LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Zoology in the college course.

THE recent appearance of three zoölogical text-books, so diverse in treatment as to be well-nigh contradictory, revives the question, 'How shall zoölogy be taught?' The three books to which I refer are Packard's 'Zoölogy,' Colton's 'Practical zoölogy,' and Sedgwick and Wilson's 'General biology.' The first of these has already proven its popularity by passing through several editions. But popularity and real merit are not identical in meaning. Professor Packard's work is a conspectus of the animal kingdom: it may justly be termed an elementary study of the classification of animals. The student is constantly brought to view orders or classes as exemplified in a few types selected for study.

Sedgwick and Wilson designed their work for college use. The latter part of it is an introduction to the study of zoölogy. It is the counterpart of Packard's 'Zoölogy.' In it the principles and facts of classification are not first in importance, but the student is kept upon the study of one animal until he has mastered it from every stand-point, — anatomical, histological, embryological, and also to some extent physiological.

Colton's 'Practical zoölogy' occupies a place between the other two. It was not designed for use as a college text-book, and we should not speak of it here but for the fact that it will be used in many colleges, and we consider that it has serious limitations if used for this purpose, and should be largely added to, to make it capable of doing proper service. The work is virtually a set of superficial studies of the gross anatomy of a variety of animals arranged without reference to classification. Only the most easily seen features in the anatomy are touched upon, and all the more difficult ones are omitted.

We consider these text-books as representing two distinct ideas in zoölogical teaching, and the third a compromise between them: first, the view that the student of zoölogy should have at least a glimpse at every large group in the animal kingdom; second, the view that the student should have a very full fund of information about a very few forms; and the third, the attempt at bridging the chasm between them. The first view leads to superficial knowledge of the whole, the second to thorough knowledge of a part, and the compromise secures neither result.

Before considering the relative merits of these two ideas, we must be careful to make it understood that we are speaking now of a college course in zoölogy, and neither, on the one hand, a high-school course in natural history, nor, on the other hand, a professional course in zoölogy. Zoölogy is not taught in college to make zoölogists: it should guide such study of the phenomena of animal life as will best increase the powers of observation or quicken the activity of perception, but, at the same time, not omit to acquaint the student with the principles of the science, and ground him well for future deeper study, should he ever wish to pursue it. If the college course has, then, this twofold purpose, — to develop the student's powers and to show him somewhat of the science of zoölogy, — two questions arise: what is zoölogy as a science, and does it train the mind aright by its pursuit?

Zoölogy was advanced from a dry collation of ill-understood facts to a living science, and with this growth its study has outgrown its old place in the curriculum. The progressive colleges give it more prominence and a strong force of instructors, and furnish laboratories, etc., for work. Even the most conservative have seasoned the ancient and dishonorable practice of a course of lectures on zoölogy without any laboratory work, with some work upon the animals studied. With this change should go the desire, dear to so many instructors' hearts, to inform the student with all the facts he has gathered after long toil. As we discard the false notion that even the briefest course must still include some knowledge of every group, and realize that by 'elementary' we mean, not more dilute knowledge of a great variety of creatures, but thorough knowledge of fewer, we are in a position to use the laboratory for its legitimate purpose. This purpose is to study animals as the zoölogist studies them, not fully enough to learn all zoölogy, but fully enough to intelligently understand the work of the zoölogist, including the student of physiology and pathology, securing at the same time zoölogical training just so far as the study is pursued. It is all wrong and pernicious for the teacher to feel that he must get his class 'over the ground.' There is no limit to the amount to be done, and he can't 'go over the ground' except most superficially. The feeling that each large group must receive some attention, however slight, is really most harmful, though very wide-spread. The experiment is tried every year of making students apprehend principles before they have mastered enough facts, and it is always most unsatisfactory in its results.

Zoölogy is not at the present time chiefly concerned in the discrimination of species, which forms but a minor issue; but the bulk of study is in the direction of anatomy and histology, embryology and physiology. These studies all lead later to the consideration of many very difficult problems, and among them those of classification; but the zoölogist is not in a position to attack these at the outset of his study. At first he must pursue many little details, tiresome or fascinating as the case may be, such as fine dissection, section-cutting, with minutest attention to the processes of hardening, staining, embedding, cutting, and mounting, careful study and interpretation of sections, various careful experimental observations, and all these attended to with all possible precision. No one has a right to claim a notion of the science of zoölogy who has not had considerable training in such work, met some of its difficulties, and thus acquired information for himself along the arduous road of the zoölogist. Furnished thus with facts, he is ready to take some of the higher steps of the scientific zoölogist and seek the law which unifies his observations or the general principle which underlies them. How valuable an idea of the cell, its derivation, differentiation, etc., has one who has gotten his idea of cells from blackboard drawings? But let him study the growth from embryonic epidermis of skin, hair, nail, and gland, and differentiation begins to take on meaning.

