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Scope of Study: This is a study of the biological specimen as an aid for teaching secondary biology. The establishment and care of the four common habitat terraria is covered concisely. Some of the potentialities of both the non-flowering plants and the common laboratory grown flowering plants are investigated and practical suggestions offered. The preservation, care, and use of the botanical and zoological specimen is given an effectual review. The practicability of the living animal in the classroom is also given adequate consideration.

Findings and Conclusions: The use of the biological specimen enables the teacher to approach his subject while utilizing more of the discrimitory powers of the student. These aids are not to supplant ordinary classroom methods, instead they are to supplement these methods. The effort required to maintain the useable specimen is an essential part of the teachers' responsibilities. The use of the preserved specimen is an important part of the biological program and one which cannot be eliminated. The representative collection of preserved materials is a vital part of any inspiring program. However, the use of the living plant or animal is advisable when it is practical. The living organism is an asset to the study of the "Life Sciences."

ADVISER'S APPROVAL Imy V. Holt

THE USE AND PREPARATION OF THE BIOLOGICAL SPECIMEN

By

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THE USE AND PREPARATION OF THE BIOLOGICAL SPECIMEN

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CHAPTER I

INTRODUCTION

Many of our most interesting and most stimulating high school courses have been reduced to dry text book facts. Unless there is more application to the everyday lives of the students, the possibility of stimulating students to exert maximum efforts will remain lost.

Current literature provides evidence of the growing awareness of the problems of science education on the secondary school level. The high school curriculum continues to be the principal focus of concern for our nation's supply of scientists.[1] It continues, too, to be the center of attention for proposals to increase the supply of individuals with skills in science. The scope of this problem can more easily be understood when we realize the importance placed upon it by the President of the United States. He says:

> "Recent studies of the educational standards show that the gain in quantity can no longer be considered offset by lack of quality. This trend is disturbing. Indeed, according to my

[1] James G. Harlow, "The Secondary School Science Program," Science Education, XL (1957), 27.

> scientific advisers, this is for the American people the most critical problem of all. We need scientists."[2]

Statement and Importance of Problem

This is a study of the biological specimen as an aid for teaching high school biological sciences. The study includes those specimens now in general use by biology teachers in the secondary schools over the nation. The study includes, too, other specimens which the author feels should receive more use because of their value.

For this study, a teaching aid is interpreted as anything which will render assistance to the instructor in presenting material to students or in motivating the students to do independent work.

The atmosphere of crisis enveloping the whole field of science today has a special meaning for those of us engaged in education. Although some of the hysteria of the moment may be deplored, we welcome the spotlight of public attention on the crucial importance of science education for our young people of high school age. The job to be done is basic to the national welfare; it deserves and needs our most constructive support, best thinking, and accelerated action.

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[2]Dwight D. Eisenhower, Excerpt from a speech delivered at Oklahoma City, Oklahoma, November 13, 1957.

Unfortunately, there is no science-made-easy formula, no capsule for developing scientists overnight. The years ahead will see further important advances in the presentation of scientific material, and in the motivation of young people, as have the years past. Our paramount task is to build on the sound foundation of the tradition of free inquiry and the natural curiosity of young minds.

The subject matter of science must be organized logically and systematically. The instructor must present the principles and concepts directly and positively without camouflage, waste motion, or apology. A direct approach will accomplish maximum results for effective learning. The majority of secondary school students can understand and master science if the subject is carefully presented in simple, direct, and straightforward language. All new scientific words, principles, and concepts must always be defined and explained when they are first encountered.

Methods used by the teacher to insure motivation in study are part of the essential subject-matter tools for building toward the goals of our universal educational system. Seeing and hearing, looking and listening are major ways and means by which human beings learn. Armed with the many media which have been developed and which are widely used, broader opportunity for learning and more effectiveness in learning may be attained.

The charts, models, slides, filmstrips, films, and recordings are powerful testimony of mankinds desire to learn and to promote better learning. Visual aids to learning have long been used in the study of biological sciences and since the close of the Second World War the essentialness of audio-visual materials has had wide acceptance.

The teaching aids are a part of the regular curriculum and instructional program. They are some ways and means of realizing the objectives or goals of the program. The teaching aid is not an end in itself, but rather a tool of learning and teaching. Since they are tools, these materials must be utilized within and along with the pattern of the instructional program.

The high value of teaching aids has been firmly established. These aids should be utilized only because they have inherent advantages over other means of teaching and learning in any given situation.

Source of Data

A survey of books and periodicals in the Oklahoma State University Library, the files of Imy V. Holt, and from my own library was the chief source of data used in this study. Material was also obtained from the Department of Biology of East Central State College, Ada, Oklahoma.

Plan of Procedure

A survey of the specimens now in general use was first made. Many of the recent forms were also studied and those which had wide acceptance were evaluated.

For the purpose of this study the writer divided the specimens most commonly found in use into the following divisions:

1) botanical specimens--including living, preserved, and fossil plant materials, and

2) zoological specimens--including living, preserved, and fossil animal materials.

This division was made for more effective presentation and was not made to place comparative value on the divisions.

CHAPTER II

THE BOTANICAL SPECIMEN

The Use of Terraria

A terrarium is a most worthwhile unit for every biology room or laboratory because it affords an opportunity to study and arrange an unlimited variety of plant and animal groups. The purpose in maintaining a terrarium may be of a two-fold nature: to represent native flora and fauna as objects of general interest or to have it form a definite part of the class work--to show the interrelationship of such environmental factors as food habits, temperature and moisture upon plant and animal associations. The students' interest is stimulated greatly if they make the collections of native plants and animals and if they help arrange and care for the terrarium.

For the terrarium case in which the plant and animal groups are to be placed, one may use almost any type of container large enough to accommodate the group, for example: a wide-mouth gallon jar, a battery jar, a fish bowl, an aquarium or a specially built terrarium case.[1]

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[1]Norman Taylor, _Encyclopedia of Gardening_ (Boston, 1957), p. 1099.

However, the size of the case will limit the number of plants which may be included. The large terrarium has proven easier to plant and maintain than the small one.[2] A rectangular tank, with metal frame and glass sides and ends, of from 6 to 10 gallons capacity is the most practicable receptacle.

A battery of from four to six terraria will enable the teacher to demonstrate many living ecological groups. Typical habitats easily reproduced in laboratory terraria are: desert, dry woodland, wet woodland, bog and semi-aquatic.

One should keep in mind that the main facotrs to be considered in establishing and maintaining terraria are: humidity, light and temperature, appropriate soil mixtures and suitable living specimens. Mold developing on plants is often the result of too much water; this condition may be checked by dusting the tank lightly with powdered sulphur. When plant stems are badly damaged, treat them with powdered charcoal. Weak and spindly plants are produced by an excess of heat. When the plants become overcrowded, trim them back and remove some of them if necessary.[3]

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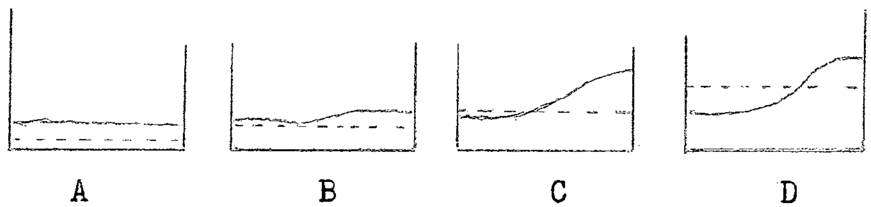
[2]Ibid., p. 1100.

