PLEASURE WITH PLANTS

L. R. TEHON

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L. R. TEHON

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The May Apple, *Podophyllum peltatum* L.

Pleasure With Plants

L. R. TEHON

THE study of plants is an occupation from which many persons interested in nature derive much pleasure. The majority of these persons pursue this study in their spare time, regarding it as an avocation to which they may turn at will. They find in it, the year around, an intensely interesting employment which encourages them to spend many hours in the open, stimulates mental alertness and, in rare cases, yields some pecuniary profit. And, what is more important, they find that by continuing their interest in it they are able both to make worthwhile contributions to botanical knowledge and to gain for themselves that personal satisfaction that accrues from the amassing of a collection.

The value to science of the enthusiastic devotion of these non-professional individuals to botanizing in local and even wider territories is inestimable. Indeed, it is desirable on this account that more persons than are now so engaged should take up the study of plants. So an attempt has been made to explain in these pages what is necessary and desirable for a prospective amateur botanizer to do and to know in order to achieve results gratifying to himself and useful to the world at large.

What Is Botanizing?

In a simple sense botanizing is seeking plants. But to an enthusiastic botanizer this term has a much broader meaning. It includes, besides searching for plants, the entire process of learning to recognize and classify them, of collecting and preserving specimens of them, and of accumulating and interpreting information about them.

A set of rather well standardized methods has grown out of the long experience of professional and amateur students of plants. These methods have come into such general use that they constitute a sort of technique. So essential are they to a realization of the fullest possibilities of botanizing that they

may reasonably be regarded as a definite part of botanizing itself.

The beginner in botanizing should master this technique, at least to the minimum extent suggested in later paragraphs but preferably in its full detail. There is a reason for each of its requirements; but it is a lenient technique, with much leeway for adaptation to individual needs. As the botanizer progresses in his work with plants, he is likely to find that no small part of his pleasure comes directly from his mastery of technique.

Ways to Botanize

A great deal of satisfaction can be obtained from studying plants even when only a small amount of time can be spent at the task. A person so restricted may find himself limited to learning to use accurately the common names of plants. But one with more time to spend may supplement this knowledge by learning the corresponding technical or Latin names and may even extend his comprehension of plants to an understanding of their classification, their habitat preferences, their life histories and their relation to and dependence upon light, soil and moisture.

With considerable leisure at hand, the amateur botanizer may go so far as to develop a personal plant collection or herbarium. He may do this quite simply, including only specimen material of outstanding value or interest. Or he may develop a pretentious herbarium which not only exhibits a multitude of plant species but also substantiates by specimens the occurrence and distribution of each species, its flowers, its fruits and its variations.

Where to Botanize

Perhaps the best place in which to begin botanizing is the ground around a person's own home. Although the lawn and the garden are not usually thought of as ground for wild plants, dandelions, chickweeds, plantains and many others persist there successfully. These plants are excellent material with which to practice the technique of botanizing, and they also present intriguing problems in classification and manifest to observing eyes fine illustrations of biological adaptation.

After this introduction to the methods of botanizing, the

beginner should select some small area that is interesting to him and that appears to support a considerable variety of plants. This area need not be so much as a square mile in extent, if it includes a small stream or river bank and has some distinctive physiographic feature or some variety of terrain. An unsuspectedly large number of plant species is certain to grow in such a place. Seeking out these species sharpens the botanizer's powers of observation. Naming and classifying them furnishes an introduction to a considerable number of plant families.

Valuable botanical contributions have been made as a result of careful botanizing in such small areas. Three contributions of this kind that have been made on the basis of studies in Illinois are Stover's *A Mesophytic Ravine* (1930), Pepoon's *Cliff Flora of Jo Daviess County* (1909) and Thone's *List of Plants at Starved Rock* (1924).

As the botanizer grows in experience and knowledge, he may find it possible to attempt more comprehensive studies. This generally means that he will botanize over a larger territory, such as a region comprising several townships, a county, a unified vegetative region or even a state. The product of such work in Illinois is exemplified by Brendel's *Flora Peoriana* (1887), Gates' *Contributions to the Flora of Hancock County, Illinois* (1925), Pepoon's *Annotated Flora of the Chicago Area* (1927) and Lapham's *Catalog of the Plants of the State of Illinois* (1857).

