

SCIENCE

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THE PRESENT EDUCATIONAL SYSTEM AND THE TRAINING OF ECONOMIC ENTOMOLOGISTS¹

At the beginning, I wish to call your attention to the fact that this paper deals with a system and its relation to the preparation of a class of men to meet certain insistent economic conditions brought about by a twentieth-century civilization. I do not wish to place the instructor in any other position than that of a more or less willing or unwilling agent of this system, or the university graduate in any other light than that of the inevitable result of the workings of that system.

The world of to-day demands the carrying out of certain undertakings, the doing of certain difficult things, which, in turn, demands certain qualifications in the men who are to do them, and demands them as never before in the world's history. These men must be taken as lads and so trained as to meet these imperative demands. Where can the American boy get this preparation that these existing conditions demand? Who has the ability, willingness and the freedom to train him therefor? If I were the only one asking these questions, or were the science of entomology alone involved, there would be grounds for suspecting that there was something wrong with the entomologists. But this is not the situation.

Several years ago Mr. F. W. Taylor, who is not only not a man with a grouch, but one of the foremost engineers in the country, stated that he had long ago made up

¹ Read before the Washington, D. C., meeting of the Entomological Society of America, December 27, 1911.

his mind not to employ another college graduate unless the latter had either worked outside in a shop for two years or else had been forced out of school and into practical work. Not only this, but Mr. Taylor goes on to say that the overwhelming majority of employers of this country want nothing to do with college graduates, if they can help themselves, until after they have been tried out, so to speak, outside the university.

More recently Mr. R. T. Crane,² a Chicago manufacturer, of nearly sixty years' experience with, as he tells us, all classes of men, is even more dissatisfied with the output of our colleges and universities and is much inclined to, unjustly, throw overboard all technical training, although evidently fully recognizing the importance of the practical application of science.

The self-educated or self-made man must, almost of necessity, possess an iron will, preferring to override obstacles that obstruct his way, rather than to evade them. He is, on the whole, more liable to become dogmatic, thus going to extremes, and to permit prejudices to obscure reason, than is his fellow with a technical training.

Railway people who are on the watch for men of action tell me that they like the university man with the technical training, provided he will have devoted his vacations to their temporary employment, thus carrying the theoretical and practical features along together.

The foremost electrical concern in this country, the Westinghouse, also likes to get college and university men, but is mighty careful not to let them get where they can do any damage, until they have given them a training in their own practical school.

Now it is not to be supposed that the instructor in entomology will be given advantage over his colleague, the instructor

in engineering, or that his students will be allowed to follow a special educational system of his own. Indeed, he is lucky if he is able to secure even equal privileges and facilities for carrying on his work. It can not, therefore, be supposed that graduates in entomology will be any better qualified than those in other courses, and I am sorry to say they are not.

During the last twenty years, including the present, I have had with me between forty and fifty assistants, nearly all college and university graduates, and I tell you candidly I would not take another one fresh from school and with no further training, were I not obliged to do so. Indeed this is true in general. All like college and university trained men, but after they have been made over elsewhere. Now, what is the matter?

The most of those who gave university instruction to the men who afterwards worked under me are here before me, and I fully believe that, had I been placed in your position, I probably could not have done better, perhaps not as well. Besides, the university graduate is not suffering from too little instruction, but from too much of it. He has had anywhere from fourteen to eighteen years of continuous, miscellaneous instruction and instead of his mind being clear and penetrating, it is more apt to be clouded and befuddled. As Bacon puts it, "The education of the senses neglected, all after education partakes of a drowsiness, a haziness, an insufficiency which it is impossible to cure." The man fresh from the university classroom is overloaded, not with what he needs but with that which he does not require; he is afflicted with dyspepsia of the brain, or mental indigestion, and until he gets rid of these ailments he is of little use. This is why there is so much aversion to employing them in practical work or investigations.

² Lately deceased.

It requires, as Mr. Taylor has stated, two years of actual outside work before they can be at all profitably employed.

