

PRESIDENT'S ADDRESS

PARASITOLOGY IN A MODERN WORLD

J. TEAGUE SELF, University of Oklahoma, Norman

Parasitology has come to be defined as the science dealing with those animals causing diseases in other animals. This is a rather restricted definition because if we choose the literal meaning of the word we should include all of those organisms which, in deriving a livelihood therefrom, do harm to other organisms. The first definition will include the topics to be discussed, and the latter will be limited primarily to a few organisms affecting man himself.

Knowledge of animal parasites is not new to modern science in spite of the fact that many modern and so-called enlightened populations live in total ignorance of the diseases caused by them. If we check early history, we find that in the time of Moses, for example, reference is made to well-known parasitic diseases. The Biblical passage, Numbers 21:6-9, dealing with the fiery serpent is considered by many to be a historical account of the infection of Moses' followers by the Guinea worm, a parasite still common among the peoples of the Near East. I suppose that some individuals look upon this Biblical passage as a reference to an epidemic of poisonous snakes and believe that the Israelites at that particular time were being bitten and killed by the bites of these snakes. If you analyze the conditions under which the passage was written, however, a different interpretation is possible. There is little reason to think there were a sufficient number of poisonous serpents in the Land of Moses to cause any real disturbance among his people, but conditions conducive to extensive infection by the Guinea worm did exist, as they do at the present time. This worm attains a length up to four feet and has the habit of lying in a tortuous tunnel under the skin of the lower limbs. It is not inconceivable that the Israelites called this parasite a serpent. The common method of removing it from its host involves getting hold of one end and wrapping it gradually around a stick until it is completely extracted. There are those who believe that the fiery serpent represents the Guinea worm, and that the pole upon which it rests is symbolic of the stick around which it is wound in extracting it from the patient. Be that as it may, definite records of many parasites well known today have been handed down to us by ancient writers. Agatharchides of Nidas gave the term *Dracontia micra* meaning "little snake" to the Guinea worm. Also, Aristotle wrote in his *Historia Animalium* about flatworms and roundworms. Hippocrates wrote of what was probably the pinworm, and other ancient writers gave evidence of knowledge concerning common human helminths.

One would presume that, since these early writers had at least some knowledge of human parasites and since such tremendous advances in knowledge have been made since their time, there would be little remaining to be learned about these animals which have taken up habitation in the human body, especially in a country so highly civilized as the United States. On the contrary, we find ourselves still woefully ignorant concerning suitable methods of treatment and control for many of the diseases caused by these animals. To illustrate, let us look at the picture in America at the beginning of World War II. It became immediately obvious that American soldiers would necessarily be sent to all parts of the world for combat purposes and that many of these regions are endemic to many parasitic diseases not common within our own continental limits. We suddenly realized that we were faced with the problem of carrying on combat in these areas and that at the same time we were lacking in trained personnel insofar as the control of these diseases was concerned. In September 1943, Dr. Horace W. Stunkard (1943) speaking at the *Conference on Parasitic Diseases in New York* made the following important observations.

It may be appropriate and instructive to compare the training and experience in the treatment, control and prevention of parasitic diseases afforded members of the medical profession in the United States and in those countries with which we are associated and those against which we are opposed in the war. The medical departments of the armies of Germany, Italy and Japan have long been preparing for the conflict and extensive studies had been carried on before the outbreak of hostilities. The staff of the British Army, likewise, was familiar with the problems and prepared to meet them. Indeed, through their colonial interests, the British, German, French, Dutch and Belgians have long recognized the importance of parasitic diseases. The trail was blazed by medical missionaries, a small but unselfish and devoted band of men who, without particular preliminary training, learned about parasitic diseases at first hand and by empirical methods. The development of commercial relations between the homeland and the colonies, the migration of Europeans to the colonies and their subsequent return, the more or less constant intercourse through shipping, the necessity of maintaining healthful conditions for Europeans and natives in the colonies, all have combined to bring the existence, prevalence and importance of parasitic diseases to the attention of the medical profession in these countries. As a consequence, the medical schools have developed strong departments of parasitology either as integral parts of the institutions or as associated institutes . . .

