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THE NEEDS AND OPPORTUNITIES IN PARASITOLOGY[1]

IN these days of many organizations and calls for service in so many directions where work and workers are clearly needed, the formation of any new society can be justified only on the basis of imperative necessity. Such a necessity may be evidenced by the importance of the topic and a rapidly growing content of special knowledge; or the increase in the number of workers in the special field may demand some means of discussing and coordinating the service which this field can render. Yet, if all this be true, the demand can be justified not merely because it is so imperative at the moment that it can not be resisted, but rather that it gives clear promise of continuing future opportunity and need. Otherwise science will not jutisfy the waste of time and the dissipation of energy which should rightly be devoted to more permanent ends.

Now all these conditions are satisfied in full measure by the facts in the field of parasitology to-day. Indeed the situation seemed clear some years ago to those who were working in this particular line, but in common with others I resisted the movement for the organization of a new special society in the effort to achieve the necessary results through cooperation with existing agencies. But that affiliation did not prove adequate to meet the needs which were growing with startling rapidity, and one may say justly that the formation of the new American Society of Parasitologists was forced on us by the pressure of circumstance.

Substantial justification of this action is found in the fact that to-day the membership roll includes more than three hundred names, although the society has not passed its first birthday, and that it brings together at this meeting about one sixth of that membership for active participation in the work of the organization. This is a record rarely if ever equalled in a national society with a membership which covers in fact the length and breadth of our country and even goes beyond those limits. Surely the membership may properly be called active and the organization justified from the standpoint of numbers and interest. Did time permit, further justification would appear in a survey of the number of courses on the demand for such instructions from students in

[1] Address of the President read at the first annual meeting of the American Society of Parasitologists, Kansas City, Dec. 30, 1925.

parasitology introduced into colleges and universities, general, medical and veterinary science, the long list of teachers and researchers engaged in developing the subject and the widespread interest in the work and its results.

Even though workers in parasitology know the magnitude and richness of the field, it may be worth while to review here in brief some facts that illustrate the task which the society has undertaken. The subject of parasitology goes back for its beginnings to the very earliest days of history. Among the first records preserved for us in writings of antiquity are evidences that the human race was afflicted then by some of the familiar parasites of to-day. The blood fluke of the Egyptians, the fiery serpent of the wilderness, the Ascaris and other conspicuous forms are discussed at length in the records of those early days.

But however definitely man may have recognized the presence of some such organisms, very little was known of the range of parasitic life or of its rôle in the causation of disease, both in man and other animals, until very recent times. To be sure, the last century accumulated a considerable mass of evidence concerning the occurrence of the larger parasites and some facts concerning their structure and biology; but it was left for this century to elucidate the complexities in life histories which made the subject so incomprehensible to students of biology fifty years ago, and to furnish thereby the methods by which the spread of these organisms can be arrested and the losses incident to them prevented. Seventy-five years ago the life history of trichina was worked out and the way found for avoiding the epidemics of trichinosis that were prevalent in those days. It is exactly forty-five years since Laveran demonstrated the presence in the blood of the malarial organism and enabled science to take the first step in the solution of the malaria problem. But instances as old as this are in reality few. The growth of parasitology belongs to the twentieth century.

It is just twenty-five years since Grassi published his famous "Studies of a Zoologist on Malaria," and the opening days of the present century saw the demonstration of the life-cycle of the malarial organism in the mosquito and of the method of transmission through that type of insect. It is just twenty-four years ago that the famous Yellow Fever Commission, headed by Dr. Walter Reed, with his associates, Drs. Carroll, Lazear and Agramonte, started in Cuba the series of experiments which led to the demonstration of the method by which that disease was transmitted. Out of this discovery have grown measures which have all but exterminated yellow fever from the surface of the earth. Such illustrations could be multiplied, but time does not permit. It may rightly be said that parasitology is in a real sense the product of the twentieth century.