Now, I do not believe that such conditions as these are necessary to a college or university education, but that the cause therefor will be found in the methods employed. If we go back to medieval times and for a considerable period thereafter, we find but scant literature, and that little accessible only to the few. Therefore instruction was of necessity oral and knowledge obtained only at great cost was retained only by committing to memory with the utmost exactness. Thus was an educational system born of necessity and fitted to the conditions existing at that time. A pupil must not only receive instruction exactly as imparted, but must be able to show by examination that he could repeat what he had heard with the same minute exactness, otherwise what he had obtained would be erroneous and, therefore, of no value.

Let us now come back from medieval times to the twentieth century. To an age when ships disabled at sea may make their situation and location known a thousand miles away and receive aid from other vessels within reach, though not within sight; to an age when you can, within a few hours, communicate with your friend, whether he happens to be in Tasmania, Alaska, Capetown or Hong Kong; to an age when, if a married man, you can, seated in your hotel here in Washington, bid your wife good-night, whether she be in Boston, Chicago, St. Louis or New Orleans; when you can board a floating palace in New York and within five days step out of it in England; and when you enter a railway coach in Chicago and in three or four days step out of it in either Portland, Oregon, San Francisco or Los Angeles; or, you can leave Chicago in the same way and in

eighteen hours walk the streets of New York City.

From a time when a serious question arose in the minds of men as to whether or not insects were the results of spontaneous generation, to a time when insects from all quarters of the earth are being transported about from one country to another and reared up in myriads to destroy other insects. Within the memory of some of us, the entomologists of America could be told off on the fingers of one hand, and these were engaged in describing genera and species in a way that to-day is in many instances practically unintelligible. Some years ago, I tried to get, from a man who had grown up from boyhood with Dr. Asa Fitch, some information regarding this one of the fathers of economic entomology. What I did succeed in learning was this: "Fitch was a queer fellow, always prying into things that the Almighty never intended us to know."

Thirty years ago a state entomologist in the middle west resigned his office, telling his friends in confidence that economic entomology had reached its limit, and, so far as he could discern, there would soon be nothing for the entomologist to do. At the close of A.D. 1911 the question is to get men properly trained to carry on the work that state and nation demands to be done. There is hardly a civilized people on the face of the earth among whom there are not to be found officials who are entomologists. Not a year passes by during which some of these may not be seen here in Washington, studying our methods of work, our collections, especially the former. One of America's foremost philanthropists is sufficiently aware of the importance of this to supply the necessary funds to enable these men from other countries to come and see for themselves how the science of entomology is being profitably applied in this

country. Now, these gentlemen from abroad have access to all of our publications; can read of what we do and how we do it. They could probably read up and go before an examiner and get an excellent grading on their replies, yet it is significant that a practical business man should think this insufficient, so much so that he willingly pays the expenses of such men to enable them to get into closer touch and see for themselves how investigations are carried on, the facilities required and the methods employed in their use.

There is another phase of our present-day entomology that, in passing, I wish to note, and that is the great desire among systematists for the examination of types, the desire to see and handle the precise insect that Say, Harris, LeConte, Grote and others, both at home and abroad, had before them when they described a species and gave it a technical name. Men will travel hundreds of miles, and visit foreign lands in order to do this. Now, all of the descriptions of these are in print, all can be committed to memory and a man with ordinary intelligence could go into a classroom and pass a most excellent if not indeed a perfect examination, all that you could possibly require of a student. Does not this of itself show clearly that, whether it be a university student of twenty or thereabout, or an independent student, official or amateur, of thrice that age, he must study the things themselves? You can not make up-to-date entomologists within the walls of a classroom.

Dropping, for the time being, the subject of present conditions in the matter of progress, let us take up the educational system under which the men who are yet to come into action are to be educated.

