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(a) ON SOME PRESIDENTIAL ADDRESSES: (b) THE WAR AGAINST THE INSECTS [1]

To prepare a presidential address to be delivered before either the British or the American Association for the Advancement of Science is a very serious matter, and many eminent men have found it so. Is it not a sad thought that each year for many years there has been a man here and one over there who has had to worry for months, first as to his subject and again as to its mode of presentation? Of course, it sometimes happens that a man like Mr. Balfour over there or Dr. Eliot on this side is made president, and of course such men can write profound and charming addresses almost in their sleep, they have become so accustomed to formal functions of great importance. But the average man of science, even of presidential caliber, is a specialist, absorbed in his work, and the sudden realization that he must prepare an address which should interest all scientific men and should help to interest others in science is appalling.

I imagine that few of you have ever thought of this psychological aspect of presidential addresses. Possibly many of you never took the trouble to read a presidential address. Presidential addresses are things one is rather inclined to take for granted, and when one turns the pages of the journal *Nature* or the journal *Science* one is apt to say to oneself "That looks good; some day I must read it"; and then, after a glance at the news notes, the journal goes on file. In other words, presidential addresses demand the serious attention of the men who prepare them and of very few besides. Yet, I have never heard a presidential address before either the British Association or

[1] Address of the President of the American Association for the Advancement of Science, Toronto, 1921.

the American Association that did not deserve serious reading and study.

For twenty-three years, year after year, I have sat on the platform near the president of the American Association for the Advancement of Science during the delivery of his address, until I may justly claim to be an expert on presidential addresses, in much the same way that the leader of a hotel-orchestra can claim to be an expert on after-dinner speeches—because he has heard so many!

At all events, the twenty-two and more addresses of this character which I have heard, and the one hundred others which I have read, have given me the idea that it would not be amiss to deliver a presidential address on the subject of presidential addresses. I have been rather pleased with this idea, and will in fact elaborate it before I take my seat.

But there are other ideas that have been almost equally insistent and which fit rather more closely to the average notion of propriety for so important an address as this theoretically should be. One of them is a consideration of what seem to me to be educational fallacies in the teaching of science to-day, and especially of the biological sciences. But I am modest, and I am ignorant. I have never been a teacher, and, in order to discuss this vital question in any but a perfectly one-sided way, one must know intimately the viewpoint and the ultimate aim of those who control the teaching, especially of the biological sciences, in our great laboratories. I should visit the work shops at Harvard and Yale, at Columbia, at the University of Pennsylvania, at Johns Hopkins, at the University of Chicago, or here, at Toronto, and talk at length with the men in charge; and then I should go to Woods Hole in the summer, where the teachers themselves go to study and to be taught, and should do my utmost to convince myself that they are right in ignoring most practical problems and are justified in spending their lives on the search for fundamental principles and, what is more to the point, teaching little but facts and methods relating to their own studies and to the studies of their school. I have no time for this, and so can not enter fairly into the subject.

As I am writing this (July 29), I see that Sir Edward Thorpe has announced as the subject of his address before the British Association at Edinburgh "The Aspects and Problems of Post-War Science, Pure and Applied." It was the war that helped make me more dissatisfied than ever with the results of biological teaching in America, just as it has been the war that has caused the British people to distrust their whole educational system. With us in Washington, the teachers from the principal universities were brought together, and a National Research Council was formed. The results of the work of this organization in the direction of biology and agriculture, so far as they applied to the prosecution of the war, were largely negative; but that much good will result to the country by the bringing of these men to Washington in the great emergency there can be little doubt, since I have the hope that it opened their eyes to the fact that their university work might have been of much greater value to their country, and to the further fact perhaps that there exist under the federal government agencies which are working upon biological problems effectively and with the highest attention to scientific methods and scientific ideas.

Laying aside then this idea of an educational discussion, the idea that is always with me, of once more considering what Sir Harry Johnston has with his usual felicity called "the next great world war"—the war of humanity against the class *Insecta*—has still further impressed itself upon me. And so there are two topics which I shall briefly discuss—first, presidential addresses, and, second, our struggle against insects.

ON SOME PRESIDENTIAL ADDRESSES

Let us hurriedly glance at the presidential addresses delivered before the British and the American Associations from 1895 down to last year, 1920, and at the men who delivered them. During that period there were 27 such addresses before the American Association and 24 before the British Association, the discrepancy being due to the omission of the 1917 meeting of the

British Association and the holding of two extra meetings by the American Association.