In contrast to the situation in Europe, the entry of the United States into the present war found the medical profession unprepared to cope with the problems which are arising as increasing numbers of American troops are sent into areas where tropical diseases are endemic. Possibly the majority of our troops in this war will serve in regions where the native populations are heavily infected, where the probability of infection is almost a certainty, and where, under field conditions, preventive and sanitary measures must be inadequate at best. I think it would be a conservative estimate to say that some million or more Americans may acquire parasitic diseases, and the . . . efficiency and striking power on the part of the armed forces will be very greatly reduced. Indeed, it has been reported that our defeat at Bataan was due as much to malaria and other diseases as to the military factors concerned . . .

The distressing situation with regard to tropical medicine and parasitic diseases, as it applies to our armed forces, is in large part due to the fact that in the past there has been little necessity for American physicians to familiarize themselves with parasitic diseases and that American medical schools and colleges have not given adequate instruction in tropical medicine. It is no secret that our medical instruction on the subject of parasitic disease has been of the most desultory character. With notably few exceptions, the diseases caused by animal parasites have been considered incidental in courses devoted primarily to other subjects, such as bacteriology, pathology or public health. Independent departments of parasitology, staffed by experts, have never been developed in American medical schools.

If, as Dr. Stunkard pointed out, the American physician was not trained at the beginning of World War II to deal with parasitic diseases, then we can hardly be surprised if the overall population of this country lives with little realization of the presence of these diseases which exist all about us. Not many months ago, a lady living on a modern Oklahoma farm told me that her family doctor had assured her that the mosquitoes which carry malaria are not the same as those which carry typhoid fever; and not long before that a public-health worker was informed by a physician in one of our more-prosperous towns that he had lots of malaria patients but that they were no bother because the disease is so easy to treat. Not knowing of a sure cure for malaria, the worker asked what remedy was used and was informed that it was typhoid

vaccine. These, of course, are extreme cases, but they do represent the state of knowledge among some physicians and certainly in the overall population. In spite of the fact, therefore, that knowledge of animal parasites dates back to early history and that the European countries and Japan had developed the science of tropical medicine to a very high degree previous to World War II, America entered it in a very backward state.

It is here that we must pause and pay tribute to the ability of Americans to rise to an occasion of emergency and defend themselves with amazing versatility and determination. As a matter of fact and as in all other endeavors related to combat, the American people rose to the occasion of defending themselves against tropical diseases during World War II. Extensive training centers were set up for the training of physicians and other public-health workers to take care of the protection of troops against tropical diseases, as well as the protection of civilian populations against diseases introduced to this country by combat men. The record made by these individuals—when properly accounted for—will be recognized as one of the great military accomplishments of the past war.

That we were able to cope in a remarkable manner with the tropical diseases during World War II does not mean that we have now solved all of the problems relating to them. We have good reason for thinking that, with modern control methods afforded by such potent chemicals as DDT, malaria may be completely eliminated from continental United States. Other important maladies, such as hookworm disease, have been declining in incidence during recent years as a result of concerted efforts directed toward their control. However, we still have with us these scourges of mankind, as well as numerous others which contribute to morbidity and mortality whether directly or as shrouded accomplices to other diseases.

