Whitman, (C. O.)

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UNIVERSITIES.

BY

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(EXTRACTED FROM THE AMERICAN NATURALIST, JUNE, 1887.)

BIOLOGICAL INSTRUCTION IN UNIVERSITIES.[1]

BY C. O. WHITMAN.[2]

THE discussion of biological instruction in relation to universities would seem properly to fall to those whose professional standing and experience lend weight to their words; but there are some aspects of the question which lie open to all whose connections with university life have been such as to afford more or less varied opportunities for observation and reflection.

At our last annual meeting Prof. Farlow discussed the question in relation to elementary instruction in colleges and schools. It was made very clear that "*the college instructor must still regard the student who studies under him as a school-boy whose capacity for observing and investigating natural objects has been blunted by a one-sided course of instruction at school.*" The charge is a most grave and startling one; but I think no one would venture to question its entire justice.

We know exactly where the evil lies, but I think the remedy is too generally sought in the wrong direction. It is, in my opinion, a great mistake to suppose that it lies within the power of

[1] Read before the American Society of Naturalists, December 29, 1886.

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teachers to abandon methods that lead to such deplorable results. Place in every one of these fitting-schools to-day teachers who know full well the injurious effects of the methods employed, and they would be powerless to abolish the system and replace it by a better. They represent only one of the factors—and that not the most important one—which must co-operate to effect the needed reform. Prof. Farlow suggests that "improvement in the quality of college graduates who could teach biology in schools, if there was any demand for it, gives room for hope." This suggestion brings back at least a part of the responsibility for unsatisfactory methods of teaching to the doors of our colleges and universities. In this direction, more than in any other, lies the remedy for the evils complained of. Our higher institutions of learning represent the creative and directive factor; and to them we must look, first of all, for the supply of competent teachers, and, in the second place, for the creation of that healthy public sentiment which will give support and protection to teachers and school boards in carrying out the desired reforms. The interest of the educated public must be aroused to the supreme importance of cultivating the observing powers of the young before any suitable provision for their training can be expected.

But how shall the capacity for observation be brought into general respect and esteem? Evidently the universities must move first. The stream does not rise higher than its source, and it can hardly be considered a reproach to our preparatory schools, if they do not attach great importance to methods of training, the value of which is not made apparent in the requirements for admission to college. It is the fashion to speak of the "cramming system" as the Pandora's box of all the evils we discover in school methods. But where in this country is the college or university which does not foster the system in its rankest form? It is difficult to see why the system is not as good for the schools as for the universities; and it seems pertinent to ask how the latter, while harboring it, can ever expect to eradicate it in the former. But is it, after all, the system itself against which complaints should be directed? We all have to "cram," more or less; and the process is perfectly legitimate and harmless within certain limits. School education begins in cramming, and all through life we go on stuffing the mind with facts, of which

comparatively few can be assimilated and turned to immediate practical account, while others are simply stored up in the crude undigested state. Observation itself is largely a process of cramming; and every investigator knows that science always keeps a large stock of these unassimilated facts on hand. If the observer places a high value on first-hand knowledge, he knows also how to appreciate results obtained by others, and how to make these his stepping-stones.

But let me not be misunderstood. I do not underestimate the difference between feeding and cramming, while insisting that both processes are legitimate. The trouble now is, that we have too much cramming and altogether too little feeding, as a direct result of a one-sided course of instruction. The field of instruction must be broadened so as to include those branches of knowledge which are now generally acknowledged to afford the best means of developing the powers of observation and comparison. The biological sciences hold this position in the estimation of all, or nearly all, who are competent to judge. Elementary training in these branches should begin in the primary schools, as they do in Germany, and be carried on through the grammar and high schools.

This important reform can only be effected through influences emanating from our higher educational institutions. They must make such a reform not only possible, but also necessary. So long as they usurp the functions of the schools, and persist in devoting a large share of their time to that elementary training which ought to begin in the primary and end in the high schools, so long shall we decry in vain the evils of present methods and courses of school instruction. Turn over to the schools the work that belongs to them, then require it of them, and they will find the means to accomplish it readily enough. By all means let biological instruction in universities be pitched on a higher key. Emerson hit the truth very squarely when he said, "Colleges have their indispensable function,—to teach elements. *But they can only highly serve us when they aim not to drill, but to create.*"