[3]E. L. Seymour, Garden Encyclopedia (New York, 1943), p. 1219-1220.



Water Level in Terraria

The dotted line indicates the proper water level in terraria of: A. Desert Habitat, B. Woodland Habitat, C. Bog Habitat, and D. Swamp or Semi-aquatic Habitat. The water level can be watched only in glass tanks.[4]

<u>The Desert Terrarium</u>.--The simplest group to assemble and one which requires the least amount of attention is the desert terrarium. The tank bottom may be covered over with one and one-half inches of coarse sand and topped with one-half inch of real desert sand. A few stones and a shallow pan of drinking water for desert animals may be added--the pan should be partially buried in the sand so that its top edge is even with the surface. The lower layer of coarse sand should be moistened slightly when it is placed in the tank; but the top layer should be kept reasonably dry.

The scene of the desert may now take form. The cacti may be planted; the larger kinds should be handled carefully. The roots of the cacti should be moistened before planting and, after all plants are satisfactorily

[4]General Biological Supply House, Service Leaflet No. 10. <u>The School Terrarium</u>, p. 2.

placed, sprinkle the surface about them. One or more desert animals add considerable life to the desert scene; horned toads, collared lizards, and small snakes, as well as scorpions, will live in the terrarium with a minimum amount of attention. The top of the terrarium should be covered with wire screen. The desert group should be kept in a warm place--temperature range 68^{o} to 85^{o}F. is satisfactory.[5]

<u>The Woodland Terrarium</u>.--The woodland terrarium offers an unlimited number of possibilities and may include a variety of combinations representing various kinds of habitats. The foundation layer should consist of one part sand, three parts humus, and one part coarse gravel thoroughly mixed; or the gravel may be placed on the bottom of the terrarium and the mixture of sand and humus placed on top of this drainage material. In either case, the soil mixture should be moistened sufficiently so that it will cling loosely together without caking. It is advisable to provide an air space beneath the foundation layer by using a piece of hardware cloth of one-half inch mesh to form a false bottom. The hardware cloth may be placed in the terrarium in such a way to give a desired

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[5]Frank K. Balthis, <u>Plants In The House</u> (New York, 1941), pp. 112-120.

forward slope. After the soil has absorbed as much moisture as possible, the excess must be pipetted off the bottom.

After the soil mixture has been properly arranged, dampen the roots of the plants, and group them to achieve the desired scenic effect. Plants whose leaves have a tendency to spread should be centered so that their leaves may grow without touching the sides of the tank. An instructive terrarium may be arranged with mosses, liverworts, lichens, clubmosses, and wood ferns. After the planting is completed, the plants should be trimmed, all broken stems and leaves as well as debris removed, and the glass given a final cleaning. The entire group should be sprinkled with a fine spray, the glass cover placed on top, and the terrarium placed in a cool location.

Animals may be included in the woodland habitat; among those to be considered are the common newt, toads, tree frogs, chameleons, small snakes, snails, slugs, beetles, and many others. Toads and salamanders dig under the moss and into the soil, often causing considerable damage to the attractive terrarium; but the opportunity to study their living and feeding habits is well worth this slight destruction. The common newt and the small green grass and garter snakes probably cause the least damage.

The Bog Terrarium.--The plants in a bog terrarium require acid conditions and the foundation must supply this need if the plants are to grow and develop normally. There are two possibilities; the bog plants may be planted in a terrarium with a layer of gravel for drainage and covered with a soil mixture of one part peat moss and two parts acid soil; or the gravel layer may be covered with a two-inch mat of peat moss, using either living or dried material.[6] In either method, the bog terrarium should be thoroughly soaked, with an excess of moisture being allowed to remain in the gravel layer. Where the soil mixture is used as a base, the roots of the bog plants should be wrapped with some peat moss; the Venus' Flytrap and Pitcher Plant should be planted deep, Sundew is a shallow-rooted plant and should be planted accordingly. The bog terrarium should be covered with a glass top and placed in a cool location.[7]

Any animals which prefer moist surroundings will do well in a bog terrarium. This group includes newts, toads, salamanders, and frogs.

The Semi-Aquatic Terrarium.--The planting and planning of a semi-aquatic terrarium is more painstaking than that of the woodland or bog terrarium. Here one is able

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[6]Balthis, op. cit., pp. 79-80.

[7]Fred W. Emerson, "Insectivorous Plants and How To Grow Them," Carolina Tips, XXI (1958), 1 and 4.

to combine the aquatic and the terrestrial habitats into one demonstration unit. The aquatic portion of this terrarium may be arranged to give a swamp-like effect, with a shallow pool of water at one end of the tank; the other end is built up a few inches higher, with a bog or woodland base, and planted accordingly with the appropriate materials. A semi-aquatic terrarium may demonstrate a group of insectivorous and bog plants. For instance, Bladderwort may be planted in the water, and Sundew, Venus' Flytrap, and Pitcher Plant planted in the bog region. Dragonfly and damselfly larvae, as well as mud minnows and tadpoles, may be introduced into the water.

If the aquatic section of the tank is to represent a truly aquatic picture, then the depth of the water must be increased to from six to ten inches and the woodland or bog section must be raised correspondingly. The soil line of the terrarium section should be above the water level of the aquatic portion and can be built up with stones. The aquatic section of this terrarium can be arranged as a regular aquarium planted with Elodea, Cabomba, and dwarf water lilies; snails, tadpoles, insect larvae, crayfish minnows, and sunfish can be used to complete the balance.

Non-Flowering Plants In The Classroom

<u>Bacteria</u>.--Currently, more and more classes in high schools are carrying on simple experiments in bacteriology.

Such studies fit in logically with health and personal hygiene work and are equally suitable for botanical study.[8]

Introductory experiments in bacteriology can be carried on safely in the high school laboratory, although it would certainly be inadvisable to give high school students access to pathogenic cultures. There are so many students who will not continue their work beyond the high school level that it is of untold value to those who take biology to be able to retain at least a mental impression of bacteria throughout their later lives.

The essential equipment is available in most high school laboratories. This includes: a compound microscope with a magnification range of at least 100X--up to 440X is desired,--microscope slides, cover slips, test tubes, petri dishes, and some culture media.