Knowledge gained from careful botanizing in small areas may likewise arouse curiosity with regard to a limited group of plants. The botanizer may be prompted to undertake a thorough study of some genus, such as the willows or the sunflowers, or of plants inhabiting distinctive kinds of situations, such as sand dunes or bogs. To carry on such studies comprehensively, he should extend the range of his collecting over the widest possible geographical territory and secure the help of other botanists in territories he himself cannot visit.

From the specialized efforts of amateur botanizers real contributions have been made to botanical science. Many of the hawthorn species became known through the work of E. J. Hill in northeastern Illinois between 1900 and 1904. The present understanding of the taxonomy of willows is based to an appreciable degree on the willow collection accumulated by M. S. Bebb of Rockford, Illinois, around 1860. Much of the knowl-

edge concerning sand-inhabiting vegetation and bog floras in Illinois has been accumulated by professional botanists who, for relaxation from teaching, have turned to the stimulating occupation of botanizing.

When to Botanize

Field work, which is so important a part of botanizing, can easily be continued throughout the year. Spring usually is looked upon as the time when plants blossom, summer as their time of growth, autumn as their time for fruiting and winter as their time for rest. Actually, however, different kinds of plants come into blossom continually from early spring until late fall, and fruits are maturing throughout the year. Even in winter, when woody plants in our region are leafless, it is possible to study buds, leaf scars and other dormant structures of trees and shrubs, which often furnish characteristics more reliable for identification than those shown by variable summer structures. This ceaseless change presents the botanizer with an almost endless variety of plants and plant conditions.

In winter the botanizer also has an opportunity to name the plant specimens he collected during the growing season, to prepare these specimens for his herbarium and to arrange them in it. He may also find leisure at this time to review the notes he made in the field, to make close and detailed comparisons of plant species he has found difficulty in distinguishing, to read some of the informative and inspiring books on botany and to plan what he himself will do the coming season.

How to Botanize

Even in its simplest form botanizing consists of two phases. One is finding and observing plants out of doors. The other is learning facts about them. These phases are not distinct. They overlap and are interrelated in so many ways that directions given for one phase almost invariably contain suggestions pertinent to the other.

The directions that follow are intended to be sufficient as to technique to enable an amateur to do, within his personal limitations, work as fine as could be done by the professional botanist. However, many persons will not have the time, resources or interest to be so thorough. For these per-

sons procedures are suggested by which they still can derive a large amount of pleasure from botanizing.

The purpose of collecting.—The botanizer collects a plant specimen primarily to identify it accurately, since identification in the field is often extremely difficult with the equipment he carries with him. So the specimen is taken home for close and careful study. When such a specimen is properly preserved, it becomes a record of the botanizer's work in collecting and identifying.

Of course it is possible to botanize without collecting. Or, if collecting is done for identification alone, only such parts of a plant need be taken as are necessary for its identification; they can be discarded when the name of the plant has been worked out. A common method of keeping permanent memorandums of such plants is that of noting on the margin of the manual page, beside the description of the species, where and when each plant was found.

Carefully taken and preserved specimens are far superior to written notes and, for reference, are next in exactness to living plants. Because of this, the enthusiastic botanizer collects and preserves a specimen of every kind of plant he finds, for comparison when naming species distinguished by minute or critical differences.

Accurate naming of plants belonging to some groups requires at the outset the critical judgment of a specialist. Specimens that have been submitted to an expert for naming serve as authoritative standards, which the amateur will find very useful in making subsequent determinations of his own.

If the botanizer has opportunity to collect in unexplored regions, is able to establish rare occurrences of plants or makes representative collections in special regions, he may be able to sell sets of specimens to museums and institutional herbaria. Such sales may partly defray the cost of his travels or the expense of botanizing, and to that extent they represent a money return for his work.

Equipment for collecting.—Permanent equipment for collecting usually consists of a vasculum, a notebook, a small digging tool and a plant press. Although good collecting can be done without any of these items, it can be done more conveniently with them.

The vasculum.—A vasculum is the carrying case in which a botanizer stows specimens as he collects them. The usual

vasculum, shown in fig. 1, is a light metal can, generally oval in cross section and entirely closed except for a side door large enough to permit easy insertion of specimens. An adjustable leather or web strap snapped into rings at each end permits it to be carried over the shoulder.

A vasculum made of metal is strong in proportion to its weight, will withstand years of hard use, can be shaped conveniently for carrying and prevents rapid wilting of specimens.

