War Against Insects.¹

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COUNT KORZYBSKI, in his recent remarkable book, "The Manhood of Humanity," gives a new definition of man, departing from the purely biological concept, on one hand, and from the mythological-biological-philosophical idea on the other, and concludes that humanity is set apart from other things that exist on this globe by its *time-binding* faculty, power, or capacity. This is another way of saying that man preserves the history of the race and should be able to profit by a knowledge of the past in order to improve the future. It is, indeed, this *time-binding* capacity which is the principal asset of humanity, and this alone would make the human species the dominant type of the vertebrate series. But, biologically speaking, there is another class of animals which, without developing the *time-binding* faculty, has carried the evolution of instinct to an extreme, and has in its turn come to be the dominant type of another great series, the Articulates, or the Arthropods. As Bouvier puts it,

Man occupies the highest point in the vertebrate scale, for he breaks the chain of instincts and assures the complete expansion of his intelligence. The insects hold the same dominating position in the Articulates where they are the crowning point of instinctive life.

Unlike the Echinoderms and the Molluscs, which have retained their hard coverings or shells, and have therefore progressed more slowly—for, as Bergson says, "The animal which is shut up in a citadel or a coat of mail is condemned to an existence of half sleep"—Vertebrates, culminating in man, have acquired the bodily structure which, guided in man by the equally acquired intelligence, has enabled him to accomplish the marvels which we see in our daily existence. Moreover, the Articulates have in the course of the ages been modified and perfected in their structure and in their biology until their many appendages have become perfect tools adapted in the most complete way to the needs of the species, until their power of existing and of multiplying enormously under the most extraordinary variety of conditions, of subsisting successfully upon an extraordinary variety of food, has become so perfected and their instincts have become so developed that the culminating type, the insects, has become the most powerful rival of the culminating vertebrate type, man.

Now this is not recognised to the full by people in general—it is not realised by the biologists themselves. We appreciate the fact that agriculture suffers enormously, since insects need our farm products and compel us to share with them. We are just beginning to appreciate that directly and in-

directly insects cause a tremendous loss of human life through the diseases that they carry. But apart from these two generalisations we do not realise that insects are working against us in a host of ways, sometimes obviously, more often in unseen ways, and that an enormous fight is on our hands.

It is difficult to understand the long-time comparative indifference of the human species to the insect danger, but even during the active lifetime of the speaker there has come a change. Good men, men of sound laboratory training, have found themselves able in increasing numbers, through college and Government support, to devote themselves to the study of insect life with the main end in view of controlling those forms inimical to humanity, and to-day the man in the street realises neither the number of trained men and institutions engaged in this work nor the breadth and importance of their results, not only in the practical affairs of life, but also in the broad field of biological research. The Governments of the different countries are supporting this work in a manner that would have been considered incredible even five and twenty years ago, and this is especially true of the United States and Canada, and scarcely less so of France, Italy, Japan, South Africa, and, at least until four years ago, Russia.

It may be worth while here, however, to point out that certain European countries are combining their studies of agricultural entomology and crop diseases under the term phytopathological studies, or an Epiphyte Service (*Service des Epiphyties*), as in France, and this is undesirable, since it obscures to a certain extent the great issue of insect warfare and divides the great field of economic entomology in a most unfortunate way. Let us hope that the movement will not grow. Let the entomologists co-operate with the pathologists, both plant and animal, wherever there is something to be gained by such co-operation, but let us keep the respective fields entirely clear.

The war against insects has, in fact, become a world-wide movement which is rapidly making an impression in many ways. Take the United States, for example, where investigations in this field are, for the time being, receiving generous Government support. Every State has its corps of expert workers and investigators. The Federal Government employs a force of four hundred trained men and equips and supports more than eighty field laboratories scattered over the whole country at especially advantageous centres for especial investigations. Also there are teachers in the colleges and universities, especially the colleges of agriculture, who are training workers in insect biology and morphology and in applied entomology both agricultural and medical.

¹ Abridged from the presidential address to the American Association for the Advancement of Science delivered on December 27, 1921, at Toronto.

All this means that we are beginning to realise that insects are our most important rivals in Nature, and that we are beginning to develop our defence.

