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PRESENT STATUS OF MAN AS HOST TO ANIMAL PARASITES

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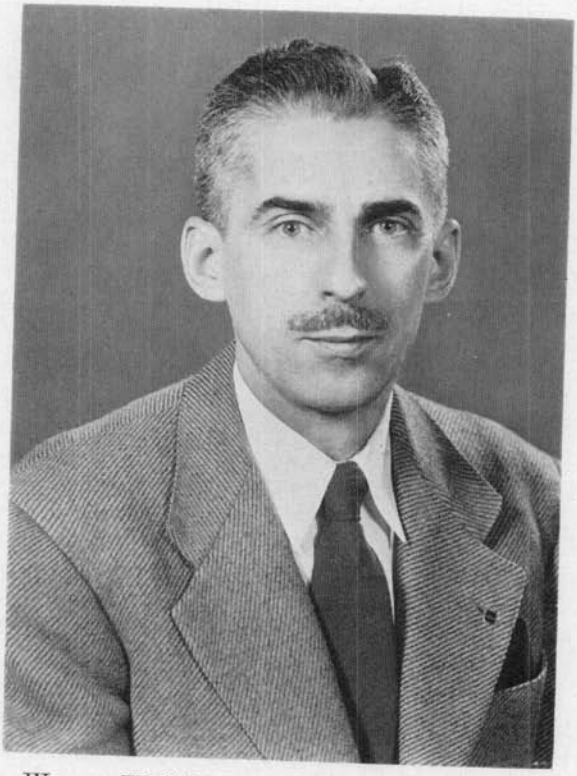

WAYNE W. WANTLAND, *President*, 1957-58

In the mind of the student of nature, two phases of the struggle for existence have great significance. Competition among ourselves resulting in war we shall leave for the time being to the sociologists and representatives of nations gathered around their discussion tables. We shall continue to nurse some degree of hope that these specialists, through debate, conference and cooperative effort, may bring about in the thinking of that great animal, man, a little more appreciation and tolerance of his neighbor, an inkling of the realization that after all, there may be some real values and benefits to *Homo sapiens* in a peaceful life.

It is not the purpose of the speaker to pass this phase of the problem in its entirety, and for all time, to the stalwart frames of the students of governments and societies. There is indeed reason to believe that students in other fields are vitally interested in the problem of war prophylaxis and have repeatedly placed their shoulders to the wheel in a cooperative effort toward its solution. This is certainly true of the student of science. The significance of this phase of the struggle for existence is second to none in the minds of all here today. However, let us defer consideration of this phase, for the present, in favor of another phase of the struggle for existence or at least ascendancy, namely our fight with certain organisms that cause disease. Furthermore, in accordance with the time allotted me may we turn our attention more specifically toward a consideration of the science of parasitology and the nature of some of those disease-producing and disease-carrying organisms that find man a most suitable host and which because of certain characteristics are labeled animals instead of plants.

An animal parasite may be defined as any animal organism living upon or within another at the expense of the latter. This biological relationship is one which prevails rather widely throughout the animal kingdom, and its origin is speculative. In the study of animal parasites one quickly discerns that one of the outstanding characteristics of these organisms is the marked capability of the reproductive system for perpetuation of the species. We shall mention later the tremendous fecundity of some of these forms that trespass upon our innards as well as the exteriors of our bodies.

The science of animal parasitology, though one of the older branches of science, has only comparatively recently achieved the greater recognition so long deserved. The medical schools of this country for a long time deemed it neither necessary nor of any great import to teach their students very much about animal parasites. True, in the better class of medical colleges one received a lecture or two on the malaria sporozoa, the hookworm and, if lucky, the opportunity to peek through a microscope at trichina larvae encysted in striped muscle. Beyond this rather scant and superficial treatment one could only gather that parasites were interesting but unwelcome and loathsome creatures or, at best, forms having significance and importance only in tropical medicine. Moreover, there was little reason to fear any of the really important parasites of the tropics or the Orient due to the great distance of our populace from these sources of infection. In the minds of many the term "parasitology" signified something repulsive, dirty, and having to do with worms and other sorts of crawling and creeping things. This was hardly a proper subject for conversation even among medical men experiencing repeated contact with disease and all its unattractive features. When some well-known and highly respected citizen was clearly demonstrated to have pinworms or to have become the unwilling and embarrassed host to body or head lice (and this did and does happen), it was a downright calamity, a situation justify-

ing prompt if not desperate measures—perhaps even an appendectomy in the first instance and at least a sojourn ostensibly to visit an ailing aunt or uncle for the last-named affliction.