It was formerly the custom in the British Association to review the progress of science each year, and this was usually done in a way in the address of the president. As time went on and science became very intricate and highly specialized in its different parts, the individual, no matter how great his ability and his general knowledge, found himself less and less able to cover the whole field, and so the character of the presidential addresses became diversified. In a measure the same trend has occurred in America. But the British, more conservative than we are over here, or perhaps having the habit of electing broader men to the presidency, have been slower in breaking away from custom, and of their later addresses on the other side seven of the twenty-four have been devoted to a review of the progress of science, while in America only two out of twenty-seven have followed this old and admirable plan. But the diversity in the other addresses has been almost as great with the British as with the Americans. On topics connected with physics, there have been 3 with the British and 3 with the Americans; with anthropology, 2 with the British and 2 with the Americans; in astronomy, 1 with the British and 3 with the Americans; botany, 1 British and 2 American; medical science, 2 British and 2 American; geology, 1 British and 2 American; chemistry, 1 British and 2 American; biology, 2 British and 3 American; economics, 2 American; engineering, 1 British; and the remaining addresses can not be classified.

What a wealth of good things can be found in these addresses! Who can forget Sir Joseph Lister's address on "The Interdependence of Science and the Healing Art" delivered at Liverpool, 1896, and the modest way (characteristic of the man) in which he broke his long silence concerning his own great part in the discoveries that revolutionized the surgical practise of the world? He said,

> Pasteur's labors on fermentation have had a very important influence upon surgery. I have been often asked to speak on my share in this matter before a public audience, but I have hitherto refused to do so, partly because the details are so entirely technical, but chiefly because I have felt an invincible repugnance to what might seem to savor of self-advertisement. The latter objection now no longer exists, since advancing years have indicated that it is right for me to leave to younger men the practise of my dearly loved profession. And it will perhaps be expected that, if I can make myself intelligible, I should say something upon the subject on the present occasion.

Who of us Americans who heard it can forget the address of Sir John Evans at the Toronto meeting in 1897, in which the following words were used,

> Our gathering this year presents a feature of entire novelty and extreme interest, inasmuch as the sister Association of the United States of America —still mourning the loss of her illustrious President, Professor Cope—and some other learned societies, have made special arrangements to allow of their members coming here to join us. I need hardly say how welcome their presence is, nor how gladly we look forward to their taking part in our discussions, and aiding us by interchange of thought. To such a meeting the term "international" seems almost misapplied. It may rather be described as a family gathering, in which our relatives more or less distant in blood, but still intimately connected with us by language, literature, and habits of thought, have spontaneously arranged to take part.
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> The domain of science is no doubt one in which the various nations of the civilized world meet upon equal terms, and for which no other passport is required than some evidence of having striven towards the advancement of natural knowledge. Here, on the frontier between the two great English-speaking nations of the world, who is there that does not inwardly feel that anything which conduces to an intimacy between the representatives of two countries, both of them actively engaged in the pursuit of science, may also, through such an intimacy, react on the affairs of daily life, and aid in preserving those cordial relations that have now for so many years existed between the great American Republic and the British Islands, with which her early foundations are indissolubly connected?

How well the following years have carried forward this idea of Sir John Evans, not only in the domain of science but in the vital affairs of national relations, was amply shown in England's influential moral support of the United

States in the war with Spain, and the response of millions of the American youth to the call from the other side during the terrible years so recently passed, thousands upon thousands of them not waiting for the direct call of their seemingly slow government.

In thinking of those days I love to remember the eloquent words of an Oxford contributor to the *London Times* of April 13, 1917, just before the cream of our youth in rapidly increasing numbers had gone over, thousands to serve with your Canadian troops, and thousands more to help the cause of right in other service.

> It is difficult to judge a whole nation. What is the criterion of judgment, and who are they that are judged? Some of us, and some of our own citizens, have judged America and found her wanting in open-eyed recognition of the issues of this struggle and unflinching determination to face the issues boldly. But if we are to be judged by our statesmen, might we not too deserve the same judgment? The issues were coming, coming, coming for years before this war began. Yet it is not easy to say that our recognition of these issues was open-eyed, and our determination to meet them unflinching. We do not dwell on these things in our past, and why should we dwell on these things and things like these in the history of another nation? If a nation is to be judged, let it be judged by the answer that its spirit makes, in the hour of need, through its purest and most chosen voices—the voice of the young, who are the first to hear and the quickest to obey, the call of Duty and Honor. If that be our criterion, and these are they that are judged, then America may be proud, and may stand secure in the day of judgment. For her young men answered, and answered early, and their answer was "We come."