The magnitude of these parasitic problems was brought clearly before us on December 27, 1946, by Dr. Norman R. Stoll (1947) in his address as retiring President of the American Society of Parasitologists. By putting together accumulated data on the incidence of human helminths and then by extrapolation Dr. Stoll predicted the approximate incidences of many helminth infections throughout the world. His figures are amazing. *Trichinella* infection, commonly known to cause trichinosis and the transmission of which is well known, is estimated to occur in one in six Americans, the highest known rate of any country. Many of you know that this worm is transmitted to man almost entirely through infected pork and that the hog usually becomes infected by eating raw garbage containing infected pork. This parasite, though perhaps not a common cause of death, is certainly responsible for more morbidity than many better-known agencies. And yet, in this, one of the most highly civilized of all countries of the world, we still must arrive at the point where the masses appreciate the importance of proper garbage disposal. It is axiomatic in this country from the largest city to the smallest hamlet that garbage is a perfect food for hogs and that hogs have two main functions: One, to destroy garbage; and the other, to supply the ham, bacon, and chops for our table. This affords an ideal situation for *Trichinella*.

Estimating the population of the earth at 2,166,000,000 human beings, Dr. Stoll presents these startling figures concerning the incidence of other well-known human parasites. *Taenia saginata*, the beef tapeworm, 39,000,000 infections; *Hymenolepis nana*, the dwarf tapeworm, 20,000,000; *Diphyllobothrium latum*, the broad or fish tapeworm, 10,000,000; *Clonorchis sinensis*, the human liver fluke, 19,000,000; *Fasciolopsis buski*, the large intestinal fluke, 10,000,000; the several trematodes known as the human schistosomes, or blood flukes (*Schistosoma japonicum*, *Schistosoma mansoni*, *Schistosoma haematobium*) 114,000,000; *Dracunculus medinensis*, the Guinea worm, 27,500,000; the various species of filarial worms causing the disease filariasis in its several forms, 758,000,000; the pinworm, *Enterobius vermicularis*, 209,000,000; the two common human hookworms, 457,000,000; *Ascaris*, the large intestinal roundworm, 644,000,000; *Strongyloides*, 35,000,000. These are only some of the major helminth inhabitants of the human body and many other forms of equal or

greater infection rates might be mentioned. It has been estimated that the annual world incidence of malaria is 300 million cases with 3 million deaths and that directly or indirectly malaria causes at least one-half of the annual mortality of the human race. Although it has not occurred in epidemic form in this country in many years, it does occur regularly in devastating epidemics in many parts of the world.

The incidence of *Endamoeba histolytica*, the pathogenic intestinal amoeba, can hardly be less than 10 percent of the total world population and is probably much more since few modern surveys show an incidence of less than 10 percent. It is much higher than 10 percent in many of them. Infections with this parasite are often latent and go unnoticed until a change in host-parasite relationships causes it to become at least a contributor to, if not the direct cause of, mortality. Some, if not all of you, remember the Chicago World's Fair epidemic of 1933 and 1934 in which there occurred almost 1500 cases of amoebic dysentery, including 52 fatal ones, distributed through over 200 cities. This epidemic resulted from defective plumbing in certain Chicago hotels allowing the siphonage of sewage into the drinking water lines.

We might mention also the leishmanial diseases. Kala azar, meaning black sickness, does not occur in this country but appears in disastrous epidemics in the Old World, particularly in certain parts of India, North Africa, the Mediterranean countries, and northern China. It is now known to occur in South America. Oriental sore, less-frequently fatal than kala azar, is widespread through North Africa and the Mediterranean countries. Espundia, the American form of leishmaniasis, is widespread throughout South America north of the Tropic of Capricorn, as well as in Central America and Mexico northward almost to the Tropic of Cancer. This disease, though not immediately fatal, drags on for many years resulting in a horrifying destruction of the tissues of the nose and mouth.

