

## The Relation of Zoology to Medicine, Veterinary Science and Agriculture.\*

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FOR the study of the Animal Kingdom as a living unit, pure zoological studies, in which various animal types are taken in sequence and studied more or less separately with a view to getting some knowledge of the intricacies of the Animal World, have to be supplemented with a knowledge of the biological and ecological factors. Earlier trend in regard to zoological studies consisted, in the main, in detailed investigations of animals from the point of view of their anatomy, morphology and histology, their relationships with one another, their geographical distribution, their systematics, and, to a limited extent, their ecological relationships with one another, man and the Plant Kingdom. At the present day, however, much greater attention is being paid to the elucidation of biological and ecological factors, which often includes a great deal of experimental work. For all such studies, however, the work of the systematist is of prime importance. The very large number of species of the different classes of animals necessitates a careful survey and acquaintance with the different species. The vast nature of this problem can be roughly gauged from the tentative numbers of animal species which Clark estimates as follows: "The mere recitation of the names of the insects already known to us at the rate of four a minute for eight hours every day would require about ten months, and nearly three months additional would be required to name the remaining forms of animal life." The name of an animal, however, is nothing more than a key to its position in the Animal Kingdom and its probable relationships, with a possible clue to where in literature one should look for further information in regard to the particular species of animal under consideration.

Compared with most living creatures, man is relatively a new-comer on the face of the earth, for, even according to the most liberal estimates, primitive man did not appear till about a million years ago. All the same, man's interrelationships with the plant and the animal world are extraordinarily numerous and intricate. In the earlier stages of man's existence his relations with, at least, the larger animals were those of direct competition in a very keen struggle for existence. The animals supplied the major part of his food, his primitive clothing and other products for his very simple life. Later, however, when man assumed a greater mastery over the surroundings in which he lived, he, in addition to agriculture, took to domesticating certain classes of animals for making them his helpmates and companions. Several of them, such as the cattle and the horse, not only proved invaluable in connection with the advance of civilization, but made it possible for man gradually to occupy the proud position which he holds on the face of the earth to-day. Agriculture, which formed one of the main foundation-stones of his social edifice, was rendered possible by the domestic cattle, and even such insignificant animals as the earthworm and several classes of insects, birds, etc., are of infinite importance in this connection.

It is not possible to discuss here in any detail the importance of various classes of animals to one another, to man, and the plant life in general, but detailed biological and ecological studies carried out all over the world during the past 50 years or so have clearly demonstrated the great interdependence of plants and animals on one another, and how a large number of animals influence domestic animals, food-crops, fruit trees, etc., which are so essential for the existence of human life on the face of the earth. Details of some of these at least will be discussed by agriculturists, entomologists, medical men and others who have made a special study of these problems,

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\* Opening remarks in a discussion of the Sections of Zoology, Medical Research, Veterinary Research, Entomology and Agriculture in the Silver Jubilee Session of the Indian Science Congress Association, Calcutta, 1938.

and I, therefore, propose only to touch on a few of the general problems in this connection.

These general problems of the relationships of Zoology to Medicine, Veterinary Science and Agriculture, to which our discussion to-day is limited, are more or less similar and it is not necessary, therefore, to deal with them separately. The great achievements of Chemistry and Physics in the service of mankind and therefore, in reference to the advancement of civilization are well known to you all, but few of us recognise how even the somewhat superficial knowledge of the intricate laws of biology has helped in ameliorating the struggle of existence for man by providing increased supplies of food materials, by combating several dread diseases and thus making it possible for man and his domestic animals to lead longer and healthier lives, and finally by its valuable contributions to human culture and philosophy.

In a report on Economic Zoology, the late Sir Ray Lankaster divided animals in relation to man into 8 groups: 1. Edible animals, 2. Animal products, 3. Domesticated animals, 4. Animals which help in man's operations, 5. Direct enemies of mankind, 6. Indirectly injurious animals, 7. Animals that destroy man's property and stores, and 8. Man's indirect friends. Important as the edible animals and various animal products are, we need not consider them here to-day. Domesticated animals, animals which are of help to man directly or indirectly, and his indirect friends are useful to man in connection with agriculture, animal husbandry, etc., while the importance of a detailed knowledge of the direct enemies of mankind and domestic animals, the indirectly injurious animals and those that destroy man's property and stores to the allied branches of Medicine, Veterinary Science and Agriculture is incalculable.