While there have been two addresses relating to the great war, the one by Sir James Thorpe delivered at Edinburgh last summer, and that read by Van Hise at the Pittsburgh meeting of 1917 entitled "Some Economic Aspects of the World War," the subject of human warfare does not seem to have been mentioned in any of the presidential addresses of earlier years, with one exception: Asaph Hall, the astronomer, in his Washington address in 1903, the title of which was "The Science of Astronomy; Historical Sketch, its Future Development, the Influences of the Sciences on Civilization," used the following words which to-day are of extraordinary significance in view of recent events:

> Men do not change much from generation to generation. Nations that have spent centuries in robbery and pillage retain their disposition and make it necessary for other nations to stand armed. No one knows when a specious plea for extending the area of civilization may be put forth, or when some fanatic may see the hand of God beckoning him to seize a country. The progress of science and invention will render it more difficult for such people to execute their designs. A century hence it may be impossible for brutal power, however rich and great, to destroy a resolute people. It is in this direction that we may look for international harmony and peace, simply because science will make war too dangerous and too costly.

Quite as striking as this, but in another way, was Sir Norman Lockyer's address at Southport in 1903, in which he discussed "The Influence of Brain Power on History." This was mainly a plea for more universities and more research and the need of a scientific national council. Had this strong plea been heeded and acted upon, England would have found herself in much better condition to confront Germany in 1914.

In general these addresses have been extremely serious. Nearly all of the men delivering them have felt that they had an important message to give. All have felt the importance of the occasion and have tried to rise to it. As a result, traces of true humor have been scarce, and it is with a surprised joy that one greets the following paragraph in Farlow's address at New Orleans in 1906. His subject was "The Popular Conception of the Scientific Man at the Present Day," and his address was largely devoted to a discussion of government and university scientific positions. In his introduction he said:

> We are so accustomed to hear reports on the progress of science that we have almost ceased to ask ourselves what we mean by progress. What is or is not progress depends of course upon the point of view. Some are so far ahead of the majority that they can not see how much progress is made by those behind them, others are so far in the rear

that they can not distinguish what is going on ahead of them. We must also admit that there are different directions in which progress may be made. You have all seen the agile crab and been surprised to find how rapidly he gets over the ground, although he never seems to go ahead, but to scramble off sideways. The crab, perhaps, wonders why men are so stupid as to try to move straight forward. It is a popular belief, but, not being a zoologist, I am not prepared to vouch for its correctness, that the squid progresses backward, discharging a large amount of ink. One might perhaps ask: Is the progress of science sometimes like that of the crab, rapid but not straight forward, or, like the squid, may not the emission of a large amount of printer's ink really conceal a backward movement? So far as the accumulation of facts is concerned, there is a steady onward progress in science and it is only in the unwise or premature theorizing on known or supposed facts that science strikes a side track or even progresses backward.

A few Americans were present at the Australasian meeting of the British Association in 1914 and had the pleasure of listening to the remarkable addresses on heredity delivered at Melbourne and Sydney by the distinguished guest of the American Association at this present meeting, Prof. William Bateson. These lectures, for general and vital interest, are almost unsurpassed in the long list of presidential addresses delivered before the one or the other of the two great associations. Only a few of us heard them; many of us have read them; and it is a joy to know that we are to listen to Professor Bateson to-morrow night.

Several of the retiring presidents in both associations have ventured into the domain of prophecy. Even now the address of Sir William Crookes at Bristol in 1898 is remembered. His startling display and discussion of the decreasing wheat supply of the world and the necessity of securing nitrogen from the air created an enormous amount of interest. Ten years later, Nichols at Baltimore, in his discussion of "Science and the Practical Problems of the Future," referring to the exhaustion of our supply of fixed nitrogen, the contingency discussed by Sir William Crookes in 1898, and to the exhaustion of our free oxygen more recently discussed by Lord Kelvin, concluded that these problems were still so remote as to have no immediate practical importance; but his address was written at a time when the conservation movement was just beginning in this country although it had already gained much force, and he referred especially to the coming exhaustion of coal, wood, ores and soils. His address was a tremendous plea for intensive research, and included the significant sentence, "We need not merely research in the universities, but universities for research." One of his final sentences reads, "Beyond lies that future in which it will no longer be a question of supremacy among nations, but of whether the race is to maintain its foothold on the earth."