Coming from an era when oral instruction and memorizing were imperative, through an era when the educated were the

priest, the astrologer, the alchemist and the philosopher, with a few of the nobility, the remainder being illiterate and therefore ignorant and brutal, when that now powerful educator, the public press, was as yet unknown, and the almost equally powerful educator, the public library, was inaccessible to all but the few, this system has come down to our radically different twentieth-century civilization, unfortunately, deplorably intact. Indeed, what was once a necessity has now become sadly perverted. Once, the student must of necessity listen and memorize with exactness what was told him, and pass a most rigid examination. Now, however, the object appears to be to get the student to remember long enough to pass his examination. It is of such that Huxley says: "They work to pass, not to know; and outraged science takes her revenge. They do pass, and they *don't* know." Count Leo Tolstoi years ago wrote that he had become convinced that written or verbal examinations were a relic of medieval scholastic superstition, and that in the present order of things, they are decidedly impossible and only harmful. And, again, Huxley says, in his twenty years' experience as an examiner, from boys and girls of elementary schools to candidates for honors and fellowships, that it was a clear case of familiarity breeding contempt, and his admiration did not wax warmer as he saw more and more of its workings. In his opinion, examination is a good servant but a bad master, and he expressed the fear that it would sooner or later come to be the master.

But, you will ask, what has all of this to do with the entomologist, whom you have hardly mentioned? Practically nothing, gentlemen, for the reason that from the age of six years, when he entered the primary school, until he is eighteen or twenty,

or half way through his university course, he is not supposed to have any idea of what his future is to be—what he is to do in this busy world. And his education has been given with no reference to whether he is to be a doctor, lawyer, engineer or entomologist. He has simply drifted with and been one in the procession. But between his senior year in high school and his entering into the university he must pass an examination. I have just shown the value of this and all other similar examinations in forming an estimate of what he really knows. In Washington, and possibly, though rarely, elsewhere, a pupil is allowed to specialize in the high school. Here in the city we have a technical high school and a business high school which, although they may not be all that is to be desired among even those most responsible for their existence, constitute a movement in the right direction and should be encouraged both here and elsewhere.

When, therefore, on coming from the high school and presenting himself before the university for admission, where for the first time he is offered separate courses from among which he must make a selection, he naturally expects that his efforts will, or ought, to be directed along a line with what is to be his future occupation; what he is to do in future. But he soon finds that while he may select his course, about the same job lot of instruction will be administered as before.

If he has come to the university of his own accord, as is probably the case, he is like a vessel with steam up, ready to put out to sea. It does not need additional force, what it requires is direction—a pilot with a firm hand and who understands his business. Instead of this, however, the applicant will in most, though not all, cases find himself at once placed in a mental strait jacket, and if it does not fit him

the screws will be applied until he fits the jacket. Incisions will be made in his brain and a heterogeneous mass of instruction forced in. If he can stand the strait jacket and hold the instruction in long enough to pass his examinations, he will be allowed to continue and finally be graduated with much ado and a great flourish of trumpets. If he can not withstand this treatment he is sent home in disgrace.

Mr. Taylor tells us that after he had given up all hope of being able to use as engineers the men who had graduated and gone out from the university, but had been obliged to throw them all overboard until they had spent a couple of years outside in practical work, he found that there was a class going out from these institutions that it paid to look over with a view of securing material for successful engineers; and this was the class that honestly flunked and went back home to work. This, to use a western mining expression, was found to be "pay dirt."

As a matter of fact the embryo entomologist, on his first admission into the freshman class, or as soon as he has decided upon such a course, should be informed that he is there to work; to himself do things and that while there will be examinations he is there to study the science of entomology and not the science of passing examinations. In order to enable him to meet these requirements he should be given first that for which there is the greatest need, and thereafter he should be provided with what he needs, when, and not before, his progress requires it, precisely as with any other tool or instrument.

His first requisites will be honesty and good judgment. If he does not already possess these, he had best stay out of entomology, or any other science, for that matter. His mission, if he succeeds, will be to penetrate the unknown and tell his col-

leagues and the world precisely what he has seen. If he can not do this with strict honesty and good judgment his efforts will be worse than useless. Just the extent to which the present system of recitations and examinations tends to develop honesty and common sense I, for one, have never been able to clearly determine.