It is not even necessary now that the culture tubes be made up in the school laboratory. They may be purchased ready for your work and in a tested sterile condition. Most cultures growing on agar can be kept alive for several months. Bacteria for simple experiments may be obtained from saliva, mucus from the mouth, a straw infusion, or by allowing the media to be exposed to the air for a few

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[8]Roy M. Johnson, "The Use of Bacteria in High School Biology," The American Biology Teacher, XX (1958), 41-42.

minutes.[9] Allow a few days for development of the culture, which will form colonies on the surface of the culture media. The bacteria may be picked up easily on a long wire, mixed with water and observed under the microscope, stained or living.

Molds and Yeasts.--Molds are found growing in a variety of conditions. The spores are floating in the air at all times, they are widely distributed in soil and water, and in more limited numbers in plant and animal tissues. If the conditions are favorable these spores will develop into plants. Fruits, vegetables, and other foods often develop molds if left in a warm moist place. Molds may be cultured in much the same way that bacteria are grown. The same equipment is used and as in bacteriological studies most is to be gained if the study of molds is carried on over a long period of time.

Yeasts are probably not as abundant in nature as molds because of differences in nutritional requirements. Yeasts, because of their economic importance in baking and brewing industries, are very important to humans. The dry yeast may be purchased and cultured in a sugar solution very satisfactorily in the laboratory.[10]

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[9] Stanley E. Wedberg, Microbes and You (New York, 1954), p. 363.

[10] Ibid. p. 374.

Fresh-Water Algae.--Fresh-water algae are of very general distribution and are found in nearly every type of damp and aquatic habitat. Ditches, ponds, rivers, lakes, and marshes of any locality abound in a great variety of forms, both of the unicellular and multicellular types. Some algae grow on damp earth or rocks and some kinds make up the greenish covering which appears on the bark of trees. Many kinds of algae are easily cultured in the laboratory. Some kinds will grow well if brought indoors and placed in containers of pond water or in a balanced aquarium; other field-collected algae are more difficult to culture and can be maintained over long periods only by the use of nutrient solutions.[11]

The method used in collecting algae is quite simple. Care must be taken to avoid metal containers, especially on long, warm trips. Ample water must be used if the containers are to be sealed. However, forms like Spirogyra, Mougeotia, Zygnema, and Vaucheria may be rolled in wet newspapers and carried in them while in the field.

When possible, use the water in which the algae were growing, since sudden changes in kinds of water are injurious. Do not put too much material into a jar. Actively growing material will increase and gradually accommodate itself to conditions. Cultures may be started

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[11] Gilbert M. Smith, The Fresh-Water Algae of the United States (New York, 1947), pp. 26-38.

at any time of the year. In winter, bring in some mud over which the desired form was growing the previous season. Place it in a jar and add rain water. Such cultures will usually yield a variety of material.

Lichens.--Lichens are fascinating plants and the biology student should be allowed to make a study of them in the laboratory. Lichens may be collected at almost any season. They are found as encrustaceans upon stone and the bark of trees, as leafy flat thalloid bodies on the ground growing among mosses, as erect and often branching forms, and as pendant masses hanging from the branches of trees.[12]

Dry and apparently dead lichens when placed in water soon become flexible and will take on a greenish color due to the revival of the algae. Very attractive terrarium plantings can be achieved by the use of small rocks or pieces of logs or branches upon which lichens are growing.

Liverworts.--*Marchantia* is the most generally studied liverwort, but there are many other kinds and most of them are suitable for terrarium culture.

Liverworts are generally distributed and can be collected in many sections of the country during the summer and early fall months. Most species are terrestrial;

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[12]Bruce Fink and Joyce Hedrick, *The Lichen Flora of the United States* (Ann Arbor, 1935), pp. 1-19.

they grow in thin flat mats close to the substratum, attached by numerous root hairs to the bark of trees, to rotten wood and upon shaded banks and damp rocks. The reproductive stages are of special interest to the student.

The soil mixture for the liverworts should consist of one part cinders, one part sand, one part loam and one part peat moss--all thoroughly moistened. Place the liverworts on top of this mixture and cover the vivarium with glass. Keep it in a cool place out of direct sunlight. Add water sparingly from time to time. If conditions are favorable and remain constant, vegetative growth will continue. Sexual reproduction is started by increasing the amount of light. A damp shady spot close to the north side of a building is a good place to establish liverworts out of doors.[13] The woodland terrarium is usually supplied with liverworts.

Mosses.--Living mosses can be found at all seasons in a wide variety of locations. Some species grow in sandy soil, others on rock, logs, bark, in wet swampy places, moist woodlands; in hot and cold climates. Besides reproducing vegetatively, mosses also produce spores.

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[13] Henry S. Conard, How To Know The Mosses and Their Allies (Dubuque, 1944), pp. 18-21.

Mosses grow readily in the laboratory vivarium and require little attention. A small vivarium or terrarium offers the best possibilities for laboratory care. Growing mosses from spores is an interesting experiment that can be carried out when studying the mosses. Soil conditions are essentially the same as those for the liverworts.[14]

Ferns.--Many of our native ferns are of small or dwarf habit and most of these will transplant easily, and can be grown in relatively small terraria. Some other species are large, and it is difficult to handle these without injury to the fronds.

Many cultivated ferns of the greenhouse varieties will grow well in flower pots in the school room. However, wild ferns brought in to the laboratory must have their natural habitat duplicated as accurately as possible if they are to do well. Of primary importance is the regulation of humidity, especially in the winter when the building is heated.

Terraria intended primarily for ferns should be of the moist-woodland type with a glass cover or glass extension top. The bottom should have a layer of several inches of coarse gravel and broken charcoal for drainage, on which there should be a layer of three or four inches of humus,

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[14]A. J. Grout, Mosses (Harrisburg, 1910), pp. 9-36.

peat moss, and leaf mold. A very good soil for ferns can be made by thoroughly mixing one part of coarse sand, one part of pulverized peat moss, and two parts of rich loam. Most of our native ferns will grow well in such a soil, although some species will also thrive in the wetter environment of a bog terrarium.[15]

Equisetum and Club-Mosses.--For growth in a terrarium, one of the dwarf species of Equisetum will prove best. It requires a moderately dry soil with good drainage. The adult plants are not easily transplanted and it is best to collect dormant roots or very young plants during the early spring.

Deep humus, sandy woodland, dry open, and damp woods are the habitates in which club-mosses are found. They should be planted in a soil mixture consisting of two parts mixed sand and pebbles, one part peat moss, and one part loam; mix well and moisten thoroughly. Cover with glass top and place in a cool airy window--northern exposure is best. Except for watering from time to time, these plants require little attention. The glass cover is essential in order to create the humid environment.

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[15] Robert C. McCafferty, "Special Techniques for Growing Ferns," The American Biology Teacher, XVII (1955), 159-160.

Flowering Plants In The Classroom

Because they are easy to grow and yield relatively quick flowers, bulbs and tubers are favored by many teachers. They can be grown without terrarium cases or other special equipment. Among those which are easy to grow are: Narcissus, Tulips, Crocus, Amaryllis, Easter Lily, and Dahlia.[16]

The so-called insectivorous or carnivorous plants are of very wide distribution in both temperate and tropical regions, and some very interesting kinds are native to the United States. These include Pitcher-plants, Sundews, Venus' Flytrap and several other less well-known plants. All of these plants demand a moist or aquatic habitat. (pp. 11-12). To provide them with the moist, humid air they need, these plants should be grown in all-glass terraria.