The botanizer can purchase his vasculum from some biological supply house or he can have it made. If he chooses the latter, he should specify a light metal to reduce the weight and should be careful to have it made no larger than is necessary for a good load of specimens. A vasculum 24 inches long and with diameters of 6 and 8 inches for its oval cross section is large enough for any ordinary purpose.

Use of the vasculum.—Most botanizers carry both their specimens and their collecting equipment in the vasculum. The equipment usually includes a small trowel, a pad of blank 3- by 5-inch note paper, a supply of old newspaper, a notebook and any handbook or manual the botanizer may need.

Each plant chosen as a specimen should be wrapped in a piece of the newspaper with a sheet from the note pad bearing the collection number of the specimen, the place, the date and any other information the botanizer may wish to jot down. Thus wrapped, specimens are kept separate and are preserved from complete wilting or drying-out until they can be arranged in the plant press.

But the botanizer ought not to pass by an opportunity to collect because he does not have a vasculum along. Many botanizers make it a practice to carry a large-paged magazine when they go on trips not specifically for collecting. If they find interesting specimens they place them between pages of the magazine and later arrange them in the plant press. The advantages of the magazine method have been adopted in regular collecting by some botanizers who use large, heavy cardboards, joined like the covers of a book, between which folded newspaper sheets and a few dryer sheets are arranged to accept specimens as they are collected.

The digging tool.—The purpose of this tool—it may be a garden trowel, a putty knife, or anything similar—is to dig earth away from the roots of plants, usually when the plants are desired as specimens. This tool should be used to remove

the earth carefully, so that the plant can be lifted, rather than to "dig up" the plant.

Root systems and other subterranean structures are often most interesting parts of plants. Characteristic structures,

FIG. 1.—The vasculum in use. The long, oval-ended metal can with a door in its side receives specimens as they are collected and keeps them from withering while they are being carried home to be pressed.

such as the rootstocks of Solomon's seal, which bear large seal-like scars, the large, edible tubers of the wild yam and the tubers of the Jerusalem artichoke, should be represented in at least some of the specimens of these plants.

The notebook.—The botanizer's notebook is a sort of journal in which he keeps a day by day account of his collecting by making note of each plant collected, where it grew, when it was collected, and any other data he desires for future reference.

The notebook may be of any type that suits the individual botanizer's needs. Experience has shown, however, that it should be a kind readily duplicated, so that notebooks covering a period of years of collecting are uniform. It should also be well enough constructed to withstand hard handling in the field and long use afterwards. The cover should be sturdy,

wear-resisting and, if possible, waterproof. The paper should be durable and suitable for both pencil and ink. As to size, the notebook should have pages big enough to encourage the taking of full notes but it should not be too large to be carried conveniently. A notebook that is readily obtainable in most places and that fills these requirements well is a surveyor's Field Book.

Keeping notes.—Methods of keeping notebooks vary according to the individuality of botanizers. Usually, provision is made in the notebook for numbering specimens serially, as they are collected, by stamping or writing numbers serially on its pages before it is used. When a specimen is collected, it is given the next unused number in the notebook, and notes concerning that specimen are written after that number. Fig. 2 shows both a suitable notebook and a typical arrangement of numbers and notes on a page of such a book. Spacing of the numbers and other details can be arranged to suit the needs of the individual botanizer.

It is difficult to give directions about notes, for taking notes is apt to be a very individual matter. The note form shown in fig. 2 is suggestive. For each collection number the exact scientific name should be recorded, either when the plant is collected or later when it is carefully identified. The place and date of collecting should also be stated, either after each number or above a series of numbers when several specimens are collected at the same time and in the same place. Other items written down may concern the habitat, the condition of the plant or some question regarding the plant that the botanizer wishes to clear up later.

A series of carefully kept notebooks becomes one of the most valuable possessions of the amateur botanizer.

What constitutes a specimen?—A plant chosen as a specimen should illustrate to the greatest possible extent the characteristics upon which is based the species to which it belongs. Before he can select such specimens consistently, the botanizer must have long experience in collecting and much knowledge of plants. Practically it is enough at first if he collects material that illustrates typical form and structure, as he is able to observe them in the field.

The keys in botanical manuals to a large extent employ flower characteristics to distinguish families, genera and even species. They also employ characteristics exhibited by leaves,

stems, fruits and, sometimes, roots, particularly to distinguish genera and species.

