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induced varies with the rapidity with which the magnet is thrust into the coil or taken out of it. When the pole of the bar magnet is thrust into the coil quickly the deflection of the galvanometer is much more violent than when the motion is slow.

Finally, the discovery of Faraday made clear the fact that an induced current can be produced in a closed coil of wire by increasing or decreasing the number of lines of magnetic force threading the coil. We know also from Ohm's law that the magnitude of an electric current produced in a coil, where the resistence is constant, varies directly as its electro-motive force. We know also now that what really is induced in the Faraday experiments is electric pressure, or electro-motive force. Faraday's discovery in more specific terms means that the E. M. F. of an induced current varies directly as the rate of change of the number of magnetic lines of force threading the circuit of the coil affected. When this rate equals 10,000,000 lines of magnetic force per second there will be just one volt of E. M. F. induced.

The principle of current induction is no doubt the most important of all the principles of current electricity and every teacher should make a special effort to present it clearly to a class. The apparatus represented in figure 3 consisting of a primary and a secondary coil is listed at $4.50 in the catalog of the Central Scientific Company of Chicago, Ill. A galvanometer, sufficiently sensitive for these experiments would cost about $10.00. The writer will continue this discussion in a later article.

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SUGGESTIONS FOR THE TEACHING COLLECTION IN BIOLOGY

There is nothing in the Biology course which can take the place of carefullly planned and directed field work. The students should be encouraged to observe carefully and accurately for themselves and be given every opportunity to become acquainted with living things in their natural surroundings. The aquarium and terrarium can be made to supply much interesting material for study and should be in the laboratory wherever possible. In addition to these devices there are collections which can be prepared at small cost and which will supplement the field work and provide material for review or more extended study than is possible in the field. The students can assist in building up and maintaining these collections in connection with their outdoor activities and will benefit by the repeated contact with the materials. The collections can be started on a modest scale and additions can be made from year to year as the seasons permit.

An herbarium of common tree leaves can be built up with very little trouble and expense. The leaves, which should be carefully selected for type, are first dried carefully between blotters or paper towelling or newspapers under sufficient weight to press them flat and smooth. They should be changed to fresh blotters or papers frequently to hasten drying and to preserve the natural color as much as possible. After the leaves are thoroughly dried they can be kept in shallow boxes or envelopes of proper size and are available for use at any time. Since the leaves are very brittle when dry they will not stand much handling unless mounted and covered in some way. Riker mounts can be secured from any supply house and are very convenient and durable but are quite expensive if the collection is very large. Very durable mounts can be made by gluing the leaves to stiff, white cardboard and then covering the leaf with a piece of glass cut to proper size. The edges are then covered with tirro tape and with reasonable care the mount can be used for years. The leaves may be mounted separately but large sized mounts (12x16 inches) make it possible to place together for comparison leaves of trees from a large group. Blueprints of leaves are quite satisfactory for recognition work and when mounted on large cardboards permit the display of leaves from a whole family. Prints of leaves made with mimeograph ink on regular mimeograph paper show nearly all the details which are necessary for the recognition of leaves.

A collection of the fruits of different plants can be started in the fall or winter and continued through

the year as the fruits ripen. Dry fruits from such plants as honey locust, oaks, maples, cocklebur and milkweed can be stored, when thoroughly dry, in boxes of convenient sizes. Very small fruits from the dandelion, elm, sandbur and beggarsticks can be stored in small bottles or vials. Fleshy fruits, from such plants as wild crabs, hawthorns, nannyberry and dogwoods, can be preserved in bottles or fruit jars in a 4% or 5% formalin solution. If desired dry fruits could be placed in Riker mounts or fastened to cardboards for purposes of comparison. A particularly valuable collection is an assortment of fruits and seeds to show common devices for dissemination. The following examples can usually be found and others can be added as desired. (1) Winged fruits —maples, ashes, elms; (2) winged seeds—catalpa, pine; (3) fruits attached to a sail-like bract—basswood; (4) fruits with hairs—dandelion, thistles, wild lettuce; (5) seeds with hairs—milkweed, cottonwood, willows; (6) fruits with an envelope containing air—ironwood or hop hornbean, ground cherry; (7) fruits with hooks or spines—cocklebur, sandbur, burdock, Spanish needles, bedstraw; (8) nuts— hickories, walnut, hazel; (9) fleshy fruits—hawthorns, cherries, nannyberry, wild plum. Students commonly do not know many of the common farm, garden and weed seeds so that a collection of these can be prepared and studied to advantage. They can be displayed very readily in small vials.

An herbarium of common wild flowers and weeds is a very useful teaching device and its preparation will give the students a fine opportunity to become familiar with these plants. The plants can be pressed and dried as described above and then mounted on herbarium sheets which can be secured from a supply house. These mounts will not stand much handling due to the brittleness of the dried specimens. We have found that satisfactory and durable mounts can be made by mounting the specimens on stiff cardboard and covering them with sheets of pyralin cut to a slightly smaller size. The edges are fastened with tirro tape as described for the glass-covered mounts. We have used mounts of this sort for several years with very little damage to the specimens. The pyralin can be obtained from an auto supply house but is rather expensive if a large herbarium is desired.