The flowering plants present an opportunity to demonstrate the profound effect of plant hormones. The effect of these chemical substances can be shown readily without necessarily having the students understand the intricate chemical problems. The introductory experiments do not require very much in the way of general facilities and the degree of experimentation can be gauged by the equipment at hand.

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[16] Balthis, op. cit., pp. 93-98.

Flowering plants offer rewarding results to the amateur experimenter using gibberellic acid. This material is now commercially available and should interest amateurs because it is inexpensive, produces spectacular effects and offers an unusual opportunity for original experiments. Experiments with gibberellic acid are likely to reap satisfying rewards because the field is still wide open. Most of the research now under way is centered on crop plants and flowers cultivated by commercial greenhouses. Amateurs can avoid duplicating these experiments by selecting less common plants--particularly molds, mushrooms, mosses, ferns, and algae.

Aside from the fascination of producing freakish plants, experiments with gibberellic acid also provide the opportunity for gaining experience with the scientific method--of forcing answers from nature with a minimum of guesswork.

Hydroponics offers a unique method of showing the effect of various materials on the rate of growth of plants. The effect of temperature, light, as well as minerals can readily be compared to normal conditions by control plants.

It must be emphasized that the work with minerals, hormones, or gibberellic acid is experimental. There will be many other factors affecting the growth of the plants and it would be erroneous to condemn a given preparation unless every other factor is given scrupulous study also.

The Herbarium Collection

It is not the purpose of this discussion to cover entirely the information regarding the preparation and care of the herbarium specimens, but rather to give practical suggestions which will be of help to the instructor and student in preparing a herbarium collection of the greatest possible value as a teaching aid.

Equipment.--The equipment of the amateur collector need not be elaborate. There are, however, several items which each collector of botanical specimens should have. They include: pick, collecting can (vasculum), plant press, blotting paper or driers, corrugated board, collecting sheets, mounting sheets, glue, labels, notebook, ink, pen, and pencil.

The pick is used to take the roots of plants which can be taken whole. This pick should have a handle about a foot long and be equipped with a head at least five inches in length. One end of the head must be pointed to enable the collector to dig around in rocks. It is more practical to obtain a pick of rigid construction at first and eliminate delays which will surely occur later.

A vasculum may be used to take the specimens to the laboratory on shorter field trips. If the field trip is to be extensive and a number of specimens are to be collected a press and other drying materials must be taken.

The plant press should take sheets at least 11½ by 17 inches and is used in pressing the specimens when they are brought to the laboratory. This press should be made of durable materials but can be made at a nominal cost. It may be made of 1½ by ¼ inch lathing materials nailed together to leave 1½ to 2 inch squares. Two such frames are made and pressure is applied by the use of two adjustable straps. The corrugated board may be obtained from large "card-board" boxes or from sheets of corrugated board. The driers may be satisfactorily made from deadening felt obtainable at any builders supply center.

Mounting sheets, pencils, labels, and ink will be selected according to the preference of the collector. It must be remembered, however, that the herbarium collection is to be more or less permanent, and this part of the equipment should be uniform in size and color and of a uniformly high quality.

<u>Collecting Specimens</u>.--The preparation of herbarium specimens for study may be divided into two main processes: (1) collecting and (2) preservation by drying and pressing. These two processes are very closely related to each other and from the very first the collector must bear in mind the ultimate end to which he is working--the finished herbarium specimen.

As plants are procured they are placed in collecting sheets in which they are kept until they have been pressed and are ready for the mounting sheets. These collecting sheets are folders of unglazed paper. The most practical size is 11½ by 16½ when folded. Old newspapers cut and folded to size or the magazine section of the Sunday editions make good collecting sheets and a supply of them should be included in every collector's equipment.

A plant consists of many parts, often repeated in numbers such as roots, stems, leaves, flowers and fruit. A good herbarium specimen should have each of the parts represented. It is also desirable to have these arranged on the finished sheets in such a way that their relation to each other can be shown. It is, of course, impossible in the case of many of the larger plants to collect the entire plant, but this should be done whenever possible.

If the fruits of a woody plant are too thick to be placed in a press they should be put in a separate container and labeled for future reference. All too often a mount shows protuberances on the mounted side which should have been removed before pressing. Thick stems, roots and stem bases, should be split and planed down before drying.[17]

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[17]O. A. Stevens, "Thinner and Better Herbarium Specimens," <u>Turtox News</u>, XXVI (1958), 6.

It is of first importance in making a herbarium collection, that notes regarding the date, locality, habitat, height, method of branching, color of flower, common name, etc., should be kept. These should be placed in the collecting sheet with the specimen when the plant is taken and remain there until they can be recorded on the permanent record. It is necessary that the specimen be associated with its data, therefore, the specimen should be given a number and the same number be placed in the field notebook opposite the information regarding that particular specimen. This number should appear with all of the parts to the plant in question. After the specimen is permanently mounted on a herbarium sheet this information can be rewritten and placed in the permanent notebook.

Drying the Specimens.--Specimens should be taken from the vasculum and placed in the press as soon as possible after returning from the collecting trip. It is to the advantage of the collector to identify the specimen before it is pressed as all parts are more easily observed.

In pressing the herbarium specimen it must be remembered that the specimen will be the same size and shape when it comes out of the press as it is when it goes in. This means that the specimen must be neatly arranged in the proper position within a space which will allow it to be fastened to the herbarium sheet after it has been dried. The specimen must be thoroughly clean.

For arranging the specimens in the press first place a corrugated board on one of the press sides, then a blotting sheet or drier, then the collecting sheet with the specimen in place, then another drier, and so on. Corrugated boards should be used frequently to allow for proper circulation of air between the driers. After the specimens have been in the press for 24 hours they should be examined and new driers exchanged for the old ones.[18] The damp driers may be laid out in the sun to dry. Moist conditions will necessarily call for more frequent changes. In cases of excessive moisture artificial heat may be used to aid drying.[19] The press may be placed near heating units or any other source of heat.

It should not take more than a week or ten days for the average specimens to dry, while very thin ones will dry in two or three days. Very fleshy plants will require a longer period of time.

Mounting Specimens.--When dried, the specimens in their collecting sheets should be neatly stacked and each specimen identified, if this was not done earlier. The specimen is then ready for mounting.

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[18]Carolina Biological Supply Company, "Herbarium Problems," Carolina Tips, XX (1957), 40.

[19]Geraldine V. Marker, "An Insect and Leaf Drying Press," The American Biology Teacher, XX (1958), 131-132.

The standard size mounting paper is 11½ by 16½ inches and this size should be used throughout a collection. The paper should be of a good weight and not too flexible. The paper should also be of a quality which will not readily turn yellow with age. The specimen is painted with glue by means of a brush and then placed on the mounting sheet.