Events leading up to and including World War II and the Korean conflict created, among other needs, an urgent call for trained parasitologists. In various parts of the world parasitological problems presented themselves for solution—not to be solved sometime in the future but immediately if at all possible. Malaria, for example, in addition to incapacitating thousands of persons in our own southern states, became an additional hazard to our armed forces in the Central and South Pacific areas and threatened to help defeat many a mission unless more successful measures of malaria control and treatment were quickly developed. Other parasitic diseases such as filariasis, trypanosomiasis, schistosomiasis, amoebic dysentery, and leishmaniasis attacked our service personnel at various points along the vast fighting front. At the outbreak of hostilities there were comparatively few persons who had experience with even the more common parasitic diseases in this country such as malaria, taeniasis, oxyuriasis, and amoebiasis, and most of them knew little or nothing about the etiological agents, life cycles, and vectors carrying and producing parasitic disease in the Orient and the tropics. Immediate, fast and effective action was imperative against both the Oriental military forces and parasitic diseases. Special courses in parasitology were given to medical officers; the national government encouraged and supported research projects to gain new knowledge in the field of parasitology, and groups of highly trained personnel were organized to study special problems and to develop adequate control and protection in remote areas suddenly become centers of great activity.

This rather sudden acceleration in the growth of the science of parasitology and the increased cognizance of the importance of animal parasites and their relationship to man, all occasioned by human conflict, subsided some of course with the cessation of active war. However the many problems presented and the others uncovered in this area of science during turbulent times stimulated many to increased efforts in continued study of parasitic diseases both at home and abroad. Growth in these endeavors might well continue, for changes in social, economic and physical relations with other parts of the earth have placed us in a position where we can no longer take merely an academic interest in parasitic diseases found predominantly in other countries, especially those of the Far East and the tropics. We must now recognize that we are inhabitants of a ball of matter which has diminished to a point where it is not more than a few hours by jet plane between any two capital cities on earth and where rocket missiles transporting devastating explosives or perchance disease-producing organisms and disease-carrying vectors can be dropped in our laps from the opposite side of the globe in a matter of minutes. Parasitic protozoa and disease-carrying arthropods, quite as well as dogs, can be transported by Sputniks. With the more recent and

rapid developments in transportation and speed, many problems take on new importance and added significance. Even a few years ago we did not need to worry much about tsetse flies and their passenger trypanosomes or *Phlebotomus* flies carrying Brazilian leptomonads; we thought little about scrub-typhus-infected Trombiculidae from the Malayan archipelago and even less about encephalitis-virus-infected Ixodidae from Russia. Cases of filariasis, leishmaniasis, and hepatic distomiasis were of interest only to those foolish parasitologists who journeyed far into the tropics or to the Orient to investigate some bizarre disease entirely "out of this world." Today there are few parasitic diseases and few disease vectors from which we can consider ourselves safe from attack. Our best protection is to promote greater knowledge and understanding of animal parasites which occur in immediate areas as well as those organisms which may be infiltrated from one region of the earth to another more readily today, resulting in hitherto foreign diseases being brought closer to our front doors.

During the past two decades the increased study of animal parasites and diseases which they cause in man and other animals has of course resulted in the accumulation of much new and valuable information. Greater emphasis on health education, improved sanitation rules and practices including rigid regulations pertinent to plumbing installations, garbage and sewage disposal, periodic examination of food handlers, more efficient food inspection, better processing and storage of foods, the development of more effective insecticides, and more complete programs to eradicate rodent pests have given us more efficacious prophylaxis and thus greater assurance against parasitic diseases. When, in spite of these improvements as regards prevention, various parasites succeed in gaining a foothold, new methods of treatment—new less toxic and more effective medications—provide us still other weapons with which we can in most instances successfully defend ourselves. However, all of these improvements, all advances in knowledge in this area still are not enough to steal from man the role of a supremely hospitable host to parasites. He persists in aiding unintentionally or in ignorance their perpetuation and oftentimes is deeply offended if his attention is called to the fact that he is abetting in the welfare of disease-producing forms. To renew faith in the continuance of the practice of aiding such organisms one has only to observe the perennial behavior of a new group of graduate students and, alas, the practices of some of the more experienced laboratory personnel as they lick gummed labels, chew ends of pencils or bite their fingernails in animal rooms or microbiology laboratories. Again, in any of the multitudinous public gatherings of our kind one may observe a variety of behavior patterns ranging in their bases from absolute ignorance of, through utter disregard, to complete disdain for, contamination of others by the irritating currents from the cough and the drowning shower from the sneeze.