Having gained admission and taken up his freshman work, his first need will be that of language. As an investigator he will be required to penetrate the unknown and tell in clear unmistakable language what he saw there. In my own division of the Bureau of Entomology there are, or have been, over twenty-five individuals, engaged in certain investigations, whose field notes, including name of observer, locality and date, are finally copied on library cards and filed in the office under the name of the insect to which they refer. No one can tell when the information contained in these records may be required for use, who will make use of it, or where the original observer will be at that time. He may be one, two or three thousand miles away, even in another part of the world. Therefore, his records must be clear, concise, including every detail, but excluding every superfluous word, in order that any other of the division may be able to understand precisely what the observer intended to state. While the capacity for doing all of this should be attained in the freshman year, as a matter of fact if you find more than one out of every ten or fifteen university graduates who can do this you may consider that you have found an exceptional group. This seems to be one of the requisites, not obtainable in a university course, but which must be secured later.

If the student has not already had a couple of years of Latin in the high school he might take it up at once, for the reason that it contains the key to nearly one half

of the English language, while German holds the key to almost all of the other half. Both German and French are especially rich in scientific literature to which he must have easy and intelligent access. In his case, it is not a classical but a practical working knowledge of these languages that is demanded, and if any of these languages are eliminated it should be Latin. With him it is not a text-book, but a business acquaintance with languages, that he requires. He will very early become aware that the German and French scientific literature with which he will come in contact and which he must read in the original and comprehend, is quite different from that of the classroom. He will be obliged to purchase dictionaries and do a lot of self-education that will not be recognized in ordinary examinations. This need not discourage him, however, as, probably, his instructor would have to do the same thing. A professor of Greek in a theological university once told me, on returning from a summer's sojourn in Greece, that he got on very well after he had become familiar with the language. Also, at the outset the student should have elementary entomology, but it should come in the way of elementary zoology with especial reference to insects. Just what text-book is to be used here I shall leave to the instructor in entomology. Those who write text-books in zoology usually know little of insects, and it is perhaps as well that they do not give more about them. The student will need to refer to considerable literature any way, and the library is the best place to be found for keeping text-books; the more they are kept and used there the better. Entomology should be studied during the warm seasons of the year when insects are alive and active, but somehow it happens that when insects are alive the student who should study them in that condition is too

deeply engrossed in the study of dead languages. This leaves only short periods in fall and spring during which it is possible to observe living insects in the woods and fields. These brief periods should be employed to the best advantage and the student should be told, at the end of the first week of the opening term, that a large quantity of material will be required for laboratory work during winter; that the institution does not regularly supply this except for reference purposes; that it is to be found in plenty in fields and woods, where he must himself procure and preserve it for future use. He should be informed that, right then and there, the system of grading, of merits and demerits, that will be in vogue during his university career will be put into operation, and he should be marked on the quantity, condition and proper preservation of this material. The instructor should by all means be able to spend one or two afternoons each week during good weather in the fields and woods with his students. This will encourage and develop their habits of observation and enable them not only to see things, but learn where and how to find insects and properly preserve them. This last faculty appears to be another factor in the education of an entomologist that frequently there has not, in his four years' training, been time to look after. Probably any one who saw the condition of material sent to the bureau or National Museum for determination would get the same impression. As a matter of fact, all of this should be required in the freshman year and the student marked on the quality of his work precisely as if done in the laboratory. He will and indeed must learn by experience that imperfect, dirty and improperly preserved insects are unsatisfactory subjects for study. It is said that an entomological instructor, in a fit of desperation, sent an

unusually dull student to the college collection to find out the number of legs an insect possessed. The poor fellow, after being out for a considerable time, returned and reported that most of them were possessed of from one to five legs, but occasionally one was found with as many as six legs.

Laboratory work means so much and is so far reaching that it is impossible to overdo it. It is here that the instructor gets the closest to his students and all work together almost like colleagues, thus giving him the opportunity of his life to study his pupils and correct their individual defects. Then, there are so many things that enter into laboratory work, on which the instructor can grade students with absolute justice, developing the traits that we who are to use them later on are so anxious to see in them. I would rather have a few days with a man in the laboratory or field than copies of any number or all of his examination papers.

He should be required to make full notes which may be graded both from an entomological and a literary point of view; he should make drawings, both free-hand and otherwise, dissections and descriptions. Besides an endless variety of rearings, breedings and interbreedings can be carried out.