After the specimens are mounted the label, which was made out when the specimen was identified, should be placed in the lower right-hand corner. This label should contain as much information as possible regarding the specimen, including the scientific name, date location of collection, and collector's name and collection number.

The teaching collection of herbarium mounts is usually handled quite frequently and is subjected to a certain amount of unavoidable abuse. For this reason it may be covered with cellophane to protect it from dust and handling. The cellophane sheets, 12½ by 17½ inches, are placed over the specimen and the upper edge folded under the edge of the herbarium sheet. This upper edge, about one inch, is glued to the backside of the herbarium sheet. The lower corners of the cellophane are then fastened to the corners of the herbarium sheets by means of paper clips. This makes it possible for the cellophane to be rolled back should it become necessary during study of the specimen.

__Arranging and Storing the Collection__.--After the specimens have been mounted they should be arranged according to their classification so that any specimen may readily be located when reference is made to it in the class work. In doing this it is well to divide the specimens into groups according to family. The groups are placed in folders which are heavy enough to withstand considerable handling. These folders should be arranged in the case or file in which they are to be kept in their proper taxonomic order.

The file in which the specimens are kept should be fairly tight to keep out dust and moisture and should be made in such a way that any one folder may be referred to without disturbing all of the others.

Herbarium specimens are often attacked by museum pests. To guard against the collection being ruined by these pests, the specimens should be fumigated with carbon bisulphide three or four times a year.

Preserving Plant Specimens in Solutions

Green plants intended for display purposes may be preserved in the fixative known as "F.A.A." This solution, which is a dependable stand by, is made as follows:

50% Alcohol	100 cc.
40% Formalin	6½ cc.
Glacial Acetic Acid	2½ cc.

This fixative is excellent for most plant tissues. Its usefulness is due to the fact that tissues may be left in it indefinitely without harm. After being fixed in this solution they may be mounted in fluid--either in F.A.A. or in 4% formalin--in glass display jars. It is usually very difficult to preserve the natural colors of flowers and fruits.[20]

Many fleshy fungi--mushrooms--may be preserved in their natural colors in this solution. This type of preservation, in solutions, is generally used in the small laboratory.

The Seed Collection

The biology teacher finds that a survey collection of the seeds produced by plants to be very helpful when studying the types of fruits and seeds and also when studying the methods of seed dispersal. The seeds that are collected by the students will have a definite advantage of stimulating memory, but if a collection is available to supplement the collection by the class more may be accomplished.

For the collecting of seeds, a number of small glass or plastic bottles, transparent envelopes, or small boxes will be necessary. The smaller seeds may be placed in the envelopes while the larger ones are placed in the bottles or boxes. The envelopes may be placed in the larger containers to give uniformity to the collection if it is to

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[20] Anna B. Comstock, _Handbook of Nature Study_ (Ithaca, 1939), pp. 714-727.

be placed on display. Labels for each container telling the name of the plant, where it grew, and anything interesting that can be found out are essential to a useful collection.[21]

Fossil Plants

Fossil members of the plant kingdom make it possible to witness the rise, luxuriance, and extinction of several great groups; to trace the development of seed plants from lowly, fern-like forms, and to recognize approximately the point at which the higher seed plants first appeared upon the earth. In our attempt to visualize the very primitive plants we get our most reliable clues from the fossil record.[22]

Many forms of plant life may now be studied as fossils and generally a few specimens will be brought to the laboratory during the school year and may be studied by the entire class. A systematic collection may be kept that will grow from year to year.[23]

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[21]Ted Pettit, The Book of Nature Hobbies (New York, 1947), pp. 87-89.

[22]Merle C. Coulter, The Story of the Plant Kingdom (Chicago, 1948), p. 2.

[23]Richard P. Aulie, "The Usefulness of Fossils," The American Biology Teacher, XX (1958), 51-52.

CHAPTER III

THE ZOOLOGICAL SPECIMEN

Living Fauna in the Classroom

> "Under the pressure of many duties and responsibilities, the busy biology teacher is often tempted to order preserved materials from a supply house, rather than to secure and care for living things. The temptation should probably be resisted. In too many courses the laboratory appears as a well-stocked morgue. It is a sad commentary that such courses, supposedly dealing with 'Life Science,' are actually dedicated to the dead. To be sure, formalin has its uses, but most teachers well know that living plants and animals in the laboratory provide an antidote for formalin and greatly increase student interest in biology."[1]

Protozoa.--It is amazing how much biology one can study in a single drop of pond water. A vast community of tiny plants and animals exist in a drop of water in such numbers to make the drop seem a lake. Any pond or stream or roadside ditch teems with these tiny organisms and a study of them forms the basis for the study of the higher forms of life. The protozoa are so fascinating and attractive that the instructor has no problem at all with regard to arousing interest in them. His problems are chiefly to select and arrange the subject and materials to attract the students' interest and to make the most of the opportunities.

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[1]Elbert C. Cole, Excerpt from a speech delivered to the Biology Teachers' Conference, June 26, 1954.

Field collecting in any pond or stream will produce an abundance of protozoa from which pure cultures of some forms may be obtained. Dead grass may be put into a glass container and allowed to sit in the classroom for a few days and many forms will be observed in this "hay infusion."

The forms usually studied in the high school biology course include the Amoeba, Paramecium, and Euglena. All of these forms are generally found in varying places.[2]

Fresh-Water Hydras.--Hydras are studied in practically every beginning course of biology or zoology. They are of unusual interest because they are the only common fresh-water representatives of the group of Coelenterata. Most teachers, who may not have access to collecting areas, show their students preserved specimens in alcohol or hydras mounted on slides.

The best method for collecting the Hydra in the field is to place a few of the weeds from the water of permanent lakes or slow-flowing streams in a jar of clean pond water and examine carefully by holding it up to the light. The specimens will usually remain contracted for some time and will appear as tiny lumps of jelly with the shortened tenacles projecting outward from the free end of this lump. Do not give up the quest quickly, but make a thorough search. At certain seasons of the year the Hydra will be very

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[2]T. M. Sonneborn, "Protozoans in the Biology Class," The American Biology Teacher, XVII (1955), 187-190.

abundant, while at other seasons only an occasional specimen will be seen. Once specimens have been located the quest becomes more easily obtained.

Planaria.--Living planaria are easily collected and kept in the laboratory and their remarkable powers of regeneration make them of unusual value in the laboratory work.

Living specimens may be collected by looking for them on the under sides of stones in pools or streams. When the worms have been brought to the laboratory they should be placed in an enameled pan about half filled with clear pond water. A cover to shut out the light should be provided for the pan. Small pieces of fresh beef liver should be provided every four or five days. After two or three hours the worms will become gorged and the remainder of the meat should be removed.