During the fall and winter when the trees and shrubs have no leaves it is possible to collect the cocoons and chrysalids of different moths and butterflies. These can be kept at a low temperature until spring when at least some of them will produce adults. The large paper nests of the hornet or yellow-jacket can be secured, care being taken that they are unoccupied if the season is still warm. There will be found on a great variety of plants an almost infinite number of plants galls which will make an interesting study. The pine-cone gall on willows is one of the most common and striking of galls and people very often mistake it for something else entirely different. There can be found on different species of oaks a variety of galls known as "oak apples." Wild and cultivated roses very often have different kinds of "spiny galls" and goldenrods very often have smooth, spherical growths on the stems, known as "ball galls," which birds have been known to open in order to get at the larvae within. The hackberry tree is very commonly infested by fungi and insects of various sorts. One of the commonest of its deformations are the growths on the leaves known as "nipple galls." There are many other galls found on plants which illustrate a relationship between insects and their plant hosts. Not all plant galls are caused by insects. Some are caused by fungi of which type the familiar cedar-apple is an example. During the fall and winter the abandoned nests of birds may be collected and used for a study of nest types and building materials. This project does no injury to the birds as the old nests are seldom occupied again.

Students are usually interested in butterflies and moths and a collection of common forms together with other insects can easily be secured. It is necessary to have one or more insect nets which can be secured from a supply house or made by fastening a cheese-cloth bag to a wire hoop which is then wired to a convenient handle. Large insects, such

as butterflies, moths and dragon flies, are not easily captured without a net but smaller insects can often be secured most easily by hand picking. Several killing bottles can be made from pint fruit jars or large mouth bottles with tight-fitting rubber stoppers. A small amount of potassium cyanide, preferably in lump form, is placed in the bottle and covered with plaster of paris which has been mixed with water to form a thick paste. After the plaster of paris is set the bottles should be dried out somewhat to prevent the accumulation of moisture in the bottom and then tightly closed. It is necessary to avoid breathing the fumes from these bottles as the gas is poisonous to human beings as well as to insects. The insects when caught should be transferred at once to the killing bottles, and left there until their bodies are thoroughly saturated with the cyanide fumes. This will help to keep insect pests from doing damage when the specimens are mounted. Smaller, hard-bodied insects, such as beetles and grasshoppers, can be mounted by running a slender pin through the body into a piece of cork placed in the bottom of a box. They can be placed on a layer of cotton in a shallow box but there is some danger of having the legs and wings broken when handled. Large insects, such as butterflies, moths and dragon flies, should be dried on a spreading board in order that all wing markings are easily seen. It is possible to spread some forms by simply placing the insects on their backs on a piece of soft smooth wood and then, after drawing them into the proper position, fasten the wings in place with pins and strips of paper. The legs also can be fastened in the proper position with pins. Some forms with large, hairy bodies can be spread with better results on a board of different type. Two soft boards, about 12 inches in length, are fastened together at their ends in such manner that a groove is left between them. The groove should be large enough at one end to accommodate the larger moths and should gradually narrow toward the opposite end to fit smaller forms. Another strip of soft wood or cork should be fastened beneath the groove. A convenient, adjustable spreading board can be secured from the supply houses. The insects are placed right side up with the body in the groove and the wings and legs may be fastened in place as described. It will take several days or a week for the insects to become thoroughly dried after which they can be transferred to the exhibit box or Riker mount. Duplicate specimens can be filed away in envelopes or between layers of cotton until needed. These dry specimens can be relaxed for pinning by folding them in a moist paper or cloth and leaving them overnight in a dish. It is well to place some naphthalene flakes or moth balls in the mounts or boxes to help in driving away various pests. The specimens should be examined frequently for carpet beetles. The mounts can be fumigated by placing them in a tight container with a shallow dish of carbon disulphide. The container must be kept tightly closed and care be taken to keep fire away as the gas is very explosive when mixed with air. The collection of insects can be done with less risk of disturbing the balance in nature than is the case with many animals.

The winter twigs of common trees and shrubs can be collected and preserved for study by placing them in quart or 2-quart fruit jars with a 4% solution of formalin. The desired strength of solution can be obtained by mixing 9 parts of water with 1 part of commercial formalin (formaldehyde). The twigs should be collected in the fall or winter and should be selected carefully to show the distinguishing characteristics. A comparison of the twigs in winter condition following or preceding a study of the leaves is an illuminating and worthwhile study.

The purpose of this article has been to suggest some possiblities in the way of teaching collections and devices and the teacher can work up many others of at least equal value. In any case do not make the mistake of doing the field work in the laboratory. The collections suggested above are helpful in supplementing the field trips but nothing is so valuable as learning to know living plants and animals in the places where they actually live and grow.

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