The aim throughout the entire university course should be to eliminate teaching or instruction just as much as possible, and substitute therefor direction, encouragement with insistence upon accuracy and completeness. The only help given a student should be that which affords the greatest aid in enabling him to help himself. Make him work and do it properly. You who are training entomologists are already doing altogether too much teaching. Fully one third of the energy of the university instructor is being thrown away on account

of being misdirected. Not only does the student fail to profit by this, but it is detrimental instead of beneficial.

Just here I wish to interject an innovation which, if carried out, would mean a great deal, not only for the student himself, but for the one into whose hands he will fall after graduation.

Let the student spend all or as much as possible of his vacations in actual field work under competent entomologists. This work should count in credits for graduation and should be based upon efficiency and quality of work done. At present, he must report for duty at his own expense, often long distances away, which, with the limited compensation he could command, would not be profitable. But if his work counted for credits in the university, he might well afford the expense involved.

In his sophomore and junior years the student will require a knowledge of botany, sufficient to enable him to recognize plants and assign them to their proper family, or genera if common. Beyond this, an entomologist had better consult a botanist. He will need some knowledge of chemistry, geology, climatology, physics, comparative zoology, comparative anatomy, morphology and physiology. He must have some training in histology. He need waste no time on higher mathematics. He can get a working knowledge of mensuration, should it become necessary to apply it. He is already being trained in a science having no superior in developing exactness, acumen, and what a knowledge of higher mathematics does not always presuppose, good judgment. Incidentally, let him read Sherlock Holmes carefully and intelligently.

A few years ago a university that could hardly be convicted of underestimating its own greatness, graduated a student in entomology. By dint of hard, practical work

outside during vacation, and in the laboratory, he was fortunately better equipped in entomology than are most graduates; it was not so much a case of graduating first and completing his education afterwards. His trigonometry, however, proved almost too much for him and remained hovering over his head, like the raven of Poe, until the very last, and, even then came very nearly preventing his graduation. He is making good since leaving the university, and has succeeded in forgetting his trigonometry, which cost him so much in both time and energy, but for which he has no more use than he has for navigation; but is still handicapped for the training in histology for which, while in school, he had begged, but was prohibited from obtaining.

In languages, classroom language may well end here, probably with the freshman year, but his training in the contact, absorption, every-day-use kind, will never end. I might say here that the lazy or don't-care fellow has probably found the work uncongenial and dropped out, also during the freshman year. All of the time continue to give laboratory work whenever possible, and outside work, too, if it can possibly be arranged.

At the beginning of the senior year give your student one or more pieces of original work, no matter what so it involves and brings into action all that he has previously acquired; and include embryology, parthenogenesis, polyembryony, or any others belonging to the most advanced entomological work being carried on elsewhere. Direct him, advise him, encourage him, but make him work out his own salvation and learn to take care of himself under any condition or situation. This sort of a man will need no petting or unusual advantages. He wants only a fair chance and a square deal. He will possess a certain species of solid independence that is quite the reverse

of snobbishness. He will be completely educated before graduation instead of only in part, the remainder to come afterwards. His mind will be clear and active like the spring rushing out of the rock, clear as a crystal, unlike that of a mud puddle just after a summer's thunder storm.

Instead of taking such a man as an experiment, at \$1,000 per year salary, without much of an idea of what I am really getting, I would be only too glad to recommend his appointment at \$1,500. In the first instance, if sent perhaps a thousand miles or so away, he will expect to be told just what to do and how to do it. In the second case, he will keep both mail and wires busy piling up letters and telegrams telling me what he is doing and how he does it. The one must be bolstered up, the other can not be kept down. Your senior needs no teaching or instruction. He does require judicious, kindly but firm direction and you have almost made his future.

Some things are, however, amusing, even in serious matters. Quite possibly in case of the \$1,000 man, his college paper may contain something like this: "Mr. A. B. C., '10, has just accepted a responsible position with the United States Department of Agriculture at Washington. University of X. Y. Z. men are much in demand by this great nation, and this demand appears to exceed the supply." When similar information is allowed escape from the president's office, even with an eye to increased appropriations, the effect is doubly demoralizing.

Now, as I have already explained, the amount of teaching and instruction required will be vastly reduced, but the effectiveness will be correspondingly increased. You will say, however, that I am dealing with only one phase of the problem, that of training the investigator, and

have lost sight of the systematist and teacher.