Specimens should therefore show flowers in prime condition and should contain stems or representative parts of stems, leaves of various sizes and shapes and, whenever possible, fruits

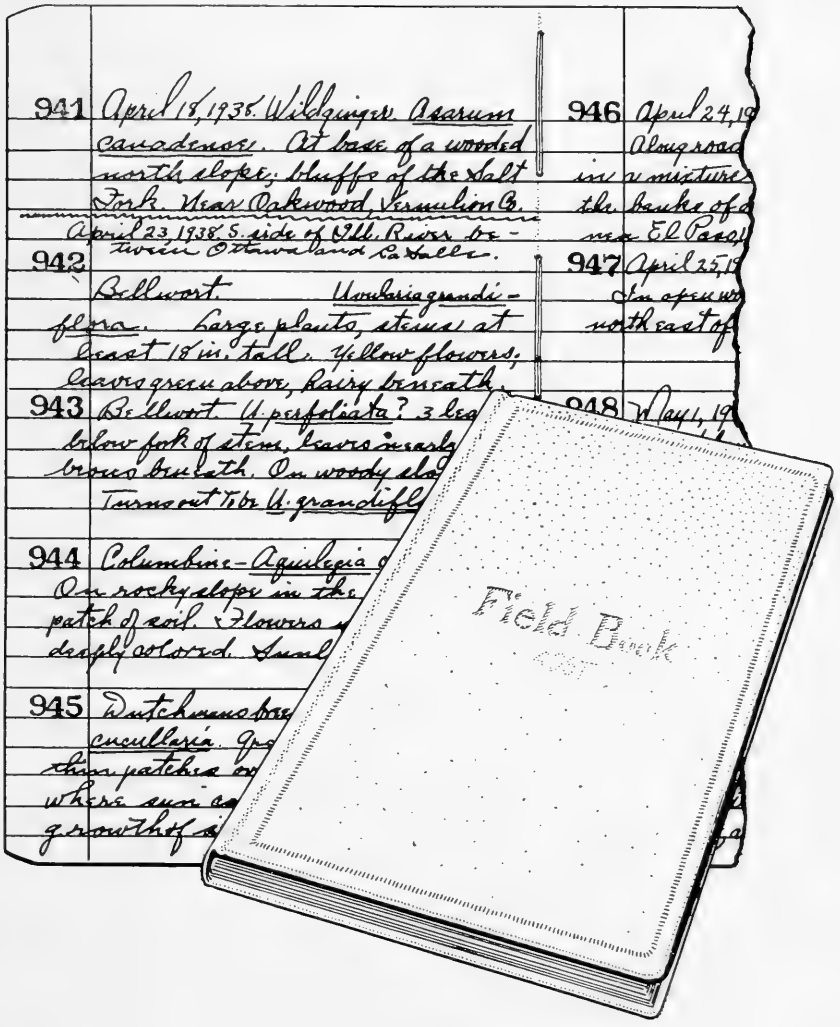

FIG. 2.—A notebook and a sample page of notes. Such a notebook has good paper and is well bound in a nearly waterproof cover. The sample page shows the method of numbering specimens and suggests kinds of notes that may be made.

or seed. Specimens may also include roots, if they are important for identification or are otherwise interesting.

If taken whole at flowering time, the majority of herbs can be identified by the characteristics they show. Because large herbs cannot be preserved in their entirety as herbarium specimens, the botanizer must select from them, as he would from trees or shrubs, representative parts that exemplify the essential characteristics of the species.

The fruit of many plants does not mature until long after the flowers have disappeared. In order to have fruit represented in specimens of such plants, the botanizer must make a second collection when the fruit is ripe, preferably from the same plant that furnished flowers.

As his knowledge of plants increases, the botanizer may desire specimens for purposes other than that of identification. He may want to exhibit in his collection, for example, the variation between individual plants that is characteristic in some species, the different aspects that are assumed by certain species at different times of year or the dissimilarities between juvenile and mature plants. Thus the variety of material that can be collected purposefully is almost endless.

The plant press.—This is the apparatus used to dry plants under pressure, so that they can be preserved as specimens in the herbarium. A typical plant press is pictured in fig. 3. It consists usually of a number of sheets of absorbent material, called dryers, and a pair of wooden lattices. Pressure to flatten out the plants in the press is applied by weights or by straps that can be drawn tight.