The very following year, Chamberlin at Boston, in making "A Geologic Forecast of the Future of our Race," concluded with a more hopeful outlook and sent his audience home in a much happier frame of mind. He said:

> While, therefore, there is to be, with little doubt, an end to the earth as a planet, and while perhaps previous to this end, conditions inhospitable to life may be reached, the forecast of these contingencies places the event in the indeterminate future. The geologic analogies give fair ground for anticipating conditions congenial to life for millions and tens of millions of years to come, not to urge even larger possibilities.

But these fifty-one addresses, as well as those that preceded them, are full of significant and quotable things. We on this side will never forget that remarkably beautiful address of Jordan's in 1910 on "The Making of a Darwin." Those on the other side who heard it will never forget Professor Schaefer's address at Dundee in 1912, on the "Nature, Origin and Maintenance of Life," in which, in closing, he gives a wonderfully eloquent description of natural death—"A simple physiological process as natural as the on-coming of sleep."

This leads us to the side thought, not only of Professor Schaefer's own age at that time (it was sixty-two), but also to the interest attaching to the ages of all of the presidents

of the two associations. It is undoubtedly true that each of these men had achieved unusual prominence in scientific work at the time he became president of the one or the other of the two great associations. An analysis of the careers of each one of them is not possible at the present time, nor is it possible to indicate whether his address was delivered at the crowning period of his productive scientific life. With some of them it was, with others it was not. As a matter of fact, however, the average age of the presidents of the British Association was sixty-one years and eleven months, and with the American Association it was sixty-one years and five months. The youngest president of the British Association during the period under consideration was fifty-three years of age. This held for Professor Rucker, Sir J. J. Thomson, and Professor Bateson. The oldest of them was Professor Bonney, whose address was delivered at the age of seventy-seven. The youngest of the American presidents were Minot and Richards, whose addresses were delivered at the age of fifty; and the oldest was Eliot, whose Philadelphia address was delivered when he was seventy-nine years old. I remember that Dr. Eliot hesitated to accept the presidency on the ground that he might not live another year to deliver his address. That was eight years ago and he is still living and writing at the age of eighty-seven.

One is strongly tempted at this point to enter briefly upon a discussion as to the average length of the productive life of a scientific man and as to the average period of its practical end. But the semi-humorous and totally misunderstood remark by Sir William Osler at his farewell address at Johns Hopkins in 1904 has been so voluminously criticized and has caused so much sorrow, or so much indignation as the case may be, to still productive men away past their early forties, and the side of the veterans has been so triumphantly defended, that further argument and illustration are unnecessary. We may safely assume, in fact, that the usefulness of the man past middle age is granted, and that, while he may not have the illuminative bursts of inventive or speculative genius which come to the younger man, he is better able to make the broad generalizations based upon accumulated experience—in other words, to prepare an appropriate presidential address as president of the British or the American Association for the Advancement of Science!

But so far I have only skirted a promising field. I have an idea that some one should go deeply into the subject, not only of presidential addresses before the British and American Associations, but of all presidential addresses. Why do we have such addresses? If there is a good reason—and there probably is—why do not people read them? Or *does* some one read them? And if so, who? and why? Some presidents prepare addresses which they hope will interest the people who come to listen to them. Others are perfectly indifferent to their listeners, and perfunctorily read addresses intended for later severely restricted groups of readers, such as the professional astronomers of the world, as Harkness did, for example, in 1893 at Madison. A host of ideas occur to me that suggest promising lines of investigation, but I leave their elaboration to some one of my successors who may like the task and who may be a psychologist fitted by training to deal with it.

THE WAR AGAINST THE INSECTS

Count Korzybski, in his recent remarkable book "The Manhood of Humanity," gives a new definition of man, departing from the purely biological concept on the 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, or 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 Mollusks 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, with man guided by the equally acquired intelligence, has enabled him to accomplish the marvels which we see in our daily existence. And, too, 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 recognized to the full by people in general—it is not realized 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 indirectly insects cause a tremendous loss of human life through the diseases that they carry. But apart from these two generalizations we do not realize 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 will be obvious, I think, that this statement is not overdrawn. Quite recently a better appreciation of the situation is beginning to show itself. Early in the war (July, 1915) Sir Harry Johnston's strong article entitled "The Next War: Man *versus* Insects" was published in *The Nineteenth Century*; and at the close of the war precisely the same title was used by Lieutenant Colonel W. Glen Liston, of the Indian Medical Service, in his address as president of the Medical Research Section of the Indian Science Congress held at Calcutta in January, 1919. On this side, articles by Felt of Albany, Brues of Harvard, and by the present speaker called especial attention to the important part that entomology and entomologists played during the world war, and since that time several energetic newspaper writers have been trying to place the case before the public.