Relative to the first, let me tell you that the systematist must in future become more and more of an investigator, and, moreover, of precisely the sort I am urging you to develop. Our present system of insect classification is all well enough if you put it away and keep it in Schmitt boxes. The moment you remove it and attempt to build a biological structure upon it, it breaks down. It is too frail and loosely put together. Let me illustrate. Some years ago we had a parasite of a very destructive aphid down in our books as *Lysiphlebus tritici*. In carrying out our investigation it became necessary to find out whether this parasite had more than a single host insect, and whether it could develop in more than one species of aphid. To this end, recently emerged males and females were allowed to pair, after which the female oviposited in several species of aphids. Both parents were then killed and preserved and all of their progeny not used in further experiments were also preserved, and thus entire broods or families were kept together. In this way females were reared out of one host species and allowed to oviposit in others until often after several hosts had been employed it would be bred back into the species whence it first originated. In all cases the host was reared from the moment of birth, while with the parasite both parents and offspring were preserved and kept together. The result of this little fragment of work was to send two genera and fourteen species to the cemetery—you may call it Mt. Synonym Cemetery if you choose—while the insect involved is now *Aphidius testaceipes*. The systematist who studies only dried corpses will soon be out of date.

Now as to the teacher: there has of late grown up among universities and colleges

a traffic, of which you will find no record in commercial literature—the training of teachers and exchanging with each other—a commerce that is indicated in university and scientific publications. This is a kind of intellectual in-and-in breeding. Among animals and plants this is only practised where the intention is to establish a fixed type that will not change but remain stable. Hence it is that your type of teacher and teaching is so fixed and to a certain degree inflexible. A teacher instructs as he was himself taught to do—taught that it was the one and only way. If he departs therefrom to the extent of substituting direction for instruction he feels as though he was a discordant note, and has somehow done something not just right.

This is not intended so much as a criticism as pointing out the fact that it simplifies correction. The matter is one that the pedagogue can change and correct, because the old method has become antiquated. The time was when the pedagogue could and did decide the sort of training necessary, and perhaps it was, at that time, best that he did so, but times have changed since then. Up to not so many years ago when instruction was even more functional than now it was hard to find a university-trained man in the employ of industrial firms or corporations. Now there are many. There must, however, be still further modifications to meet the still more exacting demands at present made upon university-trained men. The business man succeeds by being the first to see a demand as well as the first to supply it. If you will allow me to put it in a homely way, the pedagogue must get down from his antiquated pedestal that is badly affected both by dry rot and *Lyctidæ* and get on to another, more substantial, of concrete and steel perhaps.

You can not suppose, for a moment, that

we can carry on investigations that, ten years ago, we would not have dared to touch, with men trained just as they were ten or twenty years ago. This is far from being a personal matter. It is our irresistible, progressive civilization, the pride of every American, that calls for improvement, and it must come. Slowly, perhaps, but surely.

It has not been my aim in this paper to unduly criticize the progressive instructor, or the institution that is doing its best to break away from the old régime, but to encourage and if possible aid both in their laudable efforts.

If I have been able to put into the hands of those who are to train our entomologists for us in future facts or arguments that will aid them to push for a more rational, natural and therefore easier, though none the less thorough and severe, university training, I shall have certainly accomplished all that was intended.

F. M. WEBSTER

U. S. DEPARTMENT OF AGRICULTURE

*ON THE IMPROVEMENT OF MEDICAL TEACHING*¹

THE watchword of the present is conservation. Especially in the industrial world it has been shown that great improvement is possible by the elimination of needless waste of time and energy. Though not yet so clearly recognized, this is equally true in the field of education. Teachers, especially those in the higher institutions of learning, are notoriously neglectful of the principles and technique of their profession. Unquestionably this results in great losses due to inefficient methods of teaching. These losses, in medical education, may be conservatively estimated at twenty to twenty-five per cent. In other words, the adoption of more efficient methods of teaching would probably enable

¹ Read at the twenty-second annual meeting of the Association of American Medical Colleges, Chicago, February 28, 1912.