Plant presses, complete and ready to use, can be purchased from biological supply houses. They also can be made at home.

The botanizer who wishes to make his own equipment can put together a number of serviceable lattices from a bundle of smoothed laths and can cut a good supply of dryers from a roll of builder's felt or some similar material. He should make the lattices 12 inches wide by 18 inches long and cut the dryers the same size. These measurements are somewhat greater than those of the standard herbarium sheets upon which specimens usually are mounted and allow a little extra space for arranging and handling specimens during the drying process.

Dryers should have a high degree of ability to absorb water. The botanizer can make a simple test of the suitability

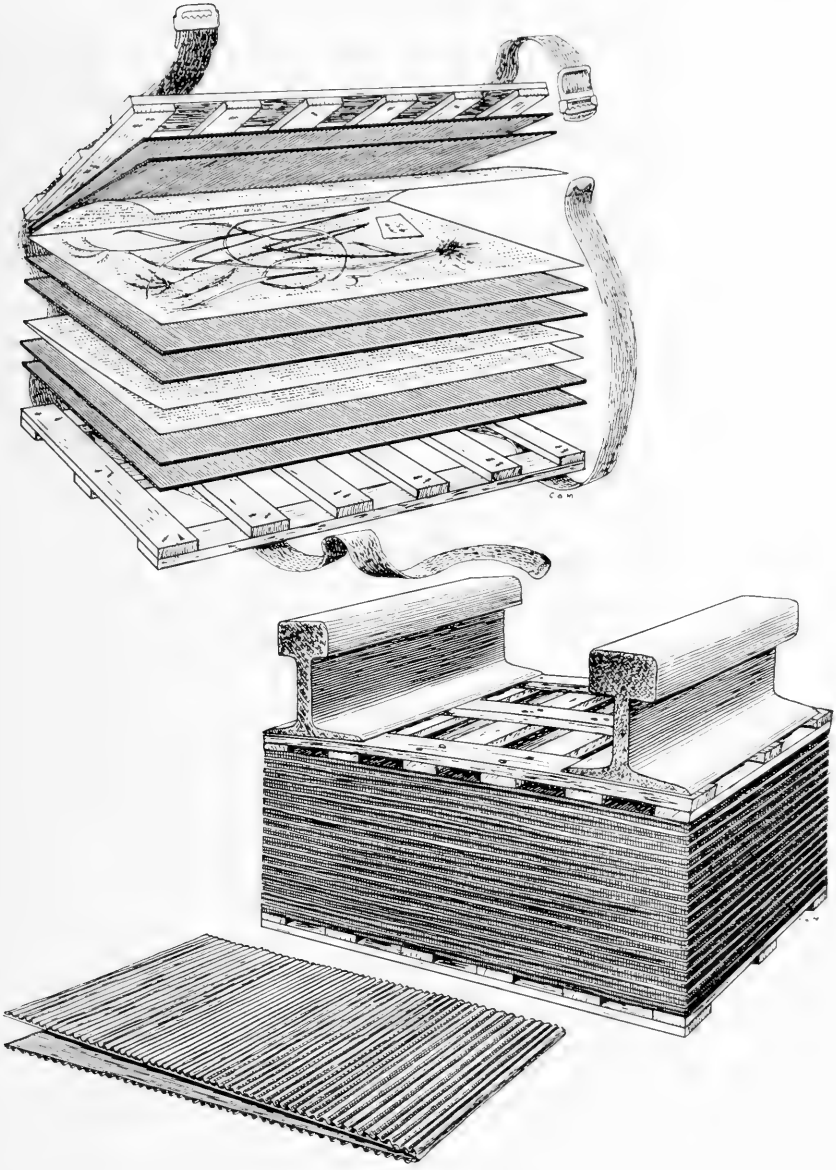

FIG. 3.—Typical plant presses. At the top, arrangement of the press—lattices below and above, dryers, newspaper folders containing specimens, and straps for binding the press. In the middle, a filled press weighted with sections of railroad rail. At the bottom, the corrugated cardboard separator used between dryers in the press to hasten drying.

of the dryer materials available to him by cutting sample sheets of each material and setting these sheets on edge in an inch of water in a tub. The height to which water rises in an hour is indicative of the ability of each material to absorb moisture from specimens. The dryer's ability to absorb water tends to increase somewhat with use.

