of malaria, or by slow starvation? In his Presidential Address to this Society in 1951, Dr. Paul Russell argued that birth rates would fall provided there was improvement in standards of living, health, and education.[20] Thus we tell ourselves that prevention of disease will make it unnecessary for people in underdeveloped countries to overproduce in order to assure their care in old age by a surviving offspring. We seem to have little cause for optimism. However, in a recent rather pessimistic review, Constance Holden states that one item on which social scientists agree is that there indeed is a need for reduction of infant mortality as a beginning towards population control.[21] Furthermore, although press reports on the World Population Conference in Bucharest have been discouraging in that some countries in greatest need appear to reject any attempt at population control under any circumstances, there was emphasis on the need for economic development. Again we would argue that control of human and animal diseases, as well as that of arthropod pests and vectors, does have a beneficial effect on industry and agriculture.

The devastating effects of malnutrition in poverty-stricken tropical areas leads naturally to a drive for greater food production. The Green Revolution is designed to alleviate food shortages, but what impact do the more intensive agricultural practices have on the proliferation of pest and vector insects? An increase in agricultural land may be accompanied by construction of large multipurpose impoundments. Whereas conversion of streams to impoundments may eliminate stream-breeding vectors such as *Simulium damnosum*, it may produce an increase in other disease vectors which find ideal habitats in the quiet waters and marginal vegetation of the vast shorelines of these impoundments. Irrigation channels themselves may furnish ideal breeding habitats for certain dangerous anophelines. At the Ninth International Congress of Tropical Medicine and Malaria, Dr. Waddy sounded this warning: "It used to be taken for granted that a dam and man-made lake would be an unqualified benefit to any country. Experience has shown that there may be serious disadvantages."[22]

Throughout Southeast Asia there is taking place a rapid destruction of the magnificant dipterocarp forests through lumbering, and slashing and burning by land hungry squatters. There appears to be little hope that under present practices the valuable large trees now in such great demand can be replenished. Yet, as Meijer points out,[23] the hilly sandstone areas from which the forests have been removed are not suitable for rice or corn. Replacement of forests by open sunlit fields may bring about an increase in the density of anopheline malaria vectors, most of which favor open sunlit breeding habitats. Long range planning is essential to persuade local governmental agencies that it is far more advantageous economically and socially to retain the forests as permanent sources of valuable lumber. The tropical disease specialist would not be out of place in such planning councils.

The Future of the American Society of Tropical Medicine and Hygiene

Section 3, Article 1 of the constitution of our Society states: "The purpose of this Society shall be the advancement of tropical medicine and hygiene, including medicine, nursing, engineering, entomology, parasitology, and allied specialities in this field." The point I have been trying to make is that the entomological work demands the thinking and services of highly trained specialists, who nevertheless have a broad appreciation and

understanding of the disciplines which make up the field of tropical public health. This is equally true of each of the other specialties mentioned above. In his Presidential Address of 1964, Dr. Weller emphasized that we must go beyond thinking in terms of exotic diseases entities and curative medicine, and that we have "a continuing obligation to prevent premature death, to reduce morbidity, to control birth, and alleviate misery."[24]

In the Macy Conference on Teaching Tropical Medicine, the needs for continued training in this field have been given in detail and with an eloquence that far exceeds my capabilities. However, I trust you will permit me to present some of my own thoughts. I have referred above to the need for highly trained and competent specialists. Most of the underdeveloped tropical countries with the greatest needs do not have the resources to train these specialists in the advanced disciplines that now are essential. This is a responsibility that should be assumed by the United States and other developed countries. Here it is possible to establish the physical educational facilities and to assemble the staff competent to teach and conduct research in the several disciplines that should be incorporated in a well balanced program in tropical public health.

At the Macy Conference, Dr. Beaver brought out that there has been a steady decline in the number of hours given to this subject in our medical schools.[25] With this deemphasis, in many schools the teaching is being done by people whose research and other professional competence are in other fields. It is not surprising that under such circumstances the harried medical student can find little inspiration for further study. Beaver suggested that there should be a few tropical medicine centers where a competent staff would maintain a significant research program and also furnish high level training to those medical students attracted to this field.

As one whose professional activities have been in one of the sciences allied to tropical medicine, it seems to me that the concept of a training center should be broadened to include not only those sciences named in our constitution, but also those concerned with overpopulation, environmental deterioration, conservation, economics, and sociology. Whether this expanded center could be accommodated within the organization of the conventional medical school seems doubtful. The medical school is essential, but it would seem, when one examined the line-up of the several disciplines, that the center of tropical health should be independent but closely allied with both a medical school and a school of public health. Our Society has had, and will continue to exert considerable influence on the progress of research and teaching, and possibly we can promote the establishment of such training and research centers.

Of these and other reasons for the existence of our Society, I think the most compelling is that it is a forum in which we can exchange ideas, tell others of the progress we are making in our own work, and find inspiration which will lead us into new pathways of research. These contacts, through our annual meetings and the pages of our journal, are essential for keeping abreast of rapidly changing conditions, and to anticipate emerging problems affecting health in the tropics. We should examine more carefully certain peripheral areas such as tropical agriculture, forestry, and the environment. We seem to have lost the traditional alliance between the physician, biologist, and engineer which characterized one of our parental organizations, The National Malaria Society. The Society should be willing to exert its influence in support of projects and institutions which it believes are vital to the health and welfare of man.

Today, no doubt, there are some of us who are envious of the excitement and sense of great accomplishment that must have permeated the meeting in 1904 when Carroll told of his work on yellow fever. Nevertheless, we have been privileged to observe the remarkable advances that have been made during the past 30 years. Opportunities for exploration and conquest in this field have not come to an end. Future members of this Society may also feel some twinges of envy in looking back at what we have seen, but will turn quickly to achieving their own goals in ridding the world of unnecessary diseases, and of creating an environment in which mankind can enjoy life to the fullest.

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