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THE CONTRIBUTION OF ZOOLOGY TO HUMAN WELFARE¹

AT the Philadelphia meeting of the American Association for the Advancement of Science, Convocation Week, 1914-15, there was held, under the auspices of the American Society of Naturalists, a symposium entitled "The Value of Zoology to Humanity." I was, unfortunately, very busy with the affairs of the general association and was unable to attend this symposium. There were four papers presented. The first of these is printed in SCIENCE for March 5, 1915, and is entitled "The Cultural Value of Zoology." The address was given by Professor E. G. Conklin, of Princeton. It is a very readable address, full of interest, containing much of that delicate humor characteristic of Professor Conklin, and possibly rises nearly to the exact height demanded by the title. But it is not a zoological address, in spite of its title. It is broader, and comprehends all biology. It is divided into two headings: (1) "Contributions of Biology to Education"; (2) "Contributions of Biology to Civilization." Under the first heading he dwells upon the immense enthusiasm and intense concentration of the biologist in his work, touching upon the evil effects of over-specialization and referring to the few great leaders in biology who have become interpreters to the plain people—men like Huxley, Galton, Metchnikoff and Forel, who have applied the teachings of biology to social problems.

¹ Read before Section F (Zoology) of the American Association for the Advancement of Science in a Symposium upon "The Contributions of Zoology to Human Welfare," Pittsburgh, Pa., December 31, 1917.

He then dwells upon the powers of observation and imagination of the biologist, and the unique place which biology occupies among all the sciences in its cultivation of esthetic appreciation and broad sympathies. He admits that these elements of personal culture are not absolutely distinctive of the biologist, and that "some good men in other fields are biologists gone astray."

Among the contributions of biology to civilization, he refers to the conquest of nature by all of the sciences, and suggests as a topic for general debate at the San Francisco meeting of the association, "Who built the Panama Canal?" feeling sure that biology would be able to show that it deserved "a large share of the credit." Without entering into detail, he states that, while biology is not generally considered the equal of physics, chemistry or engineering in its contribution to civilization, agriculture, animal breeding, bacteriology, experimental medicine, pathology, parasitology, physiology, sanitation, are all based on biological research.

It is the summary way in which Professor Conklin dismisses this aspect which, I think, weakens the effect of his address, for he goes on in his final consideration to the statement that "the highest service of science [mind you, science in general] to culture has been in the emancipation of the mind, in freeing men from the bondage of superstition and ignorance, in helping man to know himself." As a generalization this is fine, and he goes on to state that the doctrine of evolution which has revolutionized all our thinking regarding man and nature is the greatest contribution of biology to intellectual emancipation. His concluding paragraph is:

Biology has changed our whole point of view as to nature and man, and has thus contributed more than any other science to the emancipation of mankind.

Another of these four papers was read by Professor G. H. Parker, of Harvard University, and was entitled "The Value of Zoology to Humanity: The Eugenics Movement as a Public Service." Here again we have an extremely interesting and important article, from which we may quote the conclusion only:

To conclude, eugenics in the service of society is, in my opinion, entirely justified in demanding the sterilization by humane methods of those defectives who are in the nature of public wards, and this practise may be extended as experience dictates. Eugenics in its relation to propagating the best in the community has a fundamental position in that it is concerned through the elimination of the extremely unfit with the delivery of a reasonably sound stock for cultivation, but it is only secondarily connected with the final production of efficient members of society whose real effectiveness is often more a matter of social inheritance than it is of organic inheritance.

I consider Dr. Parker's address as a very valuable one, but, while showing what animal breeding has done, which may in a way be construed as relating to "the value of zoology to humanity," he uses this only as an indication as to what might be done with the human species; and, important as his address is, it is not directed specifically to the point at issue—the value of zoology to humanity.

The third of these addresses was by Dr. C. B. Davenport and was entitled "The Value of Zoology to Humanity: the Value of Scientific Genealogy." Here again we have a very important paper, written in Dr. Davenport's admirable manner. His argument in a broad way applies to the general field of biology, including botany, zoology and anthropology, and in a specific way to the human species. He refers to the complicated work of the animal breeders, and follows it with the statement,

And yet this precious human kind of ours, whose progress is so fatal to the world, goes its blind way, like any jellyfish, mates almost at random and

then, after two or three generations, has lost all knowledge of the matings that have gone before. Of course, the race has got along, somehow, just as the lower animals get along; although we have been burdened with an intelligence sufficient to lead us to interference with the operation of pure instinct but not sufficient always to interfere wisely.

He instances especially, as indicating that the nature of the mating influences the progeny, the study of half fraternities, and mentions especially the case of a man born in 1668, a graduate of Harvard, whose wife was the sister of the first rector of Yale College, who entered the ministry and preached in southeastern Connecticut. His first wife was apparently a quiet, steady, religious woman of no apparent wealth or culture. Her children were farmers, and received no special education. His second wife belonged to a wealthy New York family, of high social standing and culture, and the children by this wife were educated at Yale College and became prominent in the affairs of the nation. The thought that occurs to almost any one in studying this case is that the wealth acquired by the second marriage enabled the superior education of the children which it produced, and that obviously education and environment brought about a very considerable contrast between the children of the two wives.