Corrugated cardboard separators like the one shown in fig. 3 are frequently used by botanizers as a part of the plant press, in order to hasten the drying process. These separators are inserted between the two dryers that are usually placed between specimens, and the open spaces left by the corrugations allow air to circulate through the packed press. When using separators, most botanizers bind their presses with straps and hang them over some kind of heater, because heated air passing through the press takes up more moisture and, by warming the pack, speeds up the giving off of moisture by the specimens.

Good separators can be cut from corrugated stock which has the corrugation open on one side. They should be the same width, but twice as long, as the dryers, should be cut so that the corrugations run crosswise, not lengthwise, and should be folded crosswise in the middle so that the corrugations are on the outside.

There are many variations possible in plant press construction. If expense is a factor, the botanizer can use numerous substitutes in place of the usual materials. For example, he can make his lattices from old crate or box lumber and he can use old newspapers as dryers instead of blotting paper or felt. If he desires fine equipment, he can purchase aluminum lattices, dryers cut from specially graded blotting paper, light metal specimen separators and automatically regulated press heaters.

Using the plant press.—Although the appearance of a herbarium depends on a number of factors, the botanizer should take special care with the pressing and drying of his specimens, for the most carefully chosen specimens can be ruined by carelessness in pressing, and even poor material can be given a good appearance by careful pressing.

As soon as possible after it has been brought in from the field, a specimen should be placed in the plant press. The first step in drying the specimen is to place it within a folder of lightweight absorbent paper. Some botanizers prefer a

paper similar to newsprint stock, cut into sheets 23 by 16½ inches. These sheets, folded crosswise, make folders 16½ by 11½ inches, the exact size of the standard herbarium sheet. Other botanizers find that single newspaper pages folded crosswise serve the purpose well enough.

The plant specimen should be arranged in the folder in the most natural position possible. And, if there is a quantity of specimens to be pressed, care must be taken that the thick parts of specimens do not bunch up in the middle of the folders, or the packed press will be thick in the middle and thin at the edges. Although lattices are somewhat flexible, they usually cannot be bent enough to give the pressure necessary at the edges of a thick-centered pack. Consequently, leaves and flowers that extend outward from the pack center will not be held flat and smooth and will come out of the press wrinkled or shriveled. Obviously, such a condition detracts from the appearance of the finished specimen.

If the flowers a specimen bears are large enough to permit handling, the botanizer should arrange them so that they will appear lifelike when dry.

Because differences between upper and lower leaf surfaces are used in keys and in technical descriptions for characterizing plants, specimens should be arranged before being dried so that one or more typical leaves show the bottom surface. Bulbs, thick roots and fleshy fruits may be cut in half, lengthwise, to expedite drying and improve the appearance of specimens.

The appearance a specimen will make when finally mounted on the herbarium sheet should be kept in mind as the plant is being arranged for drying. Stems may be bent and the leaves, fruit and flower clusters so placed that all of a good-sized plant will show well on the herbarium sheet, without at the same time obscuring any of the characteristics the specimen should exhibit. Indeed, these characteristics may be emphasized by the arrangement given the plant.

When a specimen plant has been arranged to good advantage in its paper folder, the folder is laid on a dryer. Then both the dryer and the specimen-containing folder are laid on one of the lattices, upon which two or three extra dryers have already been placed to keep the imprint of the lattice from showing on the specimen. A second dryer then is laid on top of the specimen folder, and a lattice is laid on top of it and held

down with a weight while the second specimen is being prepared. When the second specimen has been arranged, the top lattice is removed and the second specimen, with a dryer below and above it, is added to the pile. Thus the plant press is packed.

When the pack is first made, the specimens in the press give off moisture very rapidly, and the dryers take it up and hold it. It is necessary to change dryers once or even twice a day during the first two to four days. If the dryers are not changed, the specimens are almost certain to become water-soaked and discolored and they are also apt to heat and disintegrate or to be rotted by molds. Frequent changing of dryers is an important factor if nicely prepared specimens are to be obtained.

Thorough drying of dryers between uses is a detail that should not be neglected. If dryers are stacked away immediately after being used, only their edges dry out. The center of the stack will remain damp for a long time. This condition encourages the growth of molds. Specimens can be ruined by these molds when the dryers are used again. The easiest and best way to care for damp dryers is to spread them out in the sunshine.