Insects.--There is no typical insect. Every species of this class of animals is unique. Varying methods, of course, must be used to keep the representatives of each insect group in the laboratory. The economic importance of this group as well as its unusual and very interesting characteristics make it an essential part of the material to receive detailed study in the secondary biology work. Life histories--stages of development, feeding habits, heredity, and economic importance--may be taken from the living specimen in the school laboratory.[3] Observation nests for ants,

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[3]Allan B. Burdich, "Drosophilia for High School Biology," The American Biology Teacher, XVII (1955), 155-154.

cultures of fruit flies for use in the study of heredity, moth cocoons and aquatic nymphs in the aquarium all add interest to the study of the insect world. A check with any good entomological reference will tell the food and other habitat needs for a particular species.

Higher Animal Forms in the Aquarium.--Most of the higher forms of animal life, both large and small forms, can most successfully be kept in the aquarium or terrarium. Such a combination of both plants and animals offers an unusual opportunity for the students to observe occurances that otherwise would be impossible for them to see.[4] This unfamiliar world that exists under water holds a great fascination for the curious-minded of all ages.

Starting and maintaining a fresh-water aquarium in the school laboratory is easily accomplished by anyone who is willing to devote a little thought and care to the work. The pleasure and practical teaching advantages to be derived from one or more aquaria containing interesting plant and animal specimens is well worth the time and effort expended. The only equipment necessary is a tank, aquatic plants and animals. It must be remembered that an aquarium is a biological association of plant and animal life to be observed during the entire school year.[5] As great a variation of life

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[4]Herbert R. Trenting, "A 'Natural Pond' in the Classroom," The American Biology Teacher, XVII (1955), 127-130.

[5]C. D. Hughes, "The Aquarium in the Classroom," The Aquarium Journal, XXI (1950), 5-7.

should be included in order to be of maximum benefit for study.

It is impossible to state hard and fast rules about the establishment and care of aquaria, but certain general instructions can be given. The tank selected should be as wide as it is high to provide adequate air-water surface. Globes are unsatisfactory because they expose comparatively small surfaces of water to the air and the plants and animals appear distorted when seen through the curved glass. Clean the aquarium tank thoroughly and put well washed medium coarse sand in the bottom to a depth of one to two inches. The tank should be placed in its permanent position as an attempt to move it after it is partially filled with water may strain the seal and result in leaking.

Fill the tank about one-half full of water and place the plants in desired position. The idea that plants are necessary in the aquarium because their green leaves produce oxygen needed by the animals has been disproven. However, plants are used for a variety of functions in the aquarium. They provide a natural habitat and protection for the smaller fishes. Plants utilize some of the excreta thrown off by the fish and other animals while they, in turn, are used as food by some species of fish and snails. They also promote the growth of microorganisms and other small animals which are an essential part of the diet of many fish. Plants are of great decorative value and should be used to best advantage for preparing an attractive tank.

The aquarium should be allowed to stand for a few days to allow the plants to become rooted before introducing animal life. In selecting the animals for the aquarium several things must be considered. Those animals which live only in running water cannot be utilized in the tank unless a constant current is artifically provided by a specially arranged air pump and filter. Predaceous forms must be kept to themselves or, in some instances, in groups of their own species. Animals which stir up the sand on the bottom or uproot the plants should not be used unless they are of such unusual interest or value to warrent the added attention which will be necessary.

It is very important not to over-crowd the tank with fish or plants. Aquarists tell us that one inch of fish to a gallon of water is a good rule to follow. Smaller fishes may be kept in greater numbers. The beginner will do well to use both plants and animals sparingly at first. As one gains experience more of either may be added--rather than experiencing difficulty from the beginning. Under proper conditions the plants will grow and spread. If too many are crowded at the beginning some will soon die and decay, thereby fouling the water.

There are a number of accessories available which may be used with the classroom aquarium. If tropical fishes are to be kept the temperature of the water must not chill below 70° Fahrenheit. If heat is not present through the night a heater and thermostat must be provided. Other extras are not necessary for the maintenance of a well balanced tank but aid in keeping the aquarium clean. Also a larger number of fish can be put into the aquarium safely when a filter and an aerator are used.

The salt-water aquarium is a very interesting project and any teacher wishing to establish one will find its interest arousing qualities rewarding. A starfish dripping with formalin generally is not regarded with the interest that the same animal receives as it crawls over the bottom of an aquarium.

The salt-water aquaria require more oxygen than do most fresh-water tanks. Constant aeration of the water must be provided as most of the forms obtained are from beaches where the oxygen content of the water is unusually high. Natural salt-water is not necessary as synthetic salts are available with directions for preparation and maintaince of proper concentration.

The care of any aquarium demands a few simple measures. Attention must be given immediately when there is any reason for it, but if there is none allow it to take care of itself. The aquarium is a most instructive and delightful project in any schoolroom. New methods of aquarium care are being worked out constantly and one may keep informed of useful items by reading any of the many journals devoted to the subject.

Higher Animal Forms in the Terrarium.--One of the first steps to follow in keeping living specimens in the laboratory is to acquire a thorough knowledge of the animals' natural requirements; such as temperature, moisture, light, and food, and to try to reproduce these conditions in the laboratory environment. It is well to assign the animals' care to only one individual until they have become accustomed to their laboratory environment.

Salamanders, frogs, alligators, turtles, and some snakes will do well in the semi-aquatic or moist woodland terrarium. Toads, lizards, some snakes and turtles are in their native habitat in the desert and dry woodland terraria.

Salamanders adapt themselves quickly to the terrarium in which they are kept. They show real friendliness to their caretaker and soon acquire the habit of begging for their food. The common aquatic phase of the red-spotted newt is the most generally seen in the school laboratory. It will eat young snails, chopped earthworms, ground lean beef and liver. Feedings should be made to the animal when it is removed to a shallow pan containing the food to avoid contamination of the tank. After feeding, the specimen may be rinsed and then returned to the terrarium. Salamanders may be collected in the field and almost all do well on the diet described.

The common toads adapt themselves readily to the school terrarium, although their burrowing habits may cause some damage to the plants. Toads will take a variety of food such as mealworms, flies, roaches, earthworms, ants, spiders, and lean beef given to them on the end of a toothpick or forceps. Feeding twice a week is sufficient for their well being. A shallow dish of water should be kept in the woodland or bog terrarium for the toads.[6]

A semi-aquatic or moist woodland terrarium is the best laboratory habitat for the common leopard frog. Their natural food is living insects; feedings of June bugs, roaches, flies, grasshoppers, caterpillars, mealworms, and earthworms whould be offered them; but, when these are not available, they may be trained to eat lean beef and liver.

If a larger semi-aquatic terrarium is available, an alligator may be an interesting addition to the school laboratory. They will not eat when cold and thrive best at 70° to 85° Fahrenheit. They are carnivorous and will eat any kind of raw meat, or fish cut up in small pieces. Food that is not eaten should be removed after two hours.