While only direct observation can give the student an adequate conception of the science of zoölogy, it at the same time secures to him the very best for which natural science training is of educational value. It is not so much the variety of observations as their exactness which produces valuable results in this direction. Nothing so irksome as exactness, nothing

so unusual, but nothing so desirable in education, whose purpose is, not to make things easy, but to strengthen ability to master difficult ones. It is just this training which zoölogy should furnish.

It may be set down as certain that in the brief time usually allotted to zoölogy in college no student can master both the technique of zoölogy and a complete survey of the classification. It is also certain that he cannot acquire without laboratory work a zoölogist's conception of, we will say, a crustacean. He may dissect a cray-fish and then be informed that it is a crustacean, in which case he merely understands the terms 'cray-fish' and 'crustacean' to be synonymous. But let him take a cray-fish or lobster for his first study; let him dissect it and study its cellular structure; let him study its larval stages. From it let him go to other macrourans and compare their forms, all the way from *Gebia* to *Hippa*. Let him have access to the systematic treatise, and hunt out the genus and species. Let him compare it with the schizopod and the crab, and with the megalops of the crab, and he will then form some adequate conception of the zoölogist's meaning of a crustacean.

We believe this to be the true way to teach zoölogy, for we doubt the value to a man of a mass of indefinite ill-digested text-book information. Occasionally an omnivore can take in every thing, and digest and so metabolize it as to organize it into healthy mental tissue. They are, however, the few.

If the requirement of zoölogy from a text-book be such as this outline would indicate, obviously no text-book can ever fully meet it. For the systematic work no smattering key but the original description should be consulted if possible. Upon the anatomy and histology the student should have the use of original articles, monographs, etc. This is, however, not always possible, but the nearest approach to it should be the chosen course. Sedgwick and Wilson's work comes the nearest to being such a text-book of any with which we are familiar. We should have preferred the selection of some animal with a larger circle of cousins and other relatives, both near and distant, and think that a crustacean or a coelenterate might be taken to exhibit better the science.

It will mark a long stride of improvement for the science of zoölogy when teachers and examiners will be content to allow the student to become broad only after he has been narrow, in place of exacting of him a large amount of varied information which is only skin deep, will foster and encourage methods of work which will make him the master of the facts. The real test of the merit of a zoölogical student should be made to lie in what he can do, how much he can see, — his ability to demonstrate facts in zoölogical science, and not merely or chiefly, as at present too largely, in how much he knows.

L. H.

Elementary instruction in zoology.

Seldom have I read an article, among the many that have been recently published dealing with that all-important question as to why biology should constitute one of the leading educational branches in the schools and universities, with more interest than I did the one contributed by Prof. H. W. Conn, and published in the issue of *Science* which appeared upon the 18th of last month.

To my mind, it not only presents in the most masterly manner why biology should be introduced into the curriculum of every grade of school, from the primary classes to the university, but how, within the near future, such a happy result will with great certainty come about.

I can remember very well how, a number of years ago, I read with the keenest interest all of Huxley's now classical essays upon this subject, and watched the untiring efforts of his to force upon the attention of those in authority in educational matters in England the prime importance of an early introduction of the biological studies not only into the graded schools, but into the curriculum of every university.

There are many, many teachers and educators in this country to-day that now hold the views of Huxley in nearly all essential particulars; and those who have thoughtfully followed, step by step, the growth of the natural sciences with us, since the early days of this century to the present hour, know full well that the time is not far distant when the education of the individual will by no means be considered a liberal one, unless it comprehends a very clear understanding of the principles of biology in their widest sense.

For more than a quarter of a century it has been my good fortune to have been able, in common with others of my date in the fields of science, to watch and study the several highly interesting phases through which the natural sciences have successively passed. These phases seem to divide themselves naturally into three quite well-marked stages; and these stages may be characterized by comparing them with the way in which any animal or group of animals has been studied. In times gone by, naturalists dealt first with the mere description of animals, — the narrative stage, as it were, — and the literature of the subject partook almost exclusively of this style of treatment. But as the knowledge of animals became more accurate, and freed of its mythical taint, why, then the needs of the minds of men demanded more than this, and the subject naturally passed into its second stage, and the study became highly classificatory. Classification reduced the enormous amount of almost chaotic descriptive literature to order and system. Next the study of the natural sciences gradually passed into its third and present stage, wherein classification is being checked and corrected by the wide-spread attention that is being devoted to the subject of structure, — the morphology of animals. It is needless for me to add here that the outcome of the present phase is slowly bringing to light a knowledge of the fundamental life-principles of organized nature, and an understanding of the universal laws that apply to the whole.

As the pressure of the necessity for the teaching of biology in the schools became greater and greater in recent times, it was soon followed by the outcropping of the text-books to be used for the purpose; and it has been with the very deepest interest possible that I have studied the casting of these very volumes. Some of them have still clinging to their pages many of the traces of the 'narrative' phase of the science; others are largely classificatory; while still others, intended even for the youngest minds, deal chiefly with morphology, — with healthy hints of a juvenile calibre, at the underlying principles of life, judiciously introduced.

From this point, space now demands that I be brief in my remarks; and I will, in concluding, simply present my matured views upon the subject of elementary teaching in biology, irrespective of any of