Is it presumption to assert that our higher educational system, so far as biology is concerned, aims too low? Then it must be presumption to affirm a truth susceptible of the clearest demonstration. Fortunately, I may assume that such a demonstration is not required here. But if any one doubts the assertion, let him

compare the best organized biological department this country affords with that found in the best German universities. The student who repairs to Berlin, Leipzig, Heidelberg, Würzburg, Freiburg, Munich, and Jena, finds there institutions that aim to make good the title they wear,—institutions that strive to represent every department of knowledge at its best, and to provide room for every form of intellectual activity. Whatever his special bent, he finds in the lecture-courses and the laboratories precisely what he needs. Representing his specialty, he sees men known and revered throughout the scientific world for their contributions to knowledge. He is recognized, not as an irresponsible school-boy, to be marked for absences, ranked for recitations, and rewarded, after a prescribed number of years of study and decent behavior, with a "graduating" degree; but as a man who knows, or ought to know, his purpose, and who, if he ever expects to attain the distinction of a degree, must demonstrate his eligibility thereto by making some worthy contribution to the advancement of knowledge in his own chosen field. Professor and student both work together to the same great end,—the advancement of science. The influences surrounding one arouse every latent energy, and kindle a love and zeal for work that fairly blaze with enthusiasm. The ideal catholicity of aim that everywhere prevails, and the whole-souled consecration of energy to research, create an intellectual atmosphere that is all aglow with inspiration. And what an imposing array of scholarship is here organized for pushing on the work of each department! Does not the enormous productivity of the twenty-one workshops of science represented in the universities of the German empire proclaim with an emphasis that makes argument superfluous, the importance of high aims in the organization of each and every department of instruction? In Germany, as here and everywhere, the character of the preparatory schools is determined by that of the academic system. But university influence does not stop with the enforcement of eight or nine years of rigid discipline in the gymnasium; it pervades the entire school-system, and is thus in a very large measure directly responsible for the methods and courses of instruction pursued.

The simple secret of this dominating influence is *devotion to research* as the prime means and the chief end of higher education. It is this same crowning feature which creates and keeps

alive popular respect for the investigator and his methods, and which makes biological training not only a possible but also a recognized essential of school-work.

With such an example before us, it ought to be unnecessary to urge the practical lesson it teaches. But we are under the spell of our "historical roots," and there seems to be a too general conviction, or conceit, that we are doing fairly well under the circumstances. In some quarters, allusion to the superiority of the German system is enough to raise a storm of indignation against the "grumbler." And yet we go on year after year sending students abroad to complete their biological education; and in nine cases out of ten they turn their backs on the land of "historical roots" and repair to Germany. The proverbial thoroughness of the Germans, their mastery of methods, the wealth of their literature, and the liberality with which they provide for instruction and assistance in every branch of knowledge, appeal to the strongest instincts and needs of every student who, having resolved to devote his life to the unremunerative service of science, and having availed himself of the best that home instruction affords, still finds himself too poorly equipped for special work.

I am well aware that within the last five or ten years there has been some improvement in this country, both in the methods and the aims of biological instruction. I have in mind especially zoological instruction, but have good reason to believe that the same is true of the botanical side. But unless my observation is greatly at fault, we are almost wholly indebted to German sources for these improvements. A few of our best colleges and universities—unfortunately not all—have in the service of the biological departments men trained in European laboratories, who, in spite of the exorbitant demands made upon their time and energy for elementary courses, undertake to provide for instruction in modern methods of research, and to introduce students into special lines of work. It is certainly one of the hopeful signs, that the incredulity which such methods and courses first encountered is fast lapsing into passive resignation. But I think it is to be regretted that such praiseworthy aims should meet with mere indifferent toleration instead of hearty co-operation and encouragement,—and this too in the very places where their high value ought to receive its first recognition.

It is certainly time that the higher side of biological instruction should receive more attention, and it is unquestionably one of the first duties of an institution, which strives to be a university in reality as well as in name, to see to it that the productive side of the department is encouraged and maintained at a level of high respectability. Scientific activity flourishes only when research is made the dominant aim, and when, for the realization of the aim, the working forces are organized with a view to representing every important side of the department, and on a basis which provides for giving the larger share of energy to productive investigation. For the efficiency of the department, then, we have this double test,—*high aims* and *comprehensive organization.*

What constitutes a properly organized corps of instructors, and what should be the paramount aim in any given department of science, are questions for the specialists in that department. It is the position, the scope, and the tendencies of the sciences represented which claim foremost consideration in such questions. The value of any plan of organization will depend, not upon whether it will provide for the more general needs ascertained by experience, but upon its capacity for expansion and its ability to supply needs not already clamored for. Any organization trimmed to provide merely what the uninstructed public ask for can never fulfil its highest function, which is to *create* and *direct*, not to adapt and conform. An educational institution which limits itself to elementary instruction may advertise itself as a university; but where is the educated public that does not see through the mask of such ill-founded pretensions?