It is fitting to introduce here a few words on the part of our country in this work. Despite the newness of the field and previous lack of organized effort in the United States, workers here have contributed in most significant fashion to the marvelous discoveries which have opened up this field, and have played an important part in the solution of the problems which have commanded the attention of investigators in these recent years. In another connection I have discussed the pioneer work of Dr. Joseph Leidy, who, studying practically alone in this field, added so richly to our knowledge of parasitic species and deservedly is recognized as the founder of American parasitology. In these later years of the twentieth century contributions have come from a series of workers. It was MacCallum who first described certain phases in the sexual cycle of the malarial organism and thereby contributed an indispensable element to the solution of the malarial problem. It was Stiles' acumen in distinguishing Necator that brought clarity into the hookworm problem. By experiment that ultimately cost him his life, Walter Reed demonstrated the rôle of the mosquito in transmitting yellow fever. The work of Howard Taylor Ricketts, again at the cost on his part of the supreme sacrifice, contributed to the knowledge of typhus and made it possible to save thousands of lives in the armies and among the people of later days. It was Noguchi who laid the keystone in the arch of discovery for yellow fever by demonstrating the nature of the causal organism.

Even more in the application of these discoveries, perhaps, than in their demonstration, has this country performed a service of which it may well be proud. The work of the Rockefeller Institute in prosecuting researches in malaria, hookworm and yellow fever, in organizing campaigns for the limitation and ultimate extermination of these diseases and in extending this activity beyond the limits of our own country to embrace the four corners of the earth, has utilized the services of parasitologists and the rapidly growing knowledge of that field in outstanding fashion for the service of the nation and the world.

It is not necessary before an audience like this to recount the contributions of parasitology to human and comparative medicine. Researchers in parasitology have contributed in large degree to the suppression of disease and the welfare of humanity. These contributions have been most conspicuously utilized in the tropics and so have given a material basis for the association of parasitology with the field of tropical medicine. One can not question the justification of such a connection. Parasitic diseases

are rampant in tropical regions and by their frequency and virulence have set a limit to the utilization of tropical resources; by their presence the white man has been practically excluded from the most fertile areas on the surface of the earth and the population of these regions has been restricted to small numbers of primitive peoples who have not been able to develop a type of civilization equal to that which obtains in temperate climes.

In recent years the conviction has been growing that the importance of parasitology is not limited to the Tropics but extends far beyond those regions. A record of the cases of amoebiasis treated at the Mayo Clinic shows that the disease has originated in all the northern states, including also Canada and Alaska. Far from being limited to tropical regions, this complaint extends to the northern limits of human residence, wherever the social conditions are favorable to its inception and transmission. Before the cause and the method of transmission of yellow fever was known this dread disease ravaged Illinois and even Philadelphia, as it did in the last century. This can never occur again. The bubonic plague, which in centuries past has swept around the earth at regular intervals and has exacted a terrible toll of human life, can now be met at the border of the nation with confidence that the scientific knowledge in possession of sanitary officials is adequate to arrest its spread and protect the people against its ravages. *Parasitology is a world topic.*

One may with apparent justice charge that this account has concerned itself up to the present moment with the achievements of the past rather than the needs and opportunities for the future. Yet the picture of the past, even if sketched only in barest outline as has been done here, gives promise of the future. The record of a few species in which the work of our precursors is shown so brilliantly stands out all the more conspicuously because of the lack of definite knowledge concerning the many related or associated species which have not been studied. The oft-repeated experiences of others have demonstrated the need of extreme caution in observation and inference. Even the most distinguished of parasitologists a generation ago confused species like Opisthorchis and Dicrocoelium that in fact differ rather strikingly in structure. In the celebrated case of the English schoolship Cornwall, failure to diagnose correctly a small nematode all but precipitated a political upheaval. Similar cases of confusion of much more recent date obscure the literature of parasitology to-day and serve to demonstrate that the urgent need of the present is greater accuracy, more precise determination of the facts based on more prolonged and exact study of the material. We have all of us been guilty of high crimes and misdemeanors of this type and I for one am glad that an increased number of workers with a growing supply of contributions will force more exact consideration of the worth of each particular study and afford more immediate critical examination of the results obtained by any worker.

It is wise to point out here in particular fashion how the situation affects the progress of parasitology. If one errs in naming the species of free-living flat worm, which is under observation, the result is not very serious, but if the structure, life history or biology of a parasite be the subject of the investigation, a similar error may introduce serious confusion in the diagnosis of the disease caused by it, the use of anthelmintics in treatment or the application of preventive measures. All these conditions are real and not supposititious and each of them may be illustrated by definite examples.