While it is true that we are *beginning* this development, it is equally true that we are only at the start. Looking at it in a broad way, we must go deeply into insect physiology and minute anatomy; we must study and secure a most perfect knowledge of all of the infinite varieties of individual development from the germ cell to the adult form; we must study all of the aspects of insect behaviour and their responses to all sorts of stimuli—their tropisms of all kinds; we must study the tremendous complex of natural control, involving as it does a consideration of meteorology, climatology, botany, plant physiology, and all the operations of animal and vegetable parasitism as they affect the Insecta. We must go down to great big fundamentals.

All this will involve the labours of an army of patient investigators and will occupy very many years—possibly all time to come. But the problem in many of its manifestations is a pressing and immediate one. That is why we are using a chemical means of warfare, by spraying our crops with chemical compounds and fumigating our citrus orchards and mills and warehouses with other chemical compounds, and are developing mechanical means both for utilising these chemical means and for independent action. There is much room for investigation here. We have only a few simple and effective insecticides. Among the inorganic compounds we have the arsenates, the lime and sulphur sprays, and recently the fluorides have been coming in. Of the organic substances we use such plant material as the poisons of hellebore and larkspur, pyrethrum and nicotine; and the cyanides and the petroleum emulsions are also very extensively used. No really synthetic organic substances have come into use. Here is a great field for future work. Some of the after happenings of the war have been the use of the army flame-throwers against the swarms of locusts in the South of France, the experimental use against insects of certain of the war gases, and the use of the aeroplane in reconnaissance in the course of the pink bollworm work along the Rio Grande, in the location of beetle-damaged timber in the forests of the North-west, and even in the insecticidal dusting of dense tree growth in Ohio. The chemists and the entomologists, working co-operatively, have many valuable discoveries yet to make, and they will surely come.

All this sort of work goes for immediate relief. Our studies of natural control follow next. It is fortunately true that there are thousands upon thousands of species of insects which live at the expense of those that are inimical to man and destroy them in vast numbers; in fact, as a distinguished physicist, in discussing this topic with me, recently said: "If they would quit fighting among themselves they would overwhelm the whole vertebrate

series." This is, in fact, one of the most important elements in natural control, and is being studied in its many phases by a small but earnest group of workers.

So far, while we have done some striking things in our efforts at biological control, by importing from one country into another the natural enemies of an injurious species which had itself been accidentally introduced, and while we have in some cases secured relief by variations in farm practice or in farm management based upon an intimate knowledge of the biology of certain crop pests, we are only touching the border of the possibilities of natural control. For an understanding of these possibilities we must await the prosecution of long studies.

Let us summarise. Few people realise the critical situation which exists at the present time. Men and nations have always struggled among themselves. War has seemed to be a necessity growing out of the ambition of the human race. It is too much, perhaps, to hope that the lesson which the world learned in the years 1914 to 1918 will be strong enough to prevent the recurrence of international war; but, at all events, there is a war, not among human beings, but between all humanity and certain forces that are arrayed against it. Man is the dominant type on this terrestrial body; he has overcome most opposing animate forces; he has subdued or turned to his own use nearly all kinds of living creatures. There still remain, however, the bacteria and protozoa that carry disease and the enormous forces of injurious insects which attack him from every point and constitute to-day his greatest rivals in the control of Nature. They threaten his life daily; they shorten his food supplies, both in his crops while they are growing, and in such supplies after they are harvested and stored, in his meat animals, in his comfort, in his clothing, in his habitations, and in countless other ways. In many ways they are better fitted for existence on this earth than he is. They constitute a much older geological type, and it is a type which had persisted for countless years before he made his appearance, and this persistence has been due to characteristics which he does not possess and cannot acquire—rapidity of multiplication, power of concealment, a defensive armour, and many other factors. With all this in view it will be necessary for the human species to bring the great group of insects under control, and to do this will demand the services of skilled biologists—thousands of them. We have ignored the insect group to a certain extent on account of the small size of its members, but their small size is one of the great elements of danger—is one of the great factors of their success in existence and multiplication.

Let all the departments of biology in our universities and colleges consider this plain statement of the situation, and let them begin a concerted movement to train the men who are needed in this defensive and offensive campaign.