It has been said that in German universities too exclusive regard is paid to the promotion of scientific and literary activity. I wish that academic administration in this country could be justly charged with such a fault. But our boasted "practical" wisdom has never been known to err in the same laudable direction. We hear altogether too much about the necessity of providing for the general purposes of education; but seldom any allusion to the fact, which appears so eminently practical to some of us, that a liberal provision for the higher ends of education is the only means by which those general purposes can be successfully reached. Let a department be organized with a view to the fulfilment of its higher functions, and you place it on the only basis that admits of the healthy exercise of its non-productive

functions. Take care of the creative functions, and the vegetative functions will take care of themselves. The precept is as pertinent to the life of a university as to that of an individual.

The question then reduces itself to this,—How can a biological department be most efficiently and comprehensively organized for the fulfilment of its higher purposes? Every special question which the subject presents finds its solution in the same direction. Take, for example, the preparation of students for teaching biology. It is plainly not a question of turning the biological department into a sort of factory for the manufacture of teachers of the stamp which may just now have the highest market value. The question is not how to fit, but how to equip,—not how young men can be fitted to teach natural history as it happens to be taught now, but how they can be most thoroughly prepared for improving and renovating existing methods and systems. The best teachers have always been investigators; hence the aim should be, on the part of one who proposes to follow teaching as a profession, to become an investigator, and, on the part of university instructors, to make as many investigators as possible. This may be an ideal plan, which, in the majority of cases, cannot be fully carried out on either side; but this, to my mind, so far from being an objection, is its best recommendation. All that I claim is, that the most satisfactory results are to be obtained by working in this direction. A plan is not necessarily impractical because its fullest realization is impossible; and in the organization of any department of instruction in a university, the highest results are never attained where anything less than ideal aims are tolerated.

A practical question of great importance here presents itself: What should be the attitude towards, and what the advice to, students who have a strong predilection for biological research, but who will be dependent for their support on the salaries which they may earn? I believe the policy of discouraging such a purpose has been carried to a dangerous extreme in this country. Those who know by personal experience what it costs to venture in this direction need no apology for the impatience which is aroused, when they see the real difficulties increased by the incubus of discouraging advice and an indifferent, unsympathetic, chilling attitude. Such advice may do little harm to one who has the self-reliance to "plant indomitably on his instincts, and

there abide till the huge world comes round to him," and the courage to defy every obstacle which timid counsels can conjure up; but it works like a damper on the aspirations of many a less resolute mind, and has unquestionably done much to retard the progress of biological work in this country. When those who speak for our leading universities tell us that these institutions are the best places for the prosecution of research, and that we must look to them for most of the work in pure science, we would fain believe it; but when, in the next breath, they proceed to give us solemn warning that we are under the curse of Adam, and that "*the first business of every man is to win his bread*," we begin to suspect that, if the intentions are all right, the policy may be all wrong. When, still further, we are advised that our first concern should be to bring "*to the educational exchange qualities which are always in demand, and which always receive remuneration*," we begin to see that, if such councils are to prevail, the days of "our long apprenticeship to the learning of other lands" are not yet numbered. How utterly unworthy appears such advice by the side of Emerson's inspiring exhortations to self-reliance! Some men never bow to Adam's curse, nor rebel against it; but, busy with higher purposes, ignore it. Such a man was Louis Agassiz. One such example, one such counsellor, puts to shame a world of those who place policy above the noblest aims of life. You might as well command the waters of Niagara to turn back as attempt to still the intellectual hunger of such men by pointing out the difficulties and disappointments which they are likely to encounter if they obey their instincts.