The woodland terrarium planted with growing ferns and a few tall plants sturdy enough for lizards to climb upon is a suitable habitat for chameleons, fence lizards, and blue-tailed skinks. Collared lizards, horned toads, and other desert species will be at home in the desert terrarium. The lizard cage must be kept warm, from 70° to 80° Fahrenheit, since the animals will not feed readily when

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[6]Robert G. Hudson, "Field Trips to an Unusual Amphibian Habitat," The American Biology Teacher, XVIII (1956), 164-165.

the temperature is cold. Water should be given daily; in the woodland terrarium, this is best done by sprinkling the plants since the lizards drink the drops of water from the plant leaves; in the desert terrarium, a shallow dish for this purpose should be provided. Feed lizards all kinds of living insects. Mealworms are realished by all species, as are roaches, blowflies, ants, Drosophilia, and small grasshoppers.

A large and airy terrarium may be provided for snakes, and the conditions in it should correspond as closely as possible to the natural habitat of the specimens to be kept there. Small snakes usually prove to be the best for such simulated environments. Snakes love warmth, from 65° to 80° Fahrenheit, and sunlight or artificial light must be available. Plenty of drinking water should be provided. Garter snakes eat quite regularly and are easily kept in healthy condition. Food for snakes may include frogs, mice, tadpoles, earthworms, and insects.[7]

Turtles are at home in a semi-aquatic terrarium. Turtles will take a large variety of food offered to them. Their diet consists of ground meat, fresh fish, tadpoles, aquatic insects, earthworms, and some vegetable matter. After each feeding, the cage should be cleaned to prevent foul water and offensive odors from developing. The common box turtle prefers a moist woodland type terrarium. They

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[7] Emilian Victor, "Why Fear A Snake," The American Biology Teacher, XVIII (1956), 159-164.

readily eat earthworms, snails, insects, and lettuce. If the turtle will not eat, it is generally more harmful than beneficial to try to force feed. Allow them a chance for brief hibernation in a cool place.

Rats, mice, guinea pigs and other small mammals require clean, well ventilated cages if they are to be kept in the laboratory. They must have food and water at all times. Except for dietary experimentation, their diet may consist of table scraps, lettuce, carrots or any of the specially prepared foods available in pet shops.

Small wire cages constructed of galvanized hardware cloth of three-eights inch mesh top and sides are best for these and other small mammals. The size of the cage will depend on which animals are to be housed in the cage and also upon the number of the occupants. The cage should be kept out of all drafts and out of direct sunlight. Room temperatures are suitable for these animals.[8]

The Preserved Zoological Specimen

Many teachers are under the impression that the preserving of animals is an exceedingly simple task. It is true that it is not difficult to preserve a few specimens picked up on short collecting trips. However, preserving

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[8] R. H. Simmons, "Vitalizing Biology With A Live Animal Project," <u>The American Biology Teacher</u>, XVII (1955), 262-265.

sufficient material to be used in class work is impractical for all except where a very limited quantity of material is to be used. The use of a representive collection in the classroom for display and study by the entire class is of great value.[9]

Formalin and either ethyl alcohol or iso-propyl alcohol are the most commonly used preservatives and varying combinations of these two substances make up most of the special solutions used in preserving many of the smaller animal forms. Pure ethyl alcohol is obtainable only by holders of a special government permit. Iso-propyl alcohol is very satisfactory for use and may be substituted for ethyl alcohol. Both formalin and iso-propyl alcohol may be obtained from the biological supply companies.

A summary, offering very brief suggestions for collecting, killing, and preserving the most commonly studied laboratory forms, is presented on the following three pages. A more complete discussion of the problems of making an insect collection is found following this summary. It should be noted, that in some cases where the fixative and the preservative are the same, the specimen need not be changed unless the solution is clouded or the specimen was not properly cleaned. A few crystals of oxalic acid added to the preservative aid in retaining original color.

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[9]J. L. Parkhurst, "Building A Classroom Museum," The American Biology Teacher, XVIII (1956), 259-260.

The Collection and Preservation of Some of The Commonly Used Laboratory Animals.

Fresh-water Sponges.
Found: Mid-summer in fresh water attached to branches and submerged wood.
Collecting Devices: Scalpel.
How to Kill: Drop into 70% alcohol.
Fixative: 70% alcohol.
Preservative: 70% alcohol.

Fresh-water Planaria.
Found: Fresh spring-fed streams, lakes, or rivers.
Collecting Devices: Fresh beef or liver placed in water where planaria are found.
How to Kill: Extend on glass plate and submerge in dilute alcohol.
Fixative: Dilute formalin or alcohol.
Preservative: 10% formalin or 80% alcohol.

Tapeworms.
Found: Intestine of dogs, cats, rabbits, or sheep.
Collecting Devices: Scalpel and forceps.
How to Kill: Extend on blotting paper saturated with formalin.
Fixative: 10% formalin.
Preservative: 10% formalin or 80% alcohol.

Ascaris and other Round Worms.
Found: Intestine of pigs, horses, cats, or dogs.
Collecting Devices: Scalpel and forceps.
How to Kill: Dip momentarily in hot water (98°C.).
Fixative: 5% formalin.
Preservative: 5% formalin.

Earthworms.
Found: Under rocks, boards, etc.
Collecting Devices: Spade.
How to Kill: Anesthetize by slowly adding alcohol to water.
Fixative: 5% formalin.
Preservative: 5% formalin.

Leeches.
Found: Hand pick from hosts or with dip net among weeds in ponds and streams.
Collecting Devices: Dip net.
How to Kill: Anesthetize by slowly adding alcohol to water.
Fixative: 10% formalin.
Preservative: 10% formalin.

Crayfish.

Found: Streams, ponds, lagoons in water or burrowed in mud.
Collecting Devices: Dip net, seine, or spade.
How to Kill: Drop alive into alcohol or formalin.
Fixative: 80% alcohol or 10% formalin.
Preservative: 80% alcohol or 10% formalin.

Scorpions, Centipedes, Spiders, etc.

Found: Under logs or stones.
Collecting Devices: Forceps.
How to Kill: Drop into 80% alcohol.
Fixative: 80% alcohol.
Preservative: 80% alcohol.

Insects. (see page 45)

Found: Everywhere.
Collecting Devices: Nets, forceps, and other equipment depending on kind collected.
How to Kill: For drying, in killing jar. For liquid preservation, in alcohol.
Fixative: For liquid preservation, in alcohol.
Preservation: Drying or alcohol.

Slugs and Snails.

Found: In damp places under leaves, logs, stones, or in streams, ponds, and lakes.
Collecting Devices: Dip net and forceps.
How to Kill: Anesthetize by slowly adding alcohol to water in which the animal has been placed.
Fixative: 80% alcohol.
Preservative: 80% alcohol.

Clams and Muscles:

Found: Streams, lakes, partly buried in the mud.
Collecting Devices: Seine or dip net.
How to Kill: Place wooden pegs between the two halves of shell and drop into 10% formalin.
Fixative: 10% formalin.
Preservative: 10% formalin.

Fishes.

Found: Streams, lakes, and ponds.
Collecting Devices: Nets, seines, and traps.
How to Kill: Drop into 10% formalin.
Fixative: 10% formalin. Inject body cavity.
Preservation: 10% formalin.

Frogs and Salamanders.