Strong pressure should be maintained on the plant press throughout the drying period. The purpose of this pressure is not to squeeze water out of the specimens but to keep them flat and smooth as they dry. Pressure may be applied by weights, such as sections of railroad rail, pieces of pig iron or paving bricks placed on the packed press, or by straps run around it and drawn tight. Many botanizers prefer to use straps, because they exert more uniform pressure throughout the press. But straps must be tightened frequently to compensate for shrinkage of the packed press as the specimens in it lose water.

After specimens have dried thoroughly in the press, they may be kept in their paper folders and tied into bundles for storage until there is time to name them and mount them on herbarium sheets.

Studying Plants

Although a botanizer can learn many of the things he wants to know about plants by reading technical and popular

botanical books and journals, he derives his greatest pleasure from studying plants themselves. One of the first aims in studying a plant is to learn its name.

How to name plants.—The easiest way to learn a plant's name is to ask someone who knows. This, contrary to the advice usually given, is a good way and it is, moreover, one that will be used many times when difficult specimens have to be submitted to experts for identification.

Generally, however, the botanizer has to name his own specimens. In doing so, he makes use of botanical manuals and handbooks. Many such books are available, some complete for large geographical regions, but a large number limited to special groups of plants, such as trees, shrubs or grasses, or to geographical areas such as counties or states. The manual now most commonly used is *Gray's New Manual of Botany*, the seventh edition of which has been considered a standard reference since its publication. Other manuals and a number of useful handbooks are listed under the heading "Useful Books."

Botanical keys.—The manuals and handbooks most useful to botanizers contain "analytical keys." These keys state in outline form the most reliable of the characteristics by which plant kinds are classified. The outline is so arranged that the botanizer can start at the beginning of it and "run down" the name of his plant.

In "Gray's Manual," for example, an Analytical Key to the Families follows immediately after the Preface. With it the botanizer can determine the plant family to which a particular specimen belongs. Further along in the book, where that family is discussed, there is an analytical key to the genera that make up the family; and where each complicated genus is treated there is an analytical key to the species that make up the genus. By using these keys successively, the botanizer can "key out" his specimen to its exact species, even though at the beginning it is entirely strange to him.

Botanical keys, however, are not perfect. It is therefore imperative that the botanizer compare the specimen he has in hand with the printed descriptions of the family, genus and species to which he has keyed his specimen. And if he has reliably named specimens of the species, he should compare his keyed specimen with them. In this way he makes certain that he has named his specimen correctly.

Using analytical keys.—Most beginners at botanizing ex-

perience difficulty in using keys. This difficulty arises mainly from a lack of understanding of how keys are made and of what they are expected to do. Perhaps the best way to understand the construction and use of keys is to make a small key for some familiar objects.

An eraser, an automatic pencil, a fountain pen, a writing pad and a book are objects that might be seen together on any desk. Among these the eraser stands out because it is flexible and because it alone is made of red rubber. The four other objects can be grouped in pairs because of certain similarities. Both the book and the writing pad are flat and oblong and are composed of pages. Both the pen and the automatic pencil are long and slender and are essentially cylindrical in shape. Yet the individuals of each pair can be distinguished. In the book, pages are bound together and bear print; in the writing pad, they are only gummed together and are clean of print. The pen has a flattish, pointed tip and writes with ink; the pencil has a conical tip and writes with lead.

When brief statements of these similarities and differences have been arranged as an outline, in the manner shown below, they form a key with which a person could identify each of the objects, even though he never had seen any of them before. From it, by following the dotted lines to the right, he would also learn the name of each object.

1. Object flexible and made of red rubber..... The Eraser
2. Object not flexible or not made of red rubber.
   - A. Object flat and oblong; composed of pages.
     - a. Pages bound together and bearing print..... The Book
     - b. Pages only gummed together, not bearing print..... The Writing Pad
   - B. Object long, slender and cylindrical.
     - c. Object with a flattish tip; writes with ink..... The Fountain Pen
     - d. Object with a conical tip; writes with lead..... The Automatic Pencil

This key to common things is similar in every respect to a botanical key; and the obvious manner in which it is used to identify the objects illustrates the exact manner in which botanical keys are used.

Keys encountered in manuals and handbooks are classified

as "natural" and "artificial." Natural keys, because they are based on characteristics important in determining whether a plant is primitive or highly developed, stress the natural relationships of plants. Artificial keys use, without regard for its significance, any conspicuous, constant difference that will serve to distinguish plant kinds easily and certainly. The accompanying examples, restated from two widely used books, illustrate the contrast between natural and artificial keys.