Let us now turn to a consideration of some specific animal parasites which have and still do constitute a

definite menace to mankind. For convenience let us divide these into three categories: 1) parasites acquired by man through the consumption of improperly prepared or contaminated food; 2) parasites transmitted by arthropod vectors and certain endoparasitic forms acquired by direct contact with other persons harboring such organisms; and 3) ectoparasites. An exhaustive treatment of forms classified in the above categories is of course not possible here. The author will limit consideration to two or three representative organisms in each of the aforementioned groups.

In the first category attention may well be directed toward a tiny protozoan known as *Entamoeba histolytica*. The disease caused by this organism is known as amoebiasis or perhaps more commonly as amoebic dysentery. This parasite has a great, though often latent, capacity for causing disease and a wide geographical distribution. Routine examinations of feces made by competent microscopists seldom indicate less than 5 to 10% infection of the entire population. A recent survey in Tennessee showed more than 10% of the rural population infected and over 22% in one group of counties were found to harbor this amoeba. One of the most remarkable findings was a 60% infection in 900 people examined in the Kola Peninsula of Russia, a locality lying within the Arctic Circle. The amoebiasis epidemic which occurred during the Chicago World's Fair in 1933 brought this parasitic disease into considerable prominence in the Mid-West. Defective plumbing in hotels and "carrier" food handlers caused 1000 known cases of amoebiasis and 58 deaths scattered over 206 cities of the United States.

Identification of the etiological agent of this disease requires specialized training, for this amoeba is enough like other harmless forms of amoeba in appearance to confuse the ordinary observer. In acute cases of amoebic dysentery are found the active motile forms which have invaded the intestinal wall and perhaps the liver, giving rise to abscesses and even perforations in advanced cases. Such patients rarely recover but are not a menace so far as transmission of this malady is concerned. As in the case of typhoid, we have here a type of disease-producing organism which is transmitted by so-called "carriers" in whom no demonstrable symptoms are found, but who carry the amoeba in a quiescent cystic form and, like Typhoid Mary, are capable of infecting others through foods handled by them or through water contaminated by improper sewage disposal.

The essentials in the prevention of amoebic infection are sanitation and protection of water and vegetables from pollution and contamination. Sanitary water systems are absolutely essential. In view of the plumbing hazards discovered in Chicago in 1933, public health officials and city governments have appropriated additional funds for periodic inspection of hotels and public buildings but the inspections are inefficient in many instances. There is some evidence that cysts of *Entamoeba histolytica* are transmitted from person to person or from contaminated food to host by some insects, particularly

the common house fly. Several fly-borne epidemics have been described in the literature. In the treatment of amoebic dysentery emetin has been largely replaced by such antibiotics as terramycin, erythromycin, and aureomycin. However, except where there is acute dysentery, certain of the arsenicals and iodine drugs are still preferred since the antibiotics though highly effective sometimes cause serious disturbances through elimination of the normal bacterial flora from the intestine.