In considering the human parasites which have been probably more carefully scrutinized as a group than any other set of species, one still finds great uncertainty as to general features of size and form, and many of the doubts would not have arisen if the earlier authors had exercised greater care in observing and recording the facts. A comparison of twenty text-books demonstrated numerous important discrepancies in the technical descriptions of the chief species of the flukes found in man. There is real need of extended morphological studies, even on well-known species of parasites, and a wealth of forms remain as yet entirely undescribed. In respect to biological features and to life histories the situation is much more striking. In the main we must depend on knowledge of the life cycle and of the habits of a parasite to furnish a foundation for the plans of attack upon it. And if information be imperfect or lacking, successful methods of preventing parasitic diseases can rarely be devised.

The lack of exact knowledge on an important relation between parasite and host is well illustrated by the case of the pinworm, *Oxyuris vermicularis*. It is nearly two centuries since Fabricius (1634) recorded the presence of this parasite in the human appendix vermiformis and similar observations recur in the literature frequently for more than one hundred and fifty years after that before the distinguished Metchnikoff (1901) emphasized the significance of this occurrence and assigned definitely to the parasite a causal rôle in appendicitis. Little serious consideration has been devoted to Metchnikoff's suggestion. More than twenty years ago I sent to several surgeons a personal appeal for excised appendices, stating that I was very anxious to test this supposed relation. I did not secure a single specimen. Why? Not that my correspondents were

unfriendly, quite the contrary, some of them were much interested and went to the trouble to write at length in order to explain to a young man the improbability of such a relation. The pinworm was too uncommon, its presence in the appendix was very unlikely, and even if it should be there it could not give rise to ulcerations of the intestinal wall. In evidence of all these contentions they cited the writings of parasitologists and authoritative texts on medicine. In consequence my project was abandoned.

The question has been argued extensively, but only in very recent years has it been studied. In 1920 Rheidorf carried out an exhaustive histological and pathological study of the intestinal mucosa which led him to the conclusion that the pinworm played an important part in the causation of many cases clinically recognized as appendicitis. Others have followed him with further evidence on the relation. Moreover, on the question of frequency Japha (1925) has just published a really careful investigation on the presence of Oxyuris in school children. In the place of a frequency of 20 to 33 per cent. given by early writers, he finds from 64 to 86 per cent. with an average of 73 per cent. in a city population in Europe. His figures are confirmed by other records of examinations on city school children and are contrasted with much lower percentages among country school children.

In comparison with these figures from the Old World may be brought forward those obtained in a study of hospital cases in this country made last year by Harris and Browne (1925). They found in one uninterrupted sequence of 121 cases of operative appendicitis that *Oxyuris vermicularis* occurred in twenty-two of the appendices removed. They say further: "The failure to recognize Oxyuris as a factor in the production of appendicitis is due in general to lack of detailed gross and microscopic study of the appendix. . . . The observations on record of the frequent relationship of Oxyuris to appendicitis justify a more general and thorough study of the subject."

How is the desired accuracy to be obtained? Some workers have sought to gain it by introducing for parasites trinomial designations. We deceive ourselves if we forget that precision is not achieved by means of words. The use of varietal names has no justification to-day in parasitology. In the present state of knowledge such designations are really due to inexactness. The author either had an imperfect picture of the original or an incomplete conception of his own specimens, so that the comparison in his mind was hazy and he sought to express this condition by refusing to decide whether the parasite being studied was new or old. He called it a variety and thus found an easy escape from arduous mental labor, but left the real scientific problem for some more capable successor.

Equally unfortunate in my opinion is the tendency, which is spreading, to devote much energy to the interpretation of ancient writings and at one's desk to determine by logical analysis of the text what one of the worthies of a century or more ago had in mind when he wrote a two-line description that in fact might belong to several species, known or unknown. Desk work has a clearly subordinate value in biology and neither in teaching nor in research shall we make adequate progress unless we follow the admonition of Agassiz and stick to our specimens until we know them.