Found: Damp places in woods, ponds, rivers, and streams.
Collecting Devices: Nets.
How to Kill: Drop into formalin.
Fixative: 10% formalin. Inject body cavity and arrange into position.
Preservative: 10% formalin.

Reptiles.

Found: Woods, fields, near and in water.
Collecting Devices: Snares and nets.
How to Kill: Drop into formalin.
Fixative: 10% formalin. Inject body cavity.
Preservative: 10% formalin.

Birds and Small Mammals.

These animals are generally used for study or reference as skins. Special permits must be obtained before collecting. The body is removed and the skin dusted with borax or arsenic powder and the skin stuffed with cotton and allowed to dry. The American Museum of Natural History, New York City, publishes a brief manual for the preparation of skins and skeletons for both birds and mammals.

The Insect Collection

Every school should have a synoptic collection of insects as a part of its permanent teaching equipment. It may not be possible for the teacher to make a very complete collection in a single year, but over a period of years it is possible to accumulate a very creditable one. The students can and should be encouraged to collect and mount insects as a part of their course work and the better material obtained by them can then be made a part of the permanent collection.

All specimens put into such a collection should be in first-class condition, correctly mounted and each should bear a locality label indicating where and when it was collected.

<u>Collecting Equipment</u>.--When organizing a trip for the collection of insects, it is well to provide water dip nets for use for aquatic forms and air nets for the terrestrial forms. Cyanide jars may be purchased from supply houses and if they are to be used it is better to purchase them rather than have the students make them because both the potassium cyanide and its fumes are deadly poisonous. Killing jars made with chloroform saturated cotton covered with card-board give very satisfactory service. Alcohol will be needed for the soft bodied insects. Insect pins, labels, and boxes for storage will also be needed.

<u>Directions for Mounting</u>.--Regular insect pins should always be used. The sizes are numbered from 00, 0, 1 to 8; 00's and 0's are very fine and 8's are the heaviest. Number 3's are recommended for practically all insects.

Too much emphasis cannot be placed on neatness of mounting. The beginner will do well to set a high standard for himself from the start and throw away all poorly mounted specimens.

About one-fourth the length of the pin should be exposed above the insect for handling. It will greatly improve the appearance of the collection if all insects are mounted at the same height and all labels placed at uniform height.

Cigar boxes with tight fitting bottoms of corrugated board are useful for housing the students' collections and may even be used for the permanent collection until better boxes can be provided.

The orders of water living insects such as the May-flies and stoneflies are so soft that pinning them is not satisfactory. They should be put in vials of 80% iso-propyl alcohol or 80% pure ethyl alcohol. Immature specimens should be placed in this alcohol preservative.

Orthoptera (grasshoppers, roaches, et al.), Neurop-tera (Dobsonflies, et al.), Odonata (Dragon flies and Dam-selflies), Homoptera (Cicadas), Lepidoptera (moths and butterflies), and Hymenoptera (bees, ants, and wasps), should be pinned through the middle of the thorax. In some of these it is best to put the pin a little to the right of the center in order not to destroy any structure which may be in the median dorsal line.

Hemiptera (bugs) should be pinned through the thorax. Coleoptera (beetles) should be pinned through the right wing, a little less than one-fourth of the length of the wing from its base.

Diptera (flies) should be pinned through the meso-thorax a little to the right of the center.

Many of the smaller insects must be mounted on card-board points. The points should be triangular in shape and about one-fourth inch long and one-eighth inch wide at the base. The specimen is attached to the point with glue.

It should be on the left side of the pin when the head is directed forward.

The larger butterflies and moths are to be pinned with the fore-wings at a ninety degree angle with the body. They will need to be placed on a drying or spreading board for a few days to allow the wings to dry in place.[10]

Labelling.--The locality label should be 7/8 by 3/8 inches and contain the name of the county and state, the date, and the name of the collector. This label should be on the pin below the specimen, leaving about the same amount of space between the label and the insect as there is between the insect and the head of the pin. For specimens in vials the same information should be written with India ink on a small bond-paper label, which is placed inside the vial.

The order and family labels are placed on the bottom of the case ahead of the insects belonging to that group.

Care of the Collection.--After a collection of pinned insects has been made it must be examined three or four times a year for museum pests. Their presence is readily detected by sawdust-like material around the bases of some of the pins. Ordinary moth balls will help keep the collection free of museum pests, but will not kill them,

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[10]Gordon G. Pond, "Preservation of Insect Specimens," Turtox News, XXXI (1953), 69.

nor drive them away once they have become established. The best general protecting agent is paradichlorobenzene which is harmless to humans, but actually kills museum pests. A few of the crystals should be placed in the insect box every three months.

Fossil Animals

Probably the most important evidence of the change that takes place in the forms of animal life on earth is the existence of fossils. These are the actual remains or impressions left in the rocks by ancient animals, caught and imbedded in the sand or mud millions of years ago. Fossils do not occur indiscriminately but similiar types appear in rock layers which are known, from their position, to be of about the same age.

The members of the phylum Mollusca are the most common animal fossils collected in the field. The shell of these animals is found imprinted in many sedimentary rock formations and a single rock may have a great variety of these interesting forms. Other fossil forms, such as the insects in amber and the bones of reptiles, birds, and mammals, are more commonly known and will be of value if specimens are available for study.

CHAPTER IV

SUMMARY AND CONCLUSION

The major ways in which human beings learn still seem to be seeing and hearing. It is to be remembered that the basic function of all teaching aids is to enable learners to see and hear more fully and discriminatingly with greater comprehension.

These materials are not ends in themselves but rather tools for learning and teaching. Since they are tools, they must be utilized in terms of the patterns of given instructional programs. The effective use of teaching aids in biological sciences is determined by the teacher, and the teacher must develop skill in their development, selection, and utilization just as carefully and imaginatively as is humanly possible. By using the biological specimen, the teacher can approach his subject using all the senses of his students. Teaching aids are not to supplant ordinary classroom methods, instead they are to supplement these methods.

Experience has demonstrated that it is necessary for the teacher of biology to use many methods and techniques. It should be emphasized that the success of any method is directly dependent upon the teacher and the total environment of the learner. The teacher should be familiar with many methods in order to select wisely the proper method to fit best the situation.

If the biological specimen is properly used, it may then be included as a part of the teaching equipment. Each year many specimens are lost in laboratories throughout the country because they are not properly handled.

A specific time should be scheduled each year for checking, reclassifying, and cleaning the preserved materials stock. As the stock is checked, each bottle or container should be examined and cleaned. Preserving fluid should be replaced if it has become badly discolored or cloudy and each container should be completely filled. The cap will be easier to remove when the specimen is used, if the threads are lightly greased before replaced.

If there are a number of small vials containing related specimens, they may be consolidated into larger containers filled with fluid and closed. This not only gives all organisms of a type or unit together, it means that only a single jar need be checked for evaporation. Other efficient methods may be worked out for the particular situation involved.

The foregoing study of specimens for use in secondary biological sciences is not all-inclusive. It does, however, reveal the necessity of examining our present procedures to ascertain whether or not the maximum use of the materials which are available is being made.

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