Another serious parasite that gains entrance to the human body through the ingestion of improperly prepared or contaminated food is a microscopic roundworm known as *Trichinella spiralis* or more commonly as the trichina worm. Trichina infections are found most frequently in omnivorous or carnivorous animals under natural conditions. Many animals, including the dog, cat, monkey, guinea pig, rabbit, rat, and others may be experimentally infected. Man becomes infected most commonly as the result of ingestion of raw or insufficiently cooked trichinous pork. Upon reaching the stomach of the host, the larval forms are liberated from enveloping capsules and the surrounding muscle tissue by the action of the gastric juice. The sexes are separate. Maturity is reached in from three to five days and copulation occurs in the small intestine of the host. The adult viviparous females penetrate the intestinal villi and deposit thousands of living larvae in the lymph system or directly in the blood stream. These minute wrigglers are carried by the blood through many tissues of the body but for some reason, at the present imperfectly understood, they select only striated, voluntary muscle in which to build a home. When the larvae invade the muscle fibers, movement of certain muscles, *e.g.* those concerned in the motion of the eye, in respiration, mastication and deglutition, becomes seriously impaired and death may occur as the result of dyspnea or from the inability of the body to withstand the accumulation of waste products of the larvae. If the individual survives the muscle-invasion phase, symptoms subside somewhat but recurrent muscular pains, stiffness, soreness, and weakness may persist for months. Rather thick hyaline capsules, usually elliptical in shape, are formed and entirely surround the invading larvae by the end of the eighth or ninth week following infection. These cysts ultimately become calcified.

Routine microscopic inspection of all marketed pork for trichina has been tried in this country and in Europe with little success, since it is impossible to examine microscopically all of the muscle of the thousands of pigs slaughtered and shipped annually. X-ray irradiation has produced sterile larvae in pigs but irradiation of thousands of hogs killed daily is not practical and would be questionable from a public health standpoint in view of recent reports on radiation hazards. Establishments in the United States today which are operated under Federal supervision regularly process such pork products as summer sausage, Italian style ham, and salami, which are usually eaten without cooking. At the present time, most of the animals slaughtered in this country are

subjected to Federal inspection but this inspection does not include inspection for trichinae. Pork products, therefore, which have not been especially processed in establishments operated under Federal supervision may be regarded as possible sources of trichinae infection and can be made safe for consumption only by thorough cooking.

The incidence of trichiniasis in the United States is difficult to determine since all cases are not recognized and all states do not require that cases of trichiniasis be reported. In three years (1930-1932 inclusive) New York state alone reported a total of 102 cases in New York City and 119 cases upstate. More recently (1941-1944) autopsy findings in Rochester, New York, Boston, and Washington, D. C., show an incidence of from 16.5 to 27.6%. One of the greatest epidemics of trichiniasis occurred in the German Army during the first World War. The soldiers became extremely hungry and stole live shoats which they barbecued over open fires. Many of these animals harbored trichinae and, in their eagerness to satisfy their appetites, the soldiers did not wait for the meat to be thoroughly roasted. In some of the infected groups, the mortality was as high as 25% and great difficulty was encountered in suppressing other outbreaks because of the desire of the men for meat, even in the raw state. It would have been interesting to compare the incidence of trichiniasis and other parasitic diseases resulting from the ingestion of improperly prepared meats containing parasitic forms during the years of World War II — particularly the summer and fall of 1945—with previous and subsequent years. Due to the meat shortage of this year, one might expect a lower incidence and yet it cannot be denied that there was definitely a state of "meat hunger" which could easily have resulted in increased consumption of rare and raw meats. Too, the bodies of many animals not usually considered edible by either the wife in the kitchen or the chef in the inn were regarded with savory similitude—indeed flavored favor—and were served garnished with parsley and parsnips, camouflaged with piccalilli and pepper, and relished as the most choice cuts of beef might be enjoyed with utter disregard for such a possible calamity as a parasitic disease.

I should like to direct attention briefly to one other type of worm acquired by ingesting improperly prepared meat containing larval forms, namely the Cestoidea or tapeworms. Species of tapeworms which infect man range in their adult size from very small forms 10 mm. in length (*Hymenolepis nana,* the dwarf tapeworm) to as much as 30 feet (*Diphyllobothrium latum,* the fish tapeworm). The incidence of tapeworm infection is greatest in certain areas and among certain groups where pork, beef, and fish are consumed in the raw state or at best rarely done and where cereals, meals and flour are not protected from contamination by rodents. Man may harbor either the larval or the adult stage of certain tapeworms. Infection with the larval stages is considered the more serious. The life cycles of tapeworms include varying periods of time spent in at least two hosts, sometimes more.