The case of the pinworm discussed a few moments ago is only one of several that might be cited to show the opportunities for study of human parasites among the dwellers in cities where conditions have been most studied and are best controlled. If there are serious gaps in our knowledge of the presence of human parasites among city dwellers what shall be said of the situation in the smaller communities and in the country? There medical service is not fortified by hospitals, laboratories, clinical assistants and skilled technicians. Even the routine tests which are common in city practice are limited under the conditions of country practice, and often none are made. But the circumstances of country life expose the individual to new chances of infection from species which are wanting in the city. In the crowded life of the city infection comes chiefly from personal contact or from food and drink. While various measures, such as sewage systems, food inspection and water supply systems, are installed and maintained at great expense, the dangers of massing population and of defects in construction or management of the municipal systems are always present; and from the crowding and the failures of his protective measures the city man acquires in the main his parasitic infections and consequent diseases. To be sure, his pets are still to be considered. Since the passing of the horse, cats and dogs are the only domestic animals with which the city dweller comes much in contact. Now we know that cats and in even greater degree dogs are disseminators of parasites which are inimical to human welfare. Here again the fact is generally well established, even though more exact data are desirable. Stray dogs and cats exist in considerable numbers in our cities and in their wanderings in search of food distribute widely several types of animal parasites which threaten to infect the human species. While the stray animals are most deeply involved in the general distribution of such parasites, mention should be made of the fact that a few parasitic species, like

Dipylidium caninum, are extremely abundant in house dogs, and through the agency of such pets are transferred to children.

But on the whole the contact of the city man with domestic animals is so limited that it stands in sharp contrast with the situation in the country, where domestic animals of many sorts are abundant and man is in intimate and constant contact with them. Furthermore, no organized safeguards protect supplies of food and drink and chances of contamination are frequent. This menace is not so much from human contamination, although that is well known to exist in significant measure. The danger comes prominently from contamination due to domestic animals. The parasitologist would say in advance that here was a real menace to human health, but the question has really never been studied at all. What we know is based on very few observations and is supported at most by probability. It affords a new and promising opportunity for scientific research in parasitology.

A single case will suffice to illustrate the situation. *Ascaris lumbricoides,* the stomach worm of children and of hogs, is considered as a rare parasite of the human species in civilized regions and of consequently little importance except in those distant primitive communities of the tropics where its abundance in man is plainly recognized. Even in hogs, where it is very common in our own region, it has been considered in the past of little importance from the practical standpoint. Within very recent years several investigators have worked out together its life history. In this study the prominent part was taken by one of our own members, Dr. Brayton H. Ransom, of the U. S. Bureau of Animal Industry, whose untimely death last September was such a blow to many of us, endeared as he was to us by years of intimate personal contact, and also such a loss to our science and the country that he served so quietly and so well.

The life cycle of Ascaris includes as the initial part of its career in the host a migration from the intestines to the lungs and produces thereby a disturbance in young pigs known as thumps. This disease is serious and causes great economic losses every year in regions where raising hogs is an important industry. The elucidation of the complex conditions in the life cycle of the parasite, of the serious effects it has on the host organism, and of the method by which the parasites may be greatly reduced in numbers if not entirely exterminated, form one of the most brilliant chapters in the history of parasitological research and these discoveries will stand as a permanent memorial to the keen intellect, the careful work and the dogged determination of Brayton H. Ransom.

But what of the possible relation of this same parasite to the human host? The problem is one that concerns directly the country population. The pig and the parasite are everywhere abundant in the country, even in the most favorite parts of our region. The eggs of Ascaris are highly resistant, they are distributed widely by the movements of men and animals, and even by the action of wind and waters. The opportunity for human infection is always ready at hand and the chance of infection is evidently greatest in childhood. The parasite follows out in the human host the same migration through the tissues into the lungs and gives rise to the same symptoms that have been demonstrated in the case of the hog. How abundant is it in man and especially in children in the country? No one knows. One can not doubt that if present, its effects would be serious, directly in proportion to its numbers. It may easily be the cause of attacks of disease of a type now designated as indefinite and obscure because the cause has not been recognized and the symptom complex adequately analyzed.

Some parasitologists have maintained that the Ascaris parasitic in the pig is a different species from that found in man; thus far no one has demonstrated differences in structure or in physiological activities that would establish such a view, and final proof is needed. This question is important and constitutes one phase of the Ascaris problem which appears in the light of present knowledge a most fruitful topic for investigation, but after all only one of the numerous interesting problems in the relation of the country dweller to his environment.