I am certain that every man who places the pursuit of pure science above public applause and the allurements of wealth, in a word, above every mercenary consideration, must be filled with surprise and regret at the avowal of such sentiments by those who are shaping the destinies of our higher educational establishments. Is that what is needed in a country that can boast of nothing higher than the performances of mechanical skill, where there is little market for anything above a bread-and-butter mediocrity, and where there is so little appreciation for any science which cannot be converted into immediate wealth? Just imagine what a dreadful misfortune it would be for this country "if we should find in the course of a few years a superabundance of men with rare acquisitions of a kind for which there is no de-

mand!" Is it possible that any one who realizes the destitution of this country in respect of men devoted to science, and who is aware of the fact that the number must be increased a hundred-fold before a position of fair respectability can be reached, can take alarm at the disposition sometimes shown by graduate students to engage in special lines of research? Whoever fears the tendency of modern science to specialization must have failed to catch the full significance of this tendency. Such counsellors have fallen into the same error against which they warn others. For, instead of looking at the subject broadly and in the light of history, they fix their eyes on some real or imaginary excesses. They find a few narrow-minded men engaged in very special lines of investigation,—men who know their specialty well, but little else,—and they infer that narrowness and specialization necessarily go together. The term specialization has thus been degraded, and specialists find themselves heirs to an opprobrium for which the only foundation is a vulgar misconception. Every specialist who stands on the approval of his own conscience is well able to bear his cross; but he cannot look with indifference on the tendency to superficiality which such a misconception directly encourages. I have in mind more than one aspirant for scientific fame who, from sheer fear of being too special, has fallen a victim to the curse of superficiality. Certainly missionary work is not very far from our doors, and if I am the least qualified of all to undertake such work, I trust I shall not transgress the bounds of propriety in urging others to do it. When we remember that specialization has marked every step in the progress of science, and that every advance in the future must inevitably carry us still farther in the same direction, we can hardly wonder that those who, as spectators, see the grand army of workers splitting up into more and more numerous divisions, as the necessity for more special work arises, should regard the whole movement as one tending to weakness and narrowness. But those who march in the ranks can have no excuse for such a groundless fear. They at least ought to know that there is just as little reason for making specialization a synonyme for narrowness as for connecting generalization with shallowness. None can know better than they that specialization is the only proper basis for generalization, and that the two are indissolubly related as means to end. But there are hangers-on who wear

the uniform and are ambitious to grab the honors without sharing the work. They are a most dangerous foe, for their pretensions are a source of deception to honest people. These are the men who, under the delusion that shallowness is breadth, flit from point to point, snatching a little here and a little there, learning a little of everything and not much of anything, aiming to amaze the vulgar with glib talk and profuse writing, while they disgust every conscientious worker. To such the hard toil of special work is irksome drudgery, proper enough for minds of small calibre, but quite foreign to the philosophical province to which they aspire. You would never recognize these impostors by the names they desecrate; for some of them call themselves zoologists, and insist that staring at the outside of things is the only proper method of teaching or investigating; and a few, seeing that biologist is a word of many meanings, and therefore just adapted to their versatile character, flourish that title. The distinctive mark of the whole genus, as you will always learn on close acquaintance, is a single eye set in the hindhead instead of the forehead. They know nothing of the tendencies of the biological sciences, and are therefore as incapable of steering their own craft as of directing others. The backward vision incapacitates them from ever understanding either the needs of the future or the lesson of the past. They would organize a biological department on a basis suited to the times of Linnæus; because, forsooth, Linnæus was a great man, whose mind could compass a "Systema Naturæ" which embodied all that was then known of the distinctive characters of minerals, plants, and animals. This was natural history in the broadest acceptation of the phrase, and it is only the breadth, as pure surface expansion, that these men look at. They cannot, or will not, see that our intellectual horizon has been extended in proportion as science has made it necessary to sacrifice superficial breadth to profundity.

The misfortune is that these opinions are so generally accepted, as the state of biological instruction in the four hundred or more institutions of the country calling themselves colleges and universities abundantly shows. Argument will never dislodge them; they can be reached only through the leavening influence of high examples. A single biological department organized on a basis broad enough to represent every important branch at its best, and provided with the means necessary to the freest exercise of its

higher functions, would furnish just the example we stand in need of. It is clear enough where we ought to look for such examples, but it is not so clear where or when we shall find them. We have often heard of the "coming university," but still it comes not. Men and money are all that is required to create such a department, and the country has both. We wait only for the rare conjunction of wisdom, will, and means for the realization of the long-postponed expectation.