A few years ago one of my major students, a young man from Ethiopia, determined to test the veracity of accounts in standard textbooks of parasitology pertinent to the symptomatology manifested in a person harboring *Taenia saginata,* the so-called beef tapeworm. The study of cysticerci in my class in parasitology reminded him of the bladder worms he had observed in samples of beef consumed by some persons in his native country. Accordingly he sent home for some of this "jerky", demonstrated the cysts to me, enlisted the services of a local practitioner of medicine, and ingested half a dozen cysticerci. After two or three months this student began bringing living ripe proglottids of *Taenia saginata* into my laboratory every few days as proof of his infection. He kept careful records of symptoms for about three more months, finding the textbooks quite accurate and then as per former agreement submitted to treatment and parted company with his "friend the worm." To perform such a test requires courage certainly and I believe a considerable degree of scientific inquisitiveness.

Various medications and anthelmintic drugs have been used with varying success in removing adult tapeworms from the intestine of man. It is necessary to procure the scolex or head and thus insure the patient against further growth and regeneration of another worm. A number of treatments, asinine and absurd, have been handed down through the years as efficacious measures in the expulsion of tapeworms. One of the most ridiculous involves the employment of a tapeworm trap, invented and patented by a physician about the middle of the 19th century. This trap consisted of a cylinder within a cylinder; the whole about the size of the first joint of a man's little finger. Each cylinder was provided with serrated openings in the sides and so constructed that the inner cylinder would slide a limited distance within the outer shell. A small pedestal was constructed inside upon which a tiny piece of cheese was fastened as bait. The patient then swallowed this contraption baited with proper lure and secured to a long string which he slowly played out allowing the trap to sink into the deep recesses of his innards. As described in the patent the patient then waited patiently for a nibble. Then when the tapeworm reared its ugly scolex and struck, a quick tug on the string closed the serrated edges upon the creature's head and the worm could then be drawn out *per os.*

In modern treatment for tapeworms atebrin has largely replaced aspidium as an efficacious anthelmintic. Recently (1953) German workers have reported 90% cures using a mixture of metallic tin, tin oxide, and zinc chloride, which is claimed to be relatively non-toxic.

Let us now turn to a consideration of the second category of parasites, namely, parasites transmitted to man by arthropod vectors and certain endoparasites acquired by direct contact with persons harboring these forms. There are many parasitic disease-producing organisms which are carried from host to host by insect and arachnid vectors. We have already mentioned the marked incapacitation and misery caused by

the malaria parasite.

The plasmodia that cause malaria spend a part of their life cycle in the female *Anopheles* mosquito and another part in man. With a reservoir of malaria, the mosquito is set to carry on her job. She ingests some of the parasites along with the blood she likes so well, and in her body these forms undergo changes and differentiations necessary for further parasitic propagation. In a few days these changes have progressed to a point where the organism, if introduced into a new patient by means of the bite of a mosquito, will give rise to another case of malaria. The tiny sporozoites injected into the blood stream of man by the female *Anopheles* in time penetrate the red blood cells and therein undergo a series of changes of a type of asexual reproduction. As a result of the asexual divisions of the parasite many more are formed, which cause the erythrocytes to swell and ultimately burst, releasing the increased number of parasites into the plasma of the patient to attack other red cells. It is at this stage of the disease (when the parasites break out of the red blood corpuscles) that the patient experiences chills and fever.

A tremendous need was evidenced during World War II for quinine, the malaria specific. We could not procure enough to meet our needs so our doctors turned to atebrin, a drug which did not cure malaria but held the organism in abeyance until more adequate medication could be obtained. Many a doctor got the "shakes" in this war and the story of the deeds of heroes is not complete without mention of these courageous men who fought malaria with such grim determination.

As a result of the tremendous amount of research on malaria during and following the second world conflict a number of new less toxic and more effective drugs are available today for both prevention and treatment of malaria. Chloroquine, Paludrine, Primaquine, and especially Daraprim are highly efficacious in suppressing *vivax* infections and protecting against *falciparum* malaria.

Prevention and control of malaria is a job for everyone. Here are a few things everyone can practice: 1) strive to eliminate all possible mosquito breeding places by draining swampy areas, emptying containers of stagnant water and covering pools with a layer of oil to prevent respiration of larvae and pupae at the surface; 2) take adequate precautions to keep mosquitoes out of dwelling places by proper screening; 3) employ mosquito repellants and nets when it is necessary to be out in the open; and, last but certainly not least, 4) consult a physician immediately if there is reason to believe that malaria has been contracted. In naval aviation we used to have three do's and three don't's —Do's: lay the spray, sweat the net, drain the rain; Don't's: expose your nose, forget the net, jettison your medicine.

