

further than for the making of a natural skeleton. Ten or fifteen minutes boiling is sometimes sufficient for a young kitten. The bones must not be boiled until the epiphyses separate from the diaphyses.

OUT-DOOR WORK BY THE PUPIL ON HIS DAILY TRIPS TO SCHOOL.

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It is quite unnecessary for me to say in the beginning, that if there is any educational value in the study of biology, it is in the fact that it cultivates the habit of accuracy. Whether a pupil is to become a botanist, or a book-keeper, a bank-clerk or what not, makes no difference. The training he gets in the biological laboratory will be of the greatest value. An accurate botanist or zoologist will be accurate wherever he is.

But there is danger, especially when classes are large and a teacher's time is limited, that scientific observation be confined to the tables of the laboratory alone. It is altogether possible for a pupil to do good work in the laboratory, hand in good note books and yet know but little of his daily surroundings. A pupil may be able to describe accurately a plant laid before him on the laboratory table and not be able afterward to recognize the same plant in the woods. I have had pupils who could point out the difference between the leaves of the sugar and silver maples and yet were not able to tell these trees apart on the street. In other words, a pupil may be a fairly good observer of things through a lens or microscope and yet be a poor observer out of doors.

Twenty years ago the teaching of botany in this state consisted chiefly in plant description and identification by means principally of the flower. That was the kind of botany taught me and however much it may have been condemned, yet the so called "analysis of flowers" was a delightful study. I would make long journeys into the woods and along lake shores and river valleys that I might have the pleasure of finding a specimen new to me. That was the way I taught botany and I had my pupils watch for the first spring flowers just as the Audubon people are now doing with the birds. Now it may be that the old way of teaching botany or the old matter that was taught, was not so scientific as more modern methods and subject matter, yet they had at least

one virtue, and that is, they took the pupil out into the woods. If the only object the pupil had was to find a new flower and a new name, yet he learned unconsciously its habitat, could tell you exactly where to look for others like it and could recognize others as far as he could see them.

Then came the days of the microscope and stains and paraffin, etc., and instead of sending the pupils out into the woods we had to make sections for them and show them cells and they had to draw and describe from the microscope.

Now while the cell is the unit of structure, and while it might seem that there would be the logical place to begin the study of biology, yet a knowledge of cells is not what pupils of high school age should know about first. It is more important that any one should know first the place where liverworts grow and how they look when they are growing and where one may expect to find them than to know how great a differentiation has taken place among its cells or what is its life history.

I have known college students who have worked out the whole of the life history of *Marchantia* and had never seen the plant growing in its native haunts. I remember well my experience with *Nostoc*. I worked it out in the laboratory and thought I was well acquainted with it, but it was long after I had finished it before I found it and when I did find it, didn't know what it was.

But this is not such a bad thing among college or university students for they have or ought to have a large background of scientific observation upon which to base their laboratory work, even if it be on plants other than those upon which they are working, but for high school pupils of the first year it does make a difference, for we must remember that on account of their extreme youth for one thing, they have no background upon which to work and in the larger towns and cities they have but little opportunity to learn anything about plants and animals from actual observation.

It is more important first that high school pupils be able to know mosses or ferns and be able to know where to find what plants they want than to know what is meant by the alternation of generations. In other words it is of *first* importance that high school pupils know the natural history of a large number of plants than their life history. Their laboratory work will then have meaning.

Now what can be done in any high school to cultivate to a greater or less degree the habit of observing things outside the laboratory? I can only give my experience, what I have and am doing and about the only thing possible with a hundred and forty pupils in botany and a programme of seven periods per day.

In the fall of the year, for about two months or so long as the weather permits, we study trees. I have a blank form for tree description, much like the old flower description blanks that were used years ago. We have a good many trees on the school lot. I take the sections of the class out for their period of time allotted on the programme. I work with them, tell them exactly what to do and see that each pupil does exactly what he is told to do. For example, we practice measuring the heights of the trees. Of course with the crude methods that must be used in measuring, accurate heights cannot be obtained but one will often be surprised at the accuracy pupils acquire after very little practice. After we have had some experience in this, I tell them to judge the heights before measuring and then verify or correct their judgment by measurement. Then we take up the other steps in the outline such as the bark, leaves, sap, fruit, etc. Each pupil has pencil and tablet and makes the briefest kind of notes from which he is expected to write a complete description. In the laboratory I give them notes on the commercial value of each tree, such as the use of lumber, sap, or fruit, and discuss with them the value of each tree as a street tree. We also discuss methods of tree pruning, for in these days of telegraph and telephone wires we find that trees are sometimes pruned with more regard for industries than to increase the beauty of the tree.

There are some days of course when we have to stay in the house on account of bad weather and on such days we write up our notes and learn to identify the specimens. Then when we have described all of the trees on the lot, we begin with those on the street around the block. Of course we find some like those we have had, but it requires as close observation to discover this as if they were unlike those described. In a similar manner we are able to describe the trees around four blocks and yet get back to the school building on time.

Then each pupil is required to bring in a check list of the trees around his home block and the descriptions of any new ones that may be found there. Then he is required to make a list of all the trees he passes on the street along his regular route to and from

school. Several times I have been able to make out a fairly complete check list of all the trees in our city streets, from the lists prepared by the pupils.

When they are able to work quite independently and rapidly, I have the programme arranged so that I may take the sections of the class, one at a time, to the woods. In ten minutes from the time we get a street car we are in the woods in a river valley where we can see the trees growing in their native surroundings and can in an elementary way see how plants are influenced by their surroundings.

I try to make the subject as practical as possible and the parents and citizens have become interested. Our mayor told me that if we would recommend a list of trees that were good street trees he would see that an ordinance be passed prohibiting the planting of any other kind in our city streets. But the thing that is of greatest value is the habit which the pupil acquires of looking at things intelligently. I have had pupils who have gone out of school tell me that they never ride through the country that they are not trying to make out what the trees are which they see in passing.

I do not know what can be done in other subjects to cultivate this habit but good work may be done by pupils on their journeys to and from school in observing the street trees. Of course there are many other things to which attention may be called. The unicellular plants that we study is the *Pleurococcus*, which grows abundantly on the bark of trees and by the time we get around to that, the pupils know from their own observations something of its habitat, where to look for it, how it looks growing and that it may be had in fresh condition at almost any time of the year.

One need not expect much from high school pupils if they are sent out alone and told to observe, but if they are given a certain thing to do such as making out a list of the trees on a certain street, one will get fairly good results. If one gets one class started in this kind of work, the plan is established for in some way the habit is passed along to the next class before it reaches you.

Let me say in conclusion, that there is no one thing that helps me so much with my indoor work as this habit which the pupils may acquire of seeing things which they pass every day.