It is difficult to understand the long-time comparative indifference of the human species to the insect danger. A little more than a hundred years ago the popular opinion of entomology and entomologists in England was well expressed by that admirable character, the Rev. William Kirby, in the following words:

> One principal cause of the little attention paid to entomology in this country has doubtless been the ridicule so often thrown upon the science. The botanist, sheltered now by the sanction of fashion, as formerly by the prescriptive union of his study with medicine, may dedicate his hours to mosses and lichens without reproach; but in the minds of most men, the learned as well as the vulgar, the idea of the trifling nature of his pursuit is so strongly associated with that of the diminutive size of its objects, that an *entomologist* is synonymous with everything futile and childish. Now, when so many other roads to fame and distinction are open; when a man has merely to avow himself a botanist, a mineralogist, or a chemist—a student of classical literature or political economy—to ensure attention

and respect, there are evidently no great attractions to lead him to a science which in nine companies out of ten with which he may associate promises to signalize him only as an object of pity or contempt. Even if he had no other aim than self-gratification, yet "the sternest stoic of us all wishes at least for some one to enter into his views and feelings, and confirm him in the opinion which he entertains of himself"; but how can he look for sympathy in a pursuit unknown to the world, except as indicative of littleness of mind?

This popular impression, so well described by Kirby, continued, and jokes, anecdotes, cartoons, novels and dramas perpetuated the old idea. 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 to control those forms inimical to humanity, and to-day the man in the street realizes 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 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 hardly less so of France and Italy and Japan and 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 unfortunate, 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 cooperate with the pathologists, both plant and animal, wherever there is something to be gained by such cooperation, 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 the largest 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 centers for especial investigations. And there are teachers in the colleges and universities, especially the colleges of agriculture, who are training clever men and clever women in insect biology and morphology and in applied entomology both agricultural and medical.

All this means that we are beginning to realize that insects are our most important rivals in nature and that we are beginning to develop our defense.

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 behavior 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 vegetal parasitism as they affect the insecta. We must go down to great big fundamentals.

All this will involve the labors 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 utilizing 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 reconnoissance in the course of the pink bollworm work along the Rio Grande, in the location of beetle-damaged timber in the forests of the Northwest, and even in the insecticidal dusting of dense tree growth in Ohio. The chemists and the entomologists, working cooperatively, 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 which 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 practise 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, just as we must await years of progress of those other studies outlined in a previous paragraph. And all of these studies must be carried on by skilled biologists—thousands of them. At present most of the best men are working away in their laboratories practically heedless of the great and inviting lines of study at which I have hinted and heedless of the tremendous necessity for the most intense work by the very best minds on the problem of overcoming and controlling our strongest rivals on this planet.

And this brings me back to the topic which I touched upon in my opening remarks, namely, the teaching of biology in our colleges and universities. You will remember that I thought to avoid a discussion of this subject because I felt that I could not do it justice without more careful investigation and without a clear knowledge of the viewpoints and purposes of the educators. A good many of us have been thinking for a long time that the teaching of zoology and botany and the so-called biology in the principal colleges and universities in the United States and Canada, and in Europe as well, has taken the wrong trend, or that, if not taking the wrong trend, very many of the more important aspects of these subjects are being ignored, and that everything was running in a single direction. I said a good many of us. That means that, when we come to count them up, there really have been a good many, but they have been so greatly in the minority that they have been ignored in the general movement. Here and there a man has spoken out, but all too infrequently. Jordan, in his presidential address before the American Association, was one of these. C. C. Nutting, in two or three papers, has in a forceful and somewhat humorous way pointed out some of the inconsistencies of modern biological training. Edwin Linton, in his strong and fine address at the Baird Memorial meeting in Washing-

ton in 1916, put it forcibly in the following words:

> As I look over the titles of theses for doctorate degrees in biology, however, knowing that they must, in some fashion, reflect the activities of our biological leaders, I am led to wonder if the failure of science to influence legislation in the interests of the people is not to be charged to the propensity on the part of these leaders to shun the practical. Is there a hierarchy in science that frowns upon independence of thought and action in her sanctuary? That can hardly be. Let the heads of departments of biological research in our universities then take heart, and not be afraid to follow the lead of Pasteur, who surely committed no violence upon science by undertaking the solution of practical problems.