I should like briefly to mention two other vector-borne parasitic diseases: 1) spotted fever occurring more and more frequently in this country; and 2) filariasis. The etiological agent of spotted fever is a nonfilterable microorganism belong-

ing to the genus *Rickettsia.* These organisms are carried by and transovarially transmitted generation after generation in ticks of the family Ixodidae. Two species, *Dermacentor andersoni* and *Dermacentor variabilis,* are most commonly involved in transmitting the disease to man. Spotted fever is characterized usually by the appearance of hyperpyrexia, a severe rash particularly on the face, hands and feet, headache and a positive Weil-Felix reaction, *i.e.* agglutination of certain strains of *Proteus vulgaris,* a gram-negative, nonspore-forming, motile, rod form of bacteria. In May, 1957, two cases of spotted fever were reported in Wayne County, Illinois. During the past 10 years 113 cases have been reported to the Illinois State Department of Health. Prophylaxis against spotted fever, and also a form of paralysis resulting from tick bites, consists of care in walking through tick-infested areas and prompt removal of any of these tenacious arachnids that have succeeded in attaching themselves to the body. Treatment of spotted fever with such antibiotics as terramycin and chloromycetin is quite successful and vaccination with killed rickettsias grown in chick embryo yolk sacs confers a fairly high degree of protection.

Man serves as a normal host for about half a dozen species of filarial worms. The most common one is the species *Filaria bancrofti. F. bancrofti* has a wide distribution throughout the warmer climates of the earth especially in moist, low-lying areas of seacoasts and river valleys. The disease filariasis was endemic for a long time in and around Charleston, South Carolina, but failed to gain a foothold elsewhere. In parts of Africa, the South Sea Islands and tropical America more than 50% of the inhabitants have the embryos of this filaria swarming in their blood. The adult form of the worm lodges in the lymphatics, chiefly the lymph channels, resulting in enlarged lymph glands and varicose lymph ducts. One of the commonest manifestations of the infection is elephantiasis, in which various parts of the body swell to enormous proportions due to the accumulation of lymph. The disease is transmitted from person to person by various species of three genera of mosquitoes, *Anopheles, Culex,* and *Aedes.* The microfilaria are sucked in by the vector with the blood of the patient and undergo developmental changes in the body of the mosquito for a period of from two to five weeks. Upon the completion of their tour of duty in this intermediate host the larvae are capable of penetrating the skin of another victim through a mosquito bite or other abrasion.

Neostibosan, an antimony compound, an arsenic compound, arsenamide, and hetrazan, a piperazine derivative, are all effective against filarial infections. Control, of course, consists in avoiding infected mosquitoes and keeping persons with filariasis away from mosquitoes. The endemic center established in South Carolina was due to the chance location there of a colony of African Negroes, large numbers of whom had microfilaria in their blood. This together with plenty of mosquitoes to act as vectors promoted the infection. Early

recognition of these factors by health authorities led to isolation of persons in whose blood microfilaria could be demonstrated as well as those showing symptoms of lymph obstruction. Today this endemic focus appears to have died out. Health authorities must nevertheless maintain an alert lookout here as well as in cases of other vector-borne parasitic diseases for we do not lack in numbers of vectors. All that is needed to establish new foci are a few people carrying the microfilaria.