The whole paper, however, is a sound and striking argument showing the value of scientific human genealogy, a proposition, however, which most of us are ready to accept without any extended argument. The paper as a whole touches upon a single aspect of the main subject of the symposium, and this aspect in itself has only been thought of as zoological of late.

The final contribution to the symposium was on the value of museums, by Dr. Henry Fairfield Osborn. This too is a rather self-

evident proposition. The address has not been published, but it is certain that the zoological work of the museums was more than competently handled. Dr. Osborn, as every one knows, entirely aside from his eminent standing as a paleontologist, is an expert in museum management, and has published many papers on the subject.

The symposium of 1914-15, as a whole, as pointing out in a comprehensive way the value of zoology to humanity, is very disappointing and by no means does justice to the subject. In fact, it touches on only four aspects of the topic and these by no means of the first importance; and, moreover, in one of the papers it confuses zoology with general biology if not scientific thought as a whole.

No one denies the abilities of the speakers, who were, and are in fact, four of the most prominent among the American workers in zoology, and any one of them, if given the whole field, would doubtless have made a magnificent showing. To each, however, was assigned a subtitle, and thus the value of zoology to humanity received a most unsatisfactory treatment. One prominent worker in zoology as applied to medicine, I am told, left the meeting undecided whether to relieve himself by jeers or by tears, and it was at his suggestion that the present supplementary symposium has been arranged. Mind you, this one will not be sufficient unto itself, since each speaker is assigned one general topic, but if it properly supplements the other it ought to outweigh it in proportion of anywhere from ten to one hundred to one.

And now let us see what those zoologists who study insects have done and are doing for the welfare of humanity. The class *Insecta* includes a host of species which are most keenly competing with the human species in the struggle for existence. The

insect type is one of the most persistent types in nature. Having its origin in Carboniferous or perhaps Silurian times, it has persisted and flourished, adapting itself to almost all conceivable conditions until at the present time it is, among all the types of living things, the chief competitor of the recently evolved human type for the control of the earth.

Man labors for months to produce a food crop—he must share it with many species of insects. He builds himself a house with infinite toil—it must harbor insects as well. He makes garments for himself—without great care on his part they are eaten by insects. His harvested food is destroyed by them; his blood is sucked by them; he sickens and dies from a multiplication of disease germs which they have introduced by their bites or with which they have contaminated his food, and after his death they consume his body.

Let us begin with food crops. Always a vital subject, this has become one of the most intense interest under the present world conditions. In time of peace and before the intensified effort was begun to feed not only ourselves but a large part of the rest of the people of the world, the damage by insects to the food products of the United States was estimated at approximately \$1,300,000,000 per year, or roughly, about ten per cent. of the whole. This estimate, as expressed in monetary terms, is open to criticism for the obvious reason that a fall in production is followed by an increase in price. But the loss may equally be estimated in terms of human food and consequently of human vitality. A loss of ten per cent. of the possible food, and not considering the question of waste, means strictly that a given number of people must live on a ration of ninety per cent. of the possible; not necessarily that ten per cent. of the people must die of starvation.

Accepting the monetary terms as the most convenient, let us see what the zoologists have done in this direction for the "welfare of humanity."

In 1907 the question arose (it was propounded by Mr. Littlefield, at that time chairman of the Committee of the House of Representatives on Expenditures in the Department of Agriculture) as to how much the work of the Department of Agriculture saves to the country annually. Secretary Wilson passed this question on to the chiefs of the bureaus. The Chief of the Bureau of Entomology passed it on to the heads of different sections of the work of the bureau. When the entomological estimates were handed in they summed up the total of \$500,000,000, and they appeared to the Chief of the Bureau to be incredibly large, and the total was scaled down to less than one half. When the resulting estimate from the chief was submitted to the Secretary of Agriculture it appeared to Mr. Wilson to be still very much too large (possibly in comparison with the saving resulting from the work of the rest of the Department of Agriculture), and he in turn scaled it down to more than one half of this half. When the totals came to Mr. Littlefield in his committee room, the estimates of the whole department appeared to him to be very much too great, and he scaled down both individual items and totals, including the estimate from the Bureau of Entomology. The result as published in Mr. Littlefield's report gives the annual saving from the labors of the Bureau of Entomology (which is only one of the organizations of zoologists at work in this direction) as \$22,750,000. But who shall say whether the original estimates of the chiefs of sections in the bureau were not more nearly correct than this? In fact, it seems more likely that the entomologists have saved to this country much more

nearly the original estimate of the experts than the final estimate of the Congressional committee. I have shown that our estimate of the loss is based at about ten per cent. of the possible production of our crops taken as a whole. Who is in position to say that it would not be twenty per cent. were it not for the general use of remedies already found and continually being improved by the students of insects?—in which case the saving would be more than a billion of dollars a year to the United States alone. And how many people can be fed with a billion dollars a year, and what work could they do!