In very recent years there has come about a slight change in the attitude of teachers. The great war has brought this about in part, but this is not the only thing that has had an influence; something intangible—something difficult to locate—perhaps it is many sided—perhaps it is many things contributing to one end—something has opened the minds of many single-track men, and there is a gradual tendency towards broadening which is having its influence on college curricula, on the character of the papers read at the recent meetings of the great national societies, and to a slight extent on the subjects chosen for doctorates in biology in the universities. The recent founding of the Ecological Society of America is a strong evidence of the working of a leavening element; and the recent publication of such books as Cockerell's "Zoology," Needham's "General Biology," and Shull, Larue and Ruthven's "Principles of Animal Biology," and others, shows that the teaching mind is broadening.

I have mentioned the theses for doctorates. I have glanced over the titles of such theses, which represent the bulk of the graduate work in biology in American universities, for the past eight years, as published in the lists of the Library of Congress and in the journal SCIENCE. I find that only a very small percentage of this output represents work which can be of the slightest use to humanity in its immediate problems regarding the insect world, and even those which may prove of use bear some evidence that the lines of study had already been adopted by students who used them incidentally to gain their degrees and were not suggested by their teachers as promising lines leading toward some great practical outcome.

How can we present a convincing argument on the necessity for a better rounded study of everything comprehended in the word *biology*! And how can we emphasize the prime importance of devoting our earliest attention to those problems which most immediately concern our well being? This can not be done authoritatively by a single individual. Perhaps a convert from the present religion, say an eminent authority on cell biology, with that enthusiasm characteristic of recent converts, could put the case more forcefully than could a man who has not achieved prominence in the now accepted lines of work. I am praying for such a convert. But much better than this would be a movement participated in by as many individuals as possible, all with the same general idea, each putting forward the views that have come to him in the course of his own restricted lines of study in biology.

Let us summarize. Few people realize 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 has recently 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 which 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 can not acquire—rapidity of multiplication, power of concealment, a defensive armor, and many other factors contribute to this persistence. With all this in view, it will be necessary for the human species to bring this great group of insects under control, and to do this will demand the services of skilled biologists—thousands of them. We have ignored these creatures to a certain extent on account of their small size, but their small size is one of the great elements of danger, is one of the great elements of success in existence and multiplication.

Let all the departments of biology in all of 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.

In closing, I can not refrain from quoting a remarkable paragraph from Maeterlinck:

> The insect does not belong to our world. The other animals, even the plants, in spite of their mute existence and the great secrets which they nourish, do not seem wholly strangers to us. In spite of all, we feel with them a certain sense of terrestrial fraternity. They surprise us, even make us marvel, but they fail to overthrow our basic concepts. The insect, on the other hand, brings with him something that does not seem to belong to the customs, the morale, the psychology of our globe. One would say that it comes from another planet, more monstrous, more energetic, more insensate, more atrocious, more infernal than ours. . . . It seizes upon life with an authority and a fecundity which nothing equals here below; we can not grasp the idea that it is a thought of that Nature of which we flatter ourselves that we are the favorite children. . . . There is, without doubt, with this amazement and this incomprehension, an I know not what of instinctive and profound inquietude inspired by these creatures, so incomparably better armed, better equipped than ourselves, these compressions of energy and activity which are our most mysterious enemies, our rivals in these latter hours, and perhaps our successors.

L. O. HOWARD
U. S. DEPARTMENT OF AGRICULTURE

ADDRESS AT THE LAYING OF THE CORNER STONE OF THE CHEMICAL LABORATORY OF THE CORNELL UNIVERSITY

THE great chemical laboratory, the cornerstone of which we lay to-day, will not be without its effect upon the life of the university. Its influence may be good or it may be bad. It is sure to be profound.

Chemistry has many aspects. Sordidly treated, as a mere bread and butter subject, it might conceivably tend to degrade our teaching to a low, materialistic level. Idealistically treated, as becomes a great fundamental science, it will promote the noblest purposes in education.

Are we out of touch with life? Chemistry has the most varied and intimate contacts with life of any of the sciences.

Do we wish to inspire, in our teaching, a passion for truth? The pursuit of science is an unending quest for truth.

Are we inclined to shun specialization lest we lose a certain breadth of training for our students? Let us remember that to really know something of any one of the many branches of a science like chemistry one must use several languages, must be something of a mathematician and physicist and must be acquainted with many allied subjects.

There are few things so broad as a " narrow specialty "—if you follow it down to the ends of its wide spreading roots!

As for the training of the imagination and the building of character, is it not inspiring to turn from the pitiful struggles of the human race as depicted in a world's history whose