Endoparasites acquired by direct contact with other persons harboring such forms or in some instances acquired through common use of utensils or linens include *Treponema pallidum,* the causative organism of syphilis, leishmania, pinworm, and the mouth protozoa, *Entamoeba gingivalis* and *Trichomonas tenax.* Although efficacious prevention measures and successful treatments have been discovered for use against most of these forms, many of them continue to abound in various cavities and tissues of the bodies of many persons due to wanton or inadvertent disregard for or nescience of the better hygienic and sanitary practices. In a study presently directed by the speaker and supported by the National Institute for Dental Research, U. S. Public Health Service Grant No. D-357, examination of wet smears and cultures of samples taken from the mouths of 200 dental patients have revealed 46% of these persons harboring *Entamoeba gingivalis,* 26% *Trichomonas tenax,* and 16% carrying both organisms. While there is still some question with reference to the relationship of these two protozoa to oral disease, evidence to date indicates that both *E. gingivalis* and *T. tenax* ingest red blood cells and nuclear fragments of white blood cells and cause cytolysis of soft tissues. Both of these protozoa are found frequently in mouths showing early signs of periodontal disease and are almost always present in cases of advanced pyorrhea. While ulceration in periodontal disease may be initiated by other factors than, or in addition to, the presence of these mouth protozoa providing for the latter an optimal field for activity, a great deal of leniency would have to be shown to exonerate them completely. Both of these mouth protozoa, due to definite adhesive qualities, commonly transport large numbers of bacteria, an activity which might lead to more extensive periodontoclasia. In this same study leptomonad forms of a leishmania were observed in a sample taken from the mouth of a woman 48 years of age who gave a history of recent travel in Mexico and the Panama area. Cultures in NNN media yielded various phases of longitudinal division of these flagellates and varying shapes with typical leptomonads most numerous. On the basis of the history of travel given by the patient and the accepted view that species of *Leishmania* cannot be differentiated morphologically the form of leptomonad observed in this case was diagnosed as a stage of *Leishmania brasiliense.*

One of the most probable means of transferring mouth protozoa, namely the habit or practice of kissing, makes it extremely difficult, even if desirable, to institute effective prophylactic measures against

these organisms. A regulation prohibiting such a method of salutation would be hard indeed to enforce even though there was general cognizance that the kiss might be a parasitological one. Moreover, resistance to a protozoological examination prior to a kiss would most certainly be forthcoming on the grounds that it was too time consuming and distracting. It seems, therefore, that we are destined to be associated with such wee beasties in greater or lesser degree for some time to come.

The last category of animal parasitic diseases to be considered in this presentation is that group of disorders which in certain instances might more properly be designated as infestations, rather than infections, and described as external discomfiture rather than internal wasting, and resulting in tickling and itching rather than pressure and pain. The parasites involved here are usually termed ectoparasites, because of periodic visits to the surfaces of their hosts. While some of these forms do make their way into the deeper parts and inner recesses of the body and many of them act as vectors in the transmission of disease, we shall mention a few of them with special reference to their ectoparasitic habits.

It is not at all difficult to procure representative forms of these ectoparasites for study. They are found quite universally. Not infrequently one may find certain rather loathsome creatures without leaving his home. I remember well the lady who once sent a certain specimen to my laboratory for identification. She was, of course, interrogated with reference to some details, *e.g.,* did she find it in her home? where? when? et cetera. She stated that she had found it in one of the bedrooms of her home and was terribly embarrassed and upset when she received the diagnostic statement that the intruder was a female *Cimex lectularius* (common bedbug). Her general attitude was conveyed by the expression "Bedbugs in *my* house!!!" "Impossible!" Now I suppose most people do not want bedbugs, cockroaches, lice or fleas in their houses, yet the fact remains that all of us are surrounded with ectoparasitic pests of one kind or another much of the time and do not put forth as much effort as we might toward their eradication. Curiously, there are still people in civilized countries who believe that some insects have medicinal value. The distinct and characteristic odor of some, such as the bedbug, may have inspired such a faith. In ancient times, it was claimed that seven bedbugs ground up in water would arouse one from a fainting spell and one a day would result in immunity to snake bites. Modern medicine has fortunately discarded such treatment.

Ectoparasites show no deferential regard for persons. They will attack the rich as well as the poor, and though certain ones, such as lice, are found in greatest numbers where association with careless people cannot be avoided and facilities for cleanliness are not all that could be desired, they all seem to enjoy tickling and feeding upon any human host that comes along. Lice act as vectors for several diseases — notably typhus fever, trench fever, and bubonic plague. Lice do not transmit

plague by their bites, but may do so when crushed near an abrasion in the skin. When nations are at war, lice enlarge their acquaintanceship extensively. During World War I, head and body lice were present, it seemed, everywhere and the soldiers referred to them as "cooties." (Some may recall the parody during World War I on the popular song, "K - K - K - Katy, you're the only g-g-g-girl that I adore;" the soldiers sang it "C-C-C-Cootie, you're the only b-b-b-bug that I abhore.")