This is perhaps the high spot in our treatment of this subject. It must be remembered that the work which brings about these results is done for the most part by trained scientific men. To find a remedy for an injurious insect presupposes a long training followed by the closest observation. It includes a broad knowledge of the structure, of the classification, of the life histories, of the behaviors of the species involved, of laboratory methods and technique, and that inspired insight which is a part of the nature of the best men of science. Workers in pure science are inclined to look down on workers in applied science, but nowhere have the qualities of the research man come into closer play than they have in the investigations in economic entomology along the line of crop enemies; and the same may be said of all of the other work in applied zoology.

We are accustomed to think of the insect enemies of growing crops as those of main importance, but after the crops are harvested and food products are stored they are attacked by a host of species. In the present crisis the problem of preserving food stuffs for considerable periods after harvest from the attacks of insects has become of the utmost importance. Long be-

fore the Russian revolution a conference of all of the entomologists of Russia was held to consider this very question. During the present month one of the most experienced entomologists of England, Professor H. Maxwell-Lefroy, passed through this country on his way out to Australia to look into the condition of Australian wheat ready for export to the United States, for the purpose of preventing damage by weevils and other insects injurious to stored grain. Much depends on the success of this man. Conditions are readily conceivable under which this great store of grain, which means so much to this country at the present time, may be utterly destroyed—an almost catastrophic prospect—and any reduction in its amount will upset the close calculations which concern themselves with the vitally important grain trade of to-day. The United States has sent milled grain in great quantities to England. To avoid the long sea haul, Australian grain will go to the port of San Francisco and will be milled in this country to replace the supply already sent to the East.

And then comes the enormous problem of medical zoology, in which the entomologist has a most important interest. Other aspects of this question will be treated by another speaker, and it is true that most of the important discoveries concerning the carriage of disease by insects have been made by medical men and not by entomologists. But even in these cases, the discovery once made, the entomologist, with his training in methods of investigating the life history and habits of insects, plays the important part in the investigation of every point in the life history, habits and behavior of the insect carrier and in the perfection of the methods for its destruction. I have even gone so far as to state, what to me seems a self-evident fact, that the prevention of insect-borne diseases is a matter

for the economic entomologist and not for the medical man; or, at the very least, for the individual who does not yet exist, namely, the medical man trained as an entomologist. It is true that the practise of the results obtained by the research of medical entomologists may eventually be placed in the hands of men of lesser training or of men who possess other sanitary qualifications, such as the sanitary engineers, but the entomologist is a vital link in the chain. Entomologists, as such, will receive more and more consideration from sanitarians, especially in Army circles, as is indicated by the fact that, from a zero beginning in 1914, at the present time with each sanitary unit of seventy in the expeditionary forces of Great Britain there are two trained entomologists.

I might easily have prepared a paper of ten times the length of this and adding to its effectiveness, but other speakers are waiting to add their expert testimony to the enormous "value of zoology to the welfare of humanity."

L. O. HOWARD

THE STATUS OF PHYSIOLOGY IN AMERICA

In a recent issue of our most widely read medical journal¹ there is presented an arraignment of modern biology which can not be passed by without serious consideration. This is so not because the writer of the review has presented the case exhaustively, or even fairly, but because the statements are commonly made and therefore deserve examination.

Modern biology is a composite, its several components derived from the following sources:

1. Traditional natural history of pre-Agassiz times.
2. The laboratory period of Agassiz.
3. The morphological period of Darwinian corroboration and consequences of the "Origin of Species."

¹ *Journal of the American Medical Association*, September 29, 1917, column Book Notices.

4. The newer physiological aspects, introduced by the experimental school.

5. The dictations of the professional schools—medical, agricultural, etc.

Of the two great divisions, botany and zoology, the former has exhibited a more catholicity of view. Unlike zoology, the curricula of departments of plant study offer a more complete survey of the essential aspects of the subject. Both the functional as well as the morphological divisions are presented, for a typical curriculum of botany includes not only the morphological studies, similar to those of the department of zoology, but an integrated division of plant physiology, part and parcel of the department. To find an equivalent to this state of affairs in zoology, one must confine himself to a comparatively few of our institutions of learning. A typical case is presented by Princeton, and the result, indicated by the character of investigations produced from the department of biology of that university, has apparently justified the incorporation of functional study into the department. However, such instances are the exception rather than the rule and the number of institutions which embody this idea increase at a very low ratio from year to year.

The arrangement which is practised in many institutions is that which is exemplified by Columbia University. The department of zoology includes a professor of experimental biology and the courses presented by him are physiological, to be sure; yet these courses are advanced and are specialized for certain research work with which the department has been identified since 1904. For the undergraduate, nothing is available as far as a survey of functional zoology is concerned; that work is relegated to the medical school. In this respect, as we have said before, Columbia is typical inasmuch as the zoologist *leaves to the medical school the functional aspects of his science.*

Owing to the growing potency of the fifth factor mentioned above in our enumeration of the various components of modern biology, this condition of affairs is growing *pari passu*. At California, where traditionally the depart-