Actually, the grand total of human parasite infections far exceeds the total population of the world, and, therefore, on the average, each human being harbors more than one infection by animal parasites. It must be admitted, of course, that this high incidence of parasitism is more common in the Tropics and the Orient and that America is relatively free of many of the species named. We must not forget, however, that the hookworm is a common parasite in this highly civilized country and yet the only thing necessary for its complete elimination is proper disposal of human waste materials. The same thing is true of *Ascaris*, the large human roundworm, and as I mentioned before, the only thing necessary for the control of trichinosis is proper public-health laws preventing the feeding of raw garbage to hogs. It would seem, therefore, an easy task to eliminate parasitism completely from a country as highly advanced as this one. Strangely enough, many of these parasites owe the success of their existence to specific human customs and these are not easy to change even among educated people. Not many years ago, a student from this institution was assigned to a C.C.C. camp in an adjoining State. The work of the C.C.C. boys was devoted to building sanitary toilets in a highly endemic hookworm area. The problem seemed simple. Sanitary toilets would be built at every human habitation. They would solve the problem of soil pollution with human night soil and, within due time, the incidence of hookworm would be materially reduced in the area. A few months after the project was completed, the student was sent back to the area to check on its success. He found that the women were using the toilets; but the male sex, never. In his amazement, he asked why. The answer was, "Any fool should know that toilets are for women and not for men." Well, this is an example of the problems with which we are faced in a so-called highly civilized country, not to mention the uncivilized areas, even when all necessary factors for control are well known. This ceases to be a purely biological and medical problem. It becomes one involving the education of the masses, this education going farther than the "three R's", but concerning itself with the real everyday problems pertinent to healthful living. We cannot hope, therefore, to rid the millions of affected people of the world of

these diseases until such time as general education shall have advanced sufficiently to overcome superstitious and otherwise distorted social habits and customs.

In isolated instances, modern methods of control which have resulted from emergencies of war have been of such startling nature they have been accepted almost one hundred percent and immediately. This is the factor which has placed such insecticides as DDT in the position of giving high promise for the elimination of diseases like malaria. To resort to history again, during the latter part of the war and since that time, the U. S. Public Health Service initiated certain projects known as residual-DDT-spray programs, whereby entire areas endemic for malaria have had all human habitations sprayed with DDT. This procedure is based on the premise that anopheles mosquitoes feed between sundown and sunrise, and, as a result, the feeding usually takes place on individuals inside human habitations. Also, having fed, the anopheles mosquito in this country seeks the nearest resting place where it remains for a number of hours. If such a mosquito, having become freshly infected, is killed during that resting period, she will not transmit the disease to another human being because an incubation period of several days is required before transmission is possible. The object toward which the program works is to kill all infected mosquitoes during the incubation period for the malarial parasite and hence prevent transmission of the disease. This program was accepted wholeheartedly by populations of endemic areas, not so much because of their desire to get rid of malaria but because they found that for the first time in their lives they were free of houseflies, bedbugs, and other vermin which had plagued them and their ancestors. It was fortunate, therefore, that DDT was equally effective against the common household pests such as houseflies and bedbugs. Such instances of success, although rare, indicate that modern science is progressing in control methods. The most-outstanding example, perhaps, is the record of the TVA in the control of malarial mosquitoes. This has been done through a scientific approach to the problem involving primarily naturalistic methods which prevent the existence of optimum breeding conditions. Most significant is the development of methods of water-level management which prevents the breeding areas from stabilizing to the extent that mosquitoes can be produced. This knowledge should serve as a guide in choosing methods to be employed in the impoundment of waters in all endemic malarious areas.

Should we in this country learn the techniques of protecting ourselves against our own parasites, would we then be safe in relinquishing our fight against the parasitic diseases? The answer is "No." We are no longer protected by ocean barriers from parasitic enemies any more than against human enemies. Our fast-transportation methods make it possible for dangerous insect vectors to be transported to this hemisphere from other lands, and subject us to diseases not previously important to us. To use an example, let me cite the case of *Anopheles gambiae*, the dreaded malaria vector of Africa. This mosquito was transported to Brazil in 1929 or 1930, probably by airplanes or by fast ships, and became established in the vicinity of Natal. Northeastern Brazil was not without malaria but here was an introduced vector much more efficient than the native mosquitoes. The result was the most-devastating malaria epidemic in the history of the Americas. In the first six months of 1938, there were 100,000 cases and 14,000 deaths in the interior of Rio Grande do Norte (Sopher and Wilson 1943). Only by concerted efforts on the part of the Brazilian Government and by the Rockefeller Foundation, was this mosquito checked and the epidemic brought under control. Had it succeeded in distributing itself beyond the region covered by eradication measures, this mosquito would have changed the entire malaria picture in the Western Hemisphere. By 1941, *Anopheles gambiae* had been eradicated in Brazil, but it has appeared again since that time; it is only by constant vigilance involving the inspection and fumigation of all fast transport across the Atlantic from Africa, plus constant watch at the ports on both sides of the Atlantic, that we can hope to prevent a repetition of the 1938 epidemic.

