

tabulation of the insect enemies of the apple already recognized in this country shows 281 species, of clover 82 species, and of so new a crop as the sugar beet 70 species. The insects of the vine, of the orange, of the wheat crop, and, in fact, of all of our prominent staples, show equally startling figures."

In another place Dr. Howard quotes statistics showing that half the cattle received at the Union Stock Yards of Chicago in 1889, were afflicted with the ox bot fly, or ox warble, resulting in an actual loss of over three million dollars in six months from that one insect alone. Instances of insect ravages might easily be multiplied *ad infinitum*. The only redeeming feature of this situation is the wonderful industry of our scientists, who in all parts of the world, have studied the problems of fighting and exterminating the foe. The public has been educated, also, in a few of the fundamental principles of economic entomology, especially in regard to the value of birds in combating insects. We are becoming more than ever impressed with the dangerous character of flies and mosquitoes. Experiments in the eradication of mosquitoes have been carried on in many parts of the country. We all know what has already been done along this line in some tropical regions. Reference will be made in another paragraph to the extraordinary battle waged in California against the scale insects. Indeed, we may say, in summing up this part of the subject, that no warfare was ever more scientifically waged than the present warfare of civilization against noxious insects, allowing, of course, that there is still ample room for improvement.

*(To be concluded in June.)*

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## THE VALUE OF MAKING AN HERBARIUM.

BY JOHN E. CAMERON,

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There should be three kinds of work required in an elementary course in botany. These three kinds are: (a) General observations in the field. Pupils should be familiar with the common names of plants, the natural conditions under which they grow, their rela-

tions to their surroundings, to animals and to each other. (b) Work in the laboratory, consisting of the study of plant structures, plant function and plant physiology. There should also be experiments with plants to determine the various conditions under which seeds will grow and to determine how the plants may be affected by light and darkness, heat and cold, moisture and dryness. (c) Work in recitation room where the facts observed in the field and the laboratory may be classified and systematized, where the practical knowledge relating to plants may be made more prominent. These three kinds of work, together with the study of a good elementary text on the subject, should prepare the pupil to get much useful knowledge out of the plant life surrounding him.

But the methods employed in getting the work done have not proved satisfactory. The laboratory work and the recitation room work have been carried on without the field work. Today the unsatisfactory condition exists in the study of elementary botany because an attempt has been made to introduce botany into the high school from the standpoint of the college. The pupil is expected to plunge directly into laboratory work, to study minute structures of plants, and to consider many of the advanced problems before he has been given an opportunity of learning the elements of the subject.

The topics presented should be within the range of the pupil's understanding. He must know the names and have practical knowledge of the various herbs, shrubs and trees, so that he may know which are useful and which are harmful to mankind. He must have a knowledge of the conditions under which each plant grows, and the way in which each plant adapts itself to its environment. He should know how pollination is accomplished and how seeds are distributed. When the pupil is familiar with the many forms of plants around him, he is then fitted to take up the more advanced problems presented by the subject.

But how is the pupil to become familiar with the plant life around him? Can he do so by spending all his time with minute structures, with cultivated plants, or with leaves, flowers and seeds, brought into the laboratory without his having any knowledge of where they came from and of the conditions under which they grow? The pupil must go outside of the laboratory and see the

tree or other plant growing as a whole in its natural habitat. The entire life history of the plant must be worked out if the knowledge obtained is to be of the most use to him.

The laboratory work is necessary, but the field work must be done if desired results are accomplished. It is no trouble for the high school teacher to get the pupils to go into the laboratory or recitation room for an hour or more a day for work; but when he attempts to have the pupils go into the field to learn where and how plants grow, he has a difficult problem to solve. The teacher has other classes and he cannot leave the school room during school hours. The pupils are retained there for the same reasons, and only the more interested ones will go after school hours. The teacher is compelled to have some method of getting all the class out into the field. Field trips are planned, but many of the less interested pupils will find an excuse for not going, and those that do go will not get so much out of the work as they would if some of the plants were collected and kept for future study. If a teacher requires a collection of at least twenty-five specimens of plants, he will create an interest in the field excursions. The pupils will all want to learn the names of the different plants, where each plant grows, the character of the plant, everything about it, for he may have to make a record of it in his plant herbarium. The teacher is thus able to give proper credit for individual work—the kind of work that will be of the most use to the pupil in later life.

The making of the herbarium is not for the sake of the herbarium, but it is used as an incentive to get the pupils out into the field in order that all phases of plant ecology and plant life may be considered. Thus the field work is carried on hand in hand with laboratory and recitation-room work.

Much valuable time is often wasted in learning the technical terms required in plant descriptions. These terms must be learned so that the pupil may be able to use intelligently a simple plant key such as the "Key to Native and Cultivated Plants" by Prof. Macbride of the State University of Iowa.

Every herbarium should contain a list of the more common terms and their definitions arranged in such a way as to enable the

pupil to learn them in the shortest possible time—an important item in a brief course in botany.

While the pupil is learning to describe plants in the laboratory, the terms relating to the root, stem, leaves, flowers and seed can be placed before him in the form of a “Key to Plant Description” as a general outline. The teacher can readily supply the other necessary terms to describe the plant in hand, and thus the work of the teacher will be lightened and the pupil gain interest and rapidity in writing the plant descriptions necessary for his herbarium.

The knowledge gained by the comparison of plants and the arrangement of these in their proper orders or families can be obtained in no other way as easily as by making a plant collection. Systematic botany should not be eliminated from the elementary course of study if we wish the pupil to have a general knowledge of the subject.

Objections have been made to the making of an herbarium because the work is largely mechanical. The high schools of today are in need of more manual training, not less of it, because it furnishes an outlet for the physical energy of the pupils. The writer has had several years’ experience in both methods of presenting the subject of modern botany, and has found the best results obtained when an herbarium was made.

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## LABORATORY STUDY OF A RIVER.

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As rivers do the greater part of the sculpturing of the earth’s surface, the study of their action forms one of the most important topics of physical geography. But a river that is making perceptible changes is rarely accessible to a class, and the natural processes are too slow for the river’s history to be readily understood by the beginner. The entire development of a river valley can be shown by a simple laboratory experiment, which may easily be prepared in any school giving elementary physical geography.