I started my own collection of graybacks fairly early in life, six years of age to be exact, from a good friend—a wayfarer—a knight of the road—known to me only as the "Keeper of the Bees." I know he was the Keeper of the Bees for he had told me so when seated on his knee in the village park and listening to some very interesting tales, I had seen and warned him against the "bees" crawling on his chest and in his beard. He had said, "Don't worry, sonny, I am the Keeper of the Bees." I have often wondered whatever became of the Keeper of the Bees. I never got to talk to him but once. My mother saw to that.

Another ectoparasitic insect which can be a very annoying pest and not infrequently interferes with the sleep of man is the flea. David Harum states, "A reasonable amount of fleas is good for a dog. They keep him from broodin' on bein' a dog." Anyone who has had his home infested with fleas will testify, I feel sure, that even a few fleas feasting on one's ankles and ribs, is of itself sufficient cause for brooding. As a vector the flea is connected with the transmission and spread of such diseases as bubonic plague, endemic typhus, tularemia and tapeworm disease.

The ticks and the mites in their ectoparasitic habits can cause man much misery. Tick bites are quite painful and can be very serious, even leading to a condition known as tick paralysis in cases where the bite is near the central nervous system. Ticks, of course, are instrumental in the spread of such diseases as Rocky Mountain spotted fever, Texas fever, and tularemia. Of the mites, perhaps the greatest tormentor is *Sarcoptes scabiei*, the itch mite. The female of this species burrows into the skin and excavates thin, tortuous tunnels. She lays her eggs which in a relatively short time hatch into young larval mites. As the young develop they are quite active and build burrows for themselves. The itching is intense and may be continuous and almost unbearable. Because of the intracutaneous burrows, elimination of these tiny ectoparasites is not easy.

Important as arthropods are as ectoparasites or bloodsuckers, it is in their capacity as carriers of etiological agents of disease, or as intermediate hosts of other parasites, that they should be reckoned with as among the foremost of human foes. One needs certainly to exercise vigilance against these pests and carriers of tiny, murderous organisms. It is not enough to swat the fly and mosquito, screen our places of business and residence, spread insecticides in the cracks and crevices of our abodes. These and other immediate prophylactic measures are known to most of us. There must be, if we are to realize gain over

the world of parasites, cooperative measures established to attack these forms in various stages of their life cycles and a widespread exposure to knowledge concerning parasites and factors concerned in their transmission. Sometimes we may feel that we can see the beginning of the end of hostilities among races of man. This would be a great achievement. Achieving supremacy over the seemingly endless hordes of wee beasties presents us with another great challenge demanding the best in knowledge and skill to bring about further amelioration of pain and suffering, better general health, and greater happiness for mankind.

Parasitological Prophylaxes

or

Advice to Those Who Would be Somebody and Have Some Body

Beware of amoebas in kisses
And flagellates hiding on lips
Your innards may house many beasties
Trichina, Plasmodium and Tryp's.
Daily baths, which have slowly supplanted
Accidental immersion in creeks,
Are a sound prophylactic measure
For more of the body than cheeks.
In the eternal strife for survival
The beasties make war to no end
Infestation of forested regions
Is P. pubis' great dividend.
Ecto — Endo, whatever the nature,
On and on the relationship goes,
Twixt the tiny intransigent beastie,
And man, from his head to his toes.
Ostentatious, supercilious vector,
A very great being thinks she,
Beware of her beautiful structure
And assiduous tenacity.
Anopheles, Pulex, and tsetse
Pediculus, the tick and the mite,
Always seeking free board—transportation
In their vicious, sanguinolent fight.
Sanitation—precaution are symbols
Denoting defense of our clan,
Lest we give up the field to the beasties
Let's remember to do what we can.
Wash your hands, cook your food before eating,
Keep your premises clean if you please,
When in public beware of the coughing
And the showering effect of the sneeze.
If a symptom appears, see a Doctor
Not the fraudulent quack charlatan
But an honest to goodness physician
Who'll proceed to see justice is done.
Then if flagellate, ciliate, spirillum
Amoeba, flea, flatworm or fly
Gains a bridgehead toward inland invasion
You'll find it less easy to die.

W. W. Wantland