In the report of the International Health Division of the Rockefeller Foundation for 1946 (Anonymous 1947), we find this all-important statement:

... With the tremendously increased movement of military aircraft during World War II, an arrangement was worked out by which American authorities assumed the responsibility for spraying their own military planes at African bases in direct communication with Brazil. Following fumigation operations a systematic search was made for all insects and other arthropods. . . . It is noteworthy that a total of 352 *A. gambiae* were identified from all types of planes between January 1942 and December 1945. Moreover, there were encountered four *Glossina palpalis*, the tsetse fly which transmits sleeping sickness. A tremendous number of other insects, both dead and alive, was encountered.

This experience has amply demonstrated the grave need that all interested nations reach agreement on a program which would protect them against the perils of commercial air traffic, bound to develop on an ever-increasing scale in the near future.

Anopheles gambiae is only an example of these dangerous vectors. There are also many others as well as the diseases transmitted by them which must be understood and watched. In 1943, Dr. Stunkard estimated that at least one million Americans would return to this country infected by parasitic diseases; although I know of no figures on the actual number, I have little doubt that he made a conservative estimate. The agencies dealing with the personnel infected with these diseases have been extremely careful to be certain that none will transmit them to civilian populations. We must remember, however, that many of these organisms characteristically produce clinical symptoms only months, or even years, after the date of infection. We cannot be sure, therefore, that one or more foreign parasitic diseases will not still become established in this country. Stunkard (1946) and his coworkers exposed 71 species of snails to infective stages of *Schistosoma hematobium*, the blood fluke of Africa and southwest Asia. (The schistosomes, as some of you know, must pass a phase of the life cycle in a snail host before becoming infective to man.) Although he found no native snails in which these schistosome larvae could survive, he pointed out that among the many other species it is entirely possible that one or more may be satisfactory hosts, and we can never be certain that species now refractory will not become susceptible. The fact that some of our native snails serve as secondary hosts for bird schistosomes suggests the possibility of a satisfactory one being found for the human species.

In the same way, we are not certain that native species of mites may not serve as vectors for tsutsugamuchi fever, or scrub typhus, the dreaded mite-borne disease of the southwest Pacific and many regions of the Orient. As indicated by records already cited, it is not inconceivable that the tsetse fly, the vector for African sleeping sickness, may be carried to the Americas by fast transport and become established with its protozoan parasite. It is almost certain that, were it not for climatic factors not well understood, the filarial worm causing filariasis could become endemic in this country. We have the mosquito vectors for this parasite, but past records of known foci established in this country indicate that certain ecological factors are not conducive to the spread of the disease. We must at least assume that the right conditions may still be found since service men with possible infections from endemic areas may carry the parasites to practically all parts of the Nation, in spite of precautions taken to prevent it. It is not inconceivable that Chagas' disease caused by a trypanosome from South America may become established particularly in southwestern United States, because the reduviid bugs which transmit it have susceptible relatives in this region, or again, the natural vectors in South America might well be introduced to this country by modern transportation.