Among the direct enemies of mankind and domestic animals, those of special importance in connection with Medicine, Veterinary Science and Agriculture are the parasites which are bionomically classed as temporary, permanent, facultative and obligate parasites or, according to their position in reference to the host, as external and internal parasites. According to Eccles,

the number of such parasites is, "more than half of all the animal creation". According to his studies of germ diseases, almost all animals harbour a great number of parasites and these, in turn, are themselves infected by other parasites. This condition is well expressed by the quatrain:

"The little fleas which us do tease  
Have other fleas to bite 'em,  
And these in turn have other fleas,  
And so—*ad infinitum*."

All of us feel very proud of the achievements of Medicine in combating several very dreadful diseases of both man and animals, but it is seldom realized that in all such work the rôle of Zoology has been of paramount importance. Even as late as 1879 when Manson by his brilliant discoveries again brought to the forefront for medical research workers the part played by various animal parasites and carriers of diseases, such animals were regarded merely "with dislike or disgust, as irritating pests or as loathsome parasites". Since this date, however, their influence in the domains of human and animal pathology as the causative agents of several diseases, as carriers and agencies for spreading infections and as aggressively or defensively harmful animals has begun to be fully recognised.

Animal parasites of importance in connection with Medicine, Veterinary Science and Agriculture may, according to the class they belong to, be considered under the headings, (1) Protozoa, (2) Helminths, and (3) Arthropods.

*Protozoa*.—Though the number of Protozoa which are harmful to their hosts is comparatively small, they are responsible for some very serious and widespread diseases of both man and animals, such as Malaria, Kala-azar, Sleeping Sickness, Red-water Fever, East-coast Fever, etc., etc. Man and all domesticated animals are susceptible to infection by protozoan parasites, and with our increasing knowledge of the number of hosts and diversity of parasites with which each host may be infested, the subject has assumed a great deal of importance for both medical and veterinary research workers. The reason why these protozoal diseases are of greater importance in tropical countries like India is not because man and animals living

in such areas are themselves more susceptible to the effects of infection, but because of the greater possibilities of transmission of such diseases by the prepondering numbers of intermediate hosts or vectors, usually biting flies or ticks. The mode of transmission of such diseases is thus entirely different from that of direct contact infection as with most bacterial or virus diseases. Great advances have been made in India in regard to our knowledge of the life-histories and modes of transmission of several types of fevers, Kala-azar, Typhus, Sandfly Fever, Dengue, etc., of man and of Surra, Dourine, Bovine and Canine Piroplasmoses, Theileriasis, Anaplasmosis, Leishmaniasis, Spirochætosis, etc., of the different domestic animals. Our knowledge of the vectors of such diseases has also materially advanced, but a great deal still remains to be done and it is in this connection that a close co-operation of teams of research workers, including zoologists, medical men, veterinarians, botanists, biochemists, etc., is essential before the life-histories of the diseases can be fully elucidated and proper remedial measures effectively evolved and applied.

*Helminths.*—The parasitic worms responsible for the helminthic diseases of man and animals have assumed a much greater importance within the last quarter of a century or so. A great deal of systematic work has been carried out in this country on the different species of Nematodes, Cestodes and Trematodes, but our knowledge of the life-histories and modes of transmission of a majority of these forms is still very meagre. With regard to the helminthic parasites of man, infection by which takes place through vectors, a great deal of work has been carried out in connection with Filariasis which is one of the most widespread human helminthic diseases in the country. Detailed biological work has shown that there are two types of infection of Filariasis in this country, one of *Wuchereria bancrofti* which is transmitted by the mosquito *Cules fatigans* and the other of *Filaria malayi* which is transmitted by mosquitoes of the genus *Mansonioides*. As the methods of control for the two species of mosquitoes responsible for the two types of infection are quite different, the biological methods of control for the two types of disease are, as has been