As I proceed with this discussion the subject opens out before me like the road across the plains where each mile appears only to add to the length of the highway stretching out to the distant horizon; but the time to stop and make camp is surely nearer at hand. It has been a difficult task to select from the wealth of available material a few items to illustrate my thoughts, and all of you can add instances of equal or even more striking character. The few that I have selected have left scant time even to mention other great phases of the subject on which we are working. The contributions of parasitology to comparative medicine have been no less striking if somewhat lower in personal import than those made to human medicine. The two phases of the subject are so intimately interwoven that no natural separation can be found. Many parasites are transferred from man to other animals and *vice versa.* Problems of the frequency, distribution, virulence and prevention of human parasitic diseases involve concurrent consideration of numerous other species of animals from snails to man. But I must forego the pleasure of discussing further this interesting subject as well as the

equally remarkable records of parasitological research on all sorts of animals from amoeba to man.

The significance of studies in parasitology is by no means limited to the fields I have been discussing. Such studies have been shown to have a direct bearing in individual cases on problems of pure science, such as phylogenetic relationships, distribution and the origin of the parasites and their hosts. Kellogg's work on Mallophaga ultimately led to the demonstration of relations between groups of birds which taxonomists had suspected but had not been able to establish on structural evidence. Metcalf's studies on Opalina, a parasite of the frog, forced him to conclude that a previous land connection had existed between South America and Australia. There has been found in the record of the parasites of the salmon, clear evidence that these royal fish are oceanic in origin and that the freshwater migration is a secondary episode in the history of the race.

In a remarkable paper, published after his death, our late deeply lamented vice-president, Dr. S. T. Darling, wrote on "Comparative Helminthology as as Aid in the Solution of Ethnological Problems." Darling advanced the view that it is possible to trace the origin and migration of races of mankind through a study of the species of hookworm which man has harbored in different regions on the earth's surface. The evidence adduced from a study of the two chief species of hookworm, species which in fact are confined to the human host, shows that their distribution depends on the migration of their hosts and not on climate or soil. The world-wide contact which Darling had had with the hookworm problem gave unusual opportunity for securing evidence on the distribution of these parasites in different races. He observed that pure cultures of one species tended to be found in certain ethnic stocks and in certain geographic areas as well. By a careful analysis of the data he traced the origins and movements of primitive peoples in a way that seems at once to confirm and to check the views of those who have attacked the problems from other sides.

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THE SCOPE OF INORGANIC CHEMISTRY. II

PETROLEUM

The complex hydrocarbons which form the main constituents of crude petroleum belong to a section of organic chemistry at present too little explored. Although many millions have been made through the production and sale of petroleum products, it is safe to say that the percentage of profit devoted to research in oil products has been infinitesimal. It is true that in the United States large sums are given by the oil interests towards research in other subjects, but until quite recently none of these was, curiously enough, given for the purpose of improving our knowledge of the science on which the utilization and isolation of petroleum products depends. The reason is not far to seek. The apparently inexhaustible supplies of petroleum render it unnecessary to devise means for economical working. The crudest and most wasteful methods were employed, because economy and the conservation of the natural product were not paying propositions. This applies not only to the methods used in fractionization, but to those employed for the purpose of "cracking" the higher boiling fractions into liquids of lower boiling point. For at the present moment it is the fraction up to 200° C. which is the important product, because it is the "petrol" of the internal combustion engine. Time was, before the introduction of this particular machine, when the light fraction from crude petroleum was a drug on the market, and in many cases was actually set on fire at the refinery because no use could be found for it. In those days the chief product was the kerosene fraction which was used as lamp oil. At the present time the rapid increase in the use of the motor car for personal and commercial transport indicates that at no distant period, if progress continues to be made in the same direction, the amount of the "petrol" fraction will be insufficient for the world's needs. This point has already been reached in America, where approximately 70 per cent. of the world's consumption of petrol (gasoline) is effected. During 1925 the consumption of petrol in the U. S. A. approached 800,000,000 gallons a month, which is about twelve times the amount consumed in this country. It has been stated that one in every five persons in the States—men, women and children—possesses a motor car,[4] and, be this as it may, it is evident that to meet such a colossal consumption means have to be found to utilize the higher boiling fractions, and indeed even the residues from the distillation processes. This "cracking" operation is now carried out on an enormous scale by numerous processes, all subject to patents, but differing from one another but slightly on the question of principle. All depend on the well-established fact that hydrocarbons of high molecular weight will break down into those of lower molecular weight if they are subjected to the requisite degree of temperature. Pressure appears to play an important part in the character of the product, as does also the surface action of the container or material used in the container to promote surface action. All

[4] Cars registered on January 1, 1925, were: U. S. A., 17,591,981; Canada, 638,794; Great Britain, 1,094,534.