I have mentioned only some of the organisms which must be guarded against at all times. Actually, the surest way of protecting ourselves against

these parasitic diseases is to attack them in their foreign habitats particularly around ports of embarkation. Even this may not be sufficient because of the networks of air bases that are being established throughout the interiors of all countries. It seems imperative, therefore, that from the standpoint of the parasitic diseases, we cannot avoid close international relations which only a decade ago seemed unnecessary. And what better medium can be found for gaining friendly relations with other peoples of the world than a cooperative and mutually beneficial program for improving public health. Political diplomats and economic exploiters do not always gain the most-favorable relations with foreign populations. Even the missionary whose main interest is to improve the conditions and destiny of the heathen's soul sometimes has his head removed but one seldom hears of animosity toward the medical man who devotes his energies toward improving the physical well-being of those with whom he deals. He is more likely to be placed in a position of deity.

In addition to these foreign parasitic diseases, we still are plagued with many of our own. We have our own malaria problems, McCurtain County, Oklahoma, ranking fifty-second in malaria morbidity and mortality among the malarious counties of the Nation. Hookworm remains a problem in the Southern States and is prevalent in Oklahoma. No combination of chronic diseases is more detrimental to health, especially among children, than that of malaria and hookworm. We have also creeping eruptions caused by the larvae of the dog-and-cat hookworm. In this State, this is primarily a disease of children who play in sand boxes frequented by dogs and cats. The larvae penetrate the skin and then migrate, producing tortuous tunnels which become inflamed and extremely irritating. Last summer I saw a two-year-old child in Norman, Oklahoma, with fifty-two tunnels distributed from its waist to the tips of its toes.

We must not omit *Trichinella*; the problem of its control in this country is very serious. Its solution involves at least three separate phases: One, teaching Americans to dislike rare meat; two, convincing municipalities of the lack of wisdom exercised in using hogs as a disposal tunnel for raw garbage; and three, educating the farmer on the importance of proper feeding methods for hogs. There is little hope that any of these will be accomplished in the near future.

Most of you over forty years of age have taken vermifuge or at least have heard grandma say "that ornery kid must be wormy and needs a vermifuge." Today, we often speak of the same situation but in more refined terms; i.e., Johnny is neurotic and maladjusted to his home life. He suffers from anorexia, restlessness, and insomnia. He is underweight and has a difficult disposition in general. We call in the pediatrician, the psychiatrist, the psychological tester, etc., in our attempts to solve the problem, but not one of our professional assistants in most cases goes to the trouble to check Johnny for pinworm which produces the very symptoms just mentioned. This worm is coming to be known as one of our most common parasites. Surveys by Cram and associates in Washington, D. C., have shown 41.5 percent of the whites and 12.9 percent of the Negroes tested to be infected. In six children's hospitals in New Orleans, 74.3 percent of the patients were found infected. These worms were found in three-fourths of the chronic mental patients in Minnesota hospitals while the rates shown in Boston and the Indiana University Hospitals have been shown to be 19 and 16.3 percent respectively. In Oklahoma, Smith and Richardson (1947) found 33.3 percent of 117 children admitted to the Oklahoma Hospital for Crippled Children to be infected. The rate was 26.9 percent in preschool children, 47.8 in the 6 to 11 age group, and 29.7 percent in the 12 to 17 age group. This is sufficient to show the importance of this parasite as a factor in public health in spite of the fact that it is relatively unknown by the common man in this country and receives little attention from many who are in position to diagnose and treat it.

CONCLUSIONS

Although the animal-parasite diseases have been of long-standing existence, the average individual is ignorant of their causes and often plays into the hands of the parasite because of peculiar and stupid customs. These diseases thrive best with ignorance and poverty but often survive among the educated and prosperous. In a modern world we can no longer enjoy the security from certain diseases of this type once afforded by ocean barriers or the great distances that separate us from their respective endemic centers. Our protection now must involve first the education of our own people as to the hazards of encountering exotic parasites and to the necessity of self protection through everyday hygienic living. Secondly, the problem has acquired international proportions and requires fighting these diseases on their home grounds because we can no longer be assured of a successful defense after they reach our own shores. It is hardly conceivable that America can any longer ignore any parasitic diseases wherever they occur over the surface of the globe.

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