

ture has been conducting a series of experiments with both seedlings and hybrids for the purpose of developing a hardy variety suitable to the climatic conditions of the southern parts of the United States. An account of this work is given in the U. S. Department of Agriculture Year Book for 1904.

Oranges are frequently raised in our northern states for ornamental purposes, but in many cases the results are unsatisfactory because of the belief of many people that tropical plants grow continuously the year round. After fruiting, these ornamental trees should be allowed two months rest at a temperature of 40 to 50 degrees, and with a limited amount of water.

Oranges, like all plants that have been introduced from foreign countries, are subject to many insect pests, fungus and bacterial diseases. An introduced plant is always subject to a greater or less extent to new diseases which are common to other more resistant plants of its new home and these diseases are carried with the plant in its introduction from country to country. So the orange grower must always contend with many difficulties if he is to grow a successful crop of fruit. However, thanks to the work of our Department of Agriculture and to the many State Experiment Stations, these diseases are being studied and methods devised by which they can, in a great measure, be controlled.

WHERE SHALL THE COURSE IN ZOOLOGY BEGIN?

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Probably a large majority of the teachers of Zoology begin the course with the lowest forms and take up the various groups in the order of development, proceeding from the lowest to the highest in as nearly regular sequence as practicable. But a very considerable number of teachers prefer to begin with a higher type, such as the grasshopper or the crayfish. Recent textbooks, like Colton's and Davenport's, adopt the latter plan, while Jordan, Kellogg and Heath's "Animal Studies," and Kellogg's Elementary Zoology, begin with the lower types. Peabody, in his contribution to the "Teaching of Zoology," makes a strong argument for commencing with the crayfish. I wish

to examine the arguments for the irregular order of study and show why it is not a good plan for the average zoology teacher to adopt, or, to put it more truthfully, why I believe it is not the best course for any teacher to adopt.

In the case of those who like to start with the crayfish the principal incentives are in the size of the animal, its interesting traits and convenience for use, and the important problems that may be worked out by its study. Now, of course, all these good points are just as good when the crayfish is reached in the regular order, and so far as the study of the animal is concerned there is nothing gained or lost by the difference in time in taking up the study. The question, then, really is as to whether the crayfish is a good type for *beginning* the work in zoology from the standpoint of results to the pupil.

What are the objections to using the crayfish in this way? Every enthusiastic teacher wishes his pupils to develop a liking for the study and to take pleasure in it. If one goes beyond a superficial study of the crayfish and tries to develop the zoological principles that may be brought out, such as homology, differentiation, specialization, etc., a thorough laboratory study must be made as a basis for developing these principles. With beginners this would require several weeks time. For the average teacher there would be serious danger that disgust rather than enthusiasm would be awakened by such a prolonged study, when we take into account that most of the work must be done with dead material which, in the case of the crayfish, cannot be made very attractive, to say the least. Apropos to this, I remember meeting some pupils of a course in zoology, which began with a laboratory study of the soft shell crab. All they seemed to have retained of that course was the memory of those alcoholic specimens of crabs over which they had held their noses daily for some weeks. While this was an exaggerated case undoubtedly, it points out a real difficulty. The success of the course depends upon the good will of the pupils for the work and a failure to secure this good will means the failure of the teaching. It would be simply marking time, but not teaching.

To add to the danger from this point, the difficulty of the study of the crayfish must be taken into account. The crayfish is a highly specialized animal and there are a great many parts

with a very formidable array of names to be memorized. Laboratory work to be valuable must be recorded in accurate sketches, and those required for the crayfish are among the most difficult in the entire course. Altogether it would seem that only the most expert teachers could hope to carry beginning classes safely through the crayfish studies without loss of interest through discouraging difficulties and unpleasant material.

But, to my mind, these difficulties just mentioned are of minor importance compared with the pedagogical error of such a course. All the zoological principles which the teacher of zoology strives to have his pupils gain an understanding of from the study of the crayfish are, after all, but names for certain external indications of the efforts of the crayfish race to adjust itself to its environment. The crayfish has its problem of life and has been adapted in structure to solving this problem. To appreciate this underlying principle which explains and gives meaning to all else, the pupil needs a back ground of the study of several animals, but especially of the lower animals where the response of the animal is more obvious, such as the case of the Annelid worms with a comparison of Nereis and the Earthworm. The pupil who is meeting the crayfish as his first study can have no comprehension of the effect of habitat upon the animal, and the zoological principles he gathers from the crayfish have no meaning or explanation to him—they would be simply “hung up in the air” until the requisite back ground could be secured. Pedagogically, then, I do not see how the study of the crayfish for beginners can be defended.

Those who begin with the grasshopper may be divided into two groups, viz., those who are led to it for the same reasons that make others choose the crayfish, and those who begin with the grasshoppers for the sake of studying insects at a favorable time of year. The objections made to the study of the crayfish for beginners apply equally well to the grasshopper study. But, I do sympathize with those teachers who wish to study insects while they are alive and to be found in every vacant lot. However, I have a plan explained further on which seems to meet this need felt by all teachers who use the regular order of studies as well as those who begin their course with the grasshopper.