Having considered the general aims and principles which should determine the organization of a biological department, some of the more dangerous prejudices in the way of improvement, and the source and direction of reform, it remains to notice more precisely the ground to be covered by such a department. As before remarked, the nearest approach to an ideal organization is to be found in German universities. The biological sciences are distributed among five separate institutes, called, respectively, the botanical, the zoological, the physiological, the anatomical, and the pathological. Each institute consists of a spacious edifice, containing special and general laboratories provided with instruments and other necessaries for instruction and investigation, lecture-rooms, library, and museum. The zoological institute has, besides, its aquaria, terraria, and garden; and the botanical institute has, of course, its experimental garden. At the head of the official staff of each institute is the professor, with two or more able assistants, and other subordinates trained to aid in laboratory work. But this is not all, for we often find as many as three or four, and sometimes as many as five or six, professors, ranking as *ordinary*, *ordinary and honorary*, and *extraordinary*, all engaged in the work of a single institute. It is a common thing to find the lecture-work in any given subject divided among three or four eminent investigators, in such a manner that each special side of the subject has its special course of lectures extending through one or more entire semesters. This is the case, for example, with histology and embryology, subjects which are often pointed out in this country as the dangerous extremes of specialization. This division of labor has thus been carried much farther than a superficial glance would lead one to suppose. And has this principle been carried too far? and are there now signs of a reaction? Absolutely nothing of the kind. On the contrary, the marvellous rapidity with which the biological sci-

ences are developing carries it still farther every day. And as the process goes on instruction becomes more thorough and, at the same time, more comprehensive, while investigation marches on with increased speed from one achievement to another. Specialization is a terror only to those who do not understand it. A German specialist devotes ten or fifteen years to the study of the development of the chick or the frog, and a German university provides courses of lectures on just such special subjects as these. Does that appear narrow? Those who imagine that such profound special study means intellectual narrowness could profitably spend five years in the study and contemplation of the facts presented in one of those embryological monographs. In the course of such an experience they might discover that the embryologist's conception of a chick is a little too broad for their idea of a barn-yard fowl. By the time they had followed this unpretentious creature through the animal kingdom, studied the comparative lessons of its anatomy, histology, embryology, and physiology, they would begin to comprehend what a fearfully general thing specialization really is. It might occur to them that more thorough methods of research have made it necessary to limit the field of original work while broadening immensely the field of vision.

The natural history of the last century, as I have said, included mineralogy as well as botany and zoology. In course of time mineralogy dropped out, while zoology and botany were drawn into the closer relation denoted by biology. The word biology was proposed as long ago as 1802, simultaneously, but independently, in France and Germany, by Lamarck and Treviranus. Since that time both divisions of biology have grown to something more than single sciences. Each represents now a great department of knowledge, embracing half a dozen or more distinct sciences. Zoology—leaving aside botany—is subdivided into anatomy, histology, embryology, phylogeny, taxonomy, and physiology. Cytology is a new offshoot, developed from embryology and histology, and forming a common basis for the botanical and zoological sciences.

A lengthy paper might profitably be devoted to the consideration of the scope of these several sciences, with a view to showing how extensive ought to be the provision for instruction and investigation in each. It is not my intention, however, to pursue

the subject further here. It suffices for the present to say that no one of them can be adequately represented by less than two instructors; and some of them require, at least, as many as four or five.

It must be evident to all that no approximation to such a standard of organization is anywhere to be found in this country. It is a common error to suppose that zoological instruction is liberally provided for by one professor and one assistant. You will find that this idea, or a worse one, still regulates the policy of our leading colleges and universities. The result is that we find the professor trying to make a single course of lectures cover anatomy, histology, embryology, cytology, physiology, distribution, evolution, and in fact everything that can be legitimately squeezed in. Allowing that there are circumstances which make it appear advisable to spread so exceedingly thin,—and that is fully enough to concede,—is it not perfectly evident that, where this is the best that can be offered, no claim can be justly made to providing for the higher needs of lecture-courses? But what shall be said of those institutions which aim to take foremost rank among our universities, and yet regard zoology as too narrow a field for one man, requiring the professor to shoulder the burden of directing the instruction in zoology and botany, and in some cases physiology too? And ought we to let it go unmentioned that some colleges and universities of high respectability still abide in the typical Linnæan stage of development, leaving one man to grapple with the whole system of nature? Still greater marvels of persistent ancestral types might be placed before you, but certainly they would not improve the picture.

Our need is a few creditable examples, and to those who know what such examples call for we must look for their ultimate attainment.

June 29, 1887.