shown by various workers, also necessarily different. The helminthic diseases of animals in the country are fairly numerous; of these, mention may be made of flukes of the genus *Schistosoma* which are responsible for a number of diseases of domestic animals, such as Bovine Nasal Granuloma, diseases due to *Schistosoma indicum* (Hepatic Cirrhosis of horses), *Bursati* (Hæmorrhagic granuloma), Hump sore, etc., all of which are due to various helminthic parasites. A thorough knowledge of the life-histories of the parasites in all these cases is necessary for devising means to check these diseases, and in this connection collaboration between zoologists and veterinary specialists is absolutely essential. Reference may also be made here to the Eel-worm, *Tylenchus angustus*, which has been shown by Butler and others to be responsible for the serious disease *Ufra* of paddy in this country. This eel-worm is amazingly resistant, being able to live at least 8 months if fully dried and 2 months if fully immersed in water. This disease is responsible for a great deal of financial loss to agriculturists, and until the life-history of the causative agent is fully worked out, efficient methods for its control cannot be devised.

*Anthropods.*—The importance of several genera and species of Anthropods as vectors of various diseases of man, animals and in connection with agriculture need not be stressed upon. A great deal of work for the control of various diseases has been directed towards the elucidation of the life-histories of the various vectors and that part of the life-history of the pests which is passed in these vectors. In reference to human pathology, mention may be made of Malaria, Kala-azar and Bubonic Plague. With reference to Malaria, our information to-day is very extensive and studies based on a detailed knowledge of the life-history and distribution of the various species of *Anopheles* in the country have enabled the Public Health authorities to adopt measures for checking and ameliorating this disease. In regard to Kala-azar, the researches by the Kala-azar Commission and the authorities of the Calcutta School of Tropical Medicine have conclusively proved that the Sandfly, *P. argentipes*, is probably the sole transmitter of Kala-azar in India, but all attempts

to infect man artificially by infected flies have so far proved abortive. In regard to Plague, the importance of the fleas of the genus *Xenopsylla* as carriers of the disease from rat to man has been fully established and it has been found that *X. cheopis* has far greater plague-carrying powers than *X. astia* or *X. brasiliensis*. A knowledge of the comparative prevalence of the different species of fleas of the genus in different areas would enable the Public Health authorities to gauge the exact situation in reference to this disease. For example, it has been found that absence of Plague in Madras City is due to the fact that the *astia* index in Madras is nearly 100 per cent, whereas in the infected areas in Bombay it is the *cheopis* index that is really high. All the same, our knowledge in reference to these forms is not quite complete, for Barraud found that both *X. cheopis* and *X. astia* are present in Assam, yet Assam has been remarkably free from Plague.

With regard to Veterinary Entomology a fair amount of work has been carried out in India, but a great deal still remains to be done and this is the reason why it has not been possible for the Veterinary authorities to evolve efficient measures for the control of various diseases of domestic animals for which Arthropods act as vectors.

The importance of insect pests to Agriculture will, I hope, be dealt with in detail by other speakers, and I need, therefore, only mention some of the more harmful species found in India: Locusts, various cotton pests such as the spotted bollworm, pink bollworm, cotton white fly, stem weevil, etc., borer parasites of sugarcane such as the top-shoot borer, stem-borer, root borer, etc., and a large number of

pests of fruit trees such as the San Jose Scale, various genera and species of hoppers, etc. All these cause a great deal of damage to the different agricultural crops and fruit trees in the country.

Among the various methods of combating the parasitic and other harmful species of animals, the methods of biological control have of recent times assumed much greater importance than was hitherto assigned to them. As Sweetman, however, rightly points out, "While it is possible that one organism may not only control but eradicate another, our present knowledge of the fundamentals of biological control does not warrant undertaking eradication on a commercial scale by the biological method. This idea is worthy of consideration, however, and should not be excluded from our minds when carrying out experimental work." Further, since "the complex of environmental conditions responsible for the control of pests may vary in composition, both quantitatively and qualitatively, in different parts of the area inhabited by the species . . . the measures necessary to re-establish control in the case of an outbreak will vary also in different times and places." The method of biological control has many advantages but with our present knowledge it is not possible to apply it successfully against all pests.

In this short resumé I have only touched on the main problems which are of importance to man in his struggle for existence in connection with which the sister sciences of Medicine, Veterinary Research and Agriculture come into close contact with Zoology. The problems awaiting investigation in India are numerous, while the number of workers is unfortunately far from sufficient.