Let us consider now the objections often made to beginning the course with the Protozoa. The following seem to be the principal objections: 1. The pupil must at the outset learn the use of a complicated instrument. 2. The pupil's view of the animal is distorted because he sees them greatly magnified. 3. There are serious difficulties of manipulation both with the microscope and with the material. 4. A fine opportunity for field work is lost while the pupil is at work on these lower forms. I shall take up these objections in order.

So far as my experience goes, pupils are always eager to learn all about the microscope, what it can do and how it does its work. If care is used there is little difficulty in teaching the use of the microscope and, indeed, it must be done sooner or later. I have found that the opening days of school while the classes are forming are particularly favorable for this work. As to the second and third objections it all depends upon how the Protozoan studies are planned. I would not think of trying to start off with an *Amoeba* study. If the *Paramoecium* is used for the main Protozoan study there will be little difficulty. They can be cultivated in the laboratory by the million with almost absolute certainty of having them ready at just the right time. They are large enough to be seen with the unaided eye and a correct idea of their real size obtained. Nearly all the observations needed can be made with low powers of the microscope, and the study so arranged that the more difficult observations with the high power will come at the end of the study and not seriously mar the work if some of the pupils fail in them. With the experience gained by the study of *Paramoecium* very brief studies of other Protozoans will suffice.

As to the objection in regard to the field work, I feel that it would be well grounded if one must really lose it while working with the Protozoa. But many teachers have found a way out of the difficulty. They take the field trips or stop for laboratory study of perishable live material at opportune times whenever they come. A break of a day or two at a time in the routine is not serious and, in fact, gives a welcome change. Any teacher can devise short lessons for these brief field or laboratory studies of the living animal, then the laboratory notes of the pupils are laid aside until the study is reached in regular order. The impressions

gained by contact with the live animal will not be lost and can be easily gathered up again at the right time. Much more study of the live animal, both in the field and in the laboratory, can be obtained in this way than by any other course.

As to the pedagogical advantages gained by following the order of development from the lower to the higher, I need not say much, for everybody appreciates that it is the logical course. I will mention some of the points that appeal most strongly to me. The lower animals are simple and little specialized and for this reason the attention of the pupils can be concentrated upon the primary conditions of animal life at the outset, a most decided advantage. Then, too, the fundamental principles of zoology are discovered one by one and step by step as the work goes on, not in complex form, but in their simplest form. They are not obscured by a wealth of details as in the case of the higher animals. The pupils become accustomed to handling animals gradually and the drawing work is simple. There is time to enforce and drill over and over again the important topics so necessary for success with beginners.

There has been much objection among educators to receiving elementary zoology into the ranks of subjects preparatory for college. There has been some change of attitude in this respect, but physics is still the only science that is required for admission to college. The reasons given for this attitude are that zoology teaching is not well organized, and that there is no disciplinary value in the work of zoology, therefore it should not be listed as a college preparatory subject.

The remedy for this, I think, lies in our own hands. There is no doubt that the charge that the zoology course was not well organized, was well founded when it was first made, but the conditions are rapidly changing. Formerly zoology was a make-shift subject, and was relegated to almost any teacher who did not happen to have full work. In the best schools now-a-days the biology teacher is specially prepared for his work and often has won his doctor's degree at a university. There is now, also, a number of good text-books and manuals for the teacher's selection. Altogether, there seems to be no good reason why good consistent courses in zoology may not be given, courses that are progressive and give the student an increasing grasp

of the subject as the work proceeds. Whether this shall be done now depends upon the teacher. Let us not as teachers lose sight of the primary purpose of a course in a search for an easy or an interesting road.

There is no inherent reason why a well-planned course in elementary zoology should have not disciplinary value. If zoology is worthy of inclusion in college courses, there can be no good reason for excluding it from secondary school courses, or for saying that it does not have disciplinary value when taught in a secondary school, but is all right when taught in a college. Again, it all depends upon the teaching in the secondary school as well as in the college as to what value the course has. If the course is well planned and the fundamental principles are insistently sought after and enforced it must be of disciplinary value. Such a course need not be dry or uninteresting, on the contrary it will give the pupil conscious power to interpret nature, a much more real pleasure than any superficial course can give. I feel strongly that the logical courses proceeding so far as practicable step by step from the lower to the higher is the best course for the great majority of teachers to use, and that it is a mistake to advocate the irregular course. While, undoubtedly some teachers may plan consistent progressive courses of that sort and carry them to successful issue, it does not follow that it can safely be made a general practice or that it is the best course.

PLANT ACTION IN THE FORMATION OF CAVES AND CLIFFS.

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Plants are active agents in rock disintegration. The physiographer is well aware of their efficiency in breaking up talus blocks or glacial erratics, by the wedging power of their growing roots. The penetration of roots into the earth is everywhere recognized as a most efficient agent in reducing partially disintegrated rocks into soil. Chemically, too, plants are powerful workers in rock weathering in several of its phases. Indirectly, by furnishing carbon dioxide, in the decay of plant tissue, which