NATURAL KEY	ARTIFICIAL KEY
1. Stamens free from the corolla, as many as its lobes..... .....Campanulaceae.	1. Leaf blades coarsely toothed, 1 to 2 teeth per cm.....Styrax.
2. Stamens inserted on the corolla.	2. Leaf blades finely toothed, more than 2 teeth per cm.
A. Stamens 1 to 3, fewer than the corolla lobes..... .....Valerianaceae.	A. Teeth rounded....Ilex decidua.
B. Stamens 4 or 5, leaves opposite or whorled.	B. Teeth sharp-pointed.
a. Ovary 1-celled, flowers in dense heads..... .....Dipsacaceae.	a. Leaves wooly-hairy on the lower surface..... .....Spirea tomentosa.
b. Ovary 2– to 5-celled.	b. Leaves not like that.
x. Leaves opposite, never whorled, and without true stipules..... .....Caprifoliaceae.	x. Leaf blades oval to orbicular.....Gaultheria.
y. Leaves opposite and stipulate, or whorled and without stipules.. .....Rubiaceae.	y. Leaf blades narrowly oblanceolate..... .....Spirea alba.

Natural keys are found almost always in manuals and complete floras. Artificial keys are encountered most frequently in handbooks that deal with such special groups of plants as trees and shrubs. A key can be completely artificial. It is, however, very difficult to make a completely natural key. Consequently the keys in manuals, although predominantly natural keys, usually contain numerous small sections that are definitely artificial.

The outline, illustrated above, is the typical key form found in most manuals and handbooks. Another form, more

economical of space and less costly to print, is also common. It is known as the bracket form, because contrasted differences are arranged together. In bracket form, the experimental key devised above appears as follows:

1. Object flexible and made of red rubber.....The Eraser
   Object not flexible or not made of red rubber.....2
2. Object flat and oblong; composed of pages.....3
   Object long, slender and cylindrical.....4
3. Pages bound together and bearing print.....The Book
   Pages only gummed together, not bearing print.....The Writing Pad
4. Object with a flattish tip; writes with ink.....The Fountain Pen
   Object with a conical tip; writes with lead.....The Automatic Pencil

In using this kind of key, the botanizer should read the first set of contrasted descriptive lines, choose the line that applies to his specimen and then proceed to the set of differences indicated by the numeral placed at its right. He should then repeat the choosing process until he arrives at the name of his plant.

The amateur botanizer should have a good working knowledge particularly of the structure of flowers, fruit, leaves and stems. With this knowledge as a background he will be able to make accurate determinations, provided he works carefully, observes accurately and exercises good judgment in interpreting what he observes in terms of the contrasted wordings in keys and of the technical descriptions in texts.

Plant names.—The names used to designate plants are of two kinds, common names and technical names.

Common names, those used in everyday speech, often vary from locality to locality. A plant known by one common name in one place may be known by a different common name in another place, and a common name used in one place for one kind of plant may be used in another place for a different kind of plant. Technical names, on the other hand, have the advantage of being used in all parts of the world to designate the same kinds of plants.

Technical plant names consist of two parts, first the name of the genus in which a plant kind is classified and second the name of the species to which a plant belongs. For example, both the black walnut and the butternut (or white walnut) are classified in the walnut genus, the name of which is *Juglans*. The black walnut belongs to the walnut species *nigra*, and the

butternut belongs to the walnut species *cinerea*. The technical name for the black walnut is, then, *Juglans nigra;* that for the butternut is *Juglans cinerea*.

Written or printed technical names customarily are followed by abbreviations that commemorate the botanists responsible for them. Thus the technical names for the pear tree and the apple tree, *Pyrus communis* L. and *Pyrus Malus* L., both commemorate Carolus Linnaeus, and the technical name for the prairie rose, *Rosa setigera* Michx., commemorates André Michaux. In botanical usage, the botanist who reclassifies a species is commemorated along with the one who named it. The abbreviations following the technical name for the small Solomon's seal, *Polygonatum biflorum* (Walt.) Ell., for example, commemorate two men, Thomas Walter, who gave to the plant the species named *biflorum*, and Stephen Elliott, who at a later date reclassified the species, removing it from the genus *Convallaria*, to which it had been assigned by Walter, and placing it in the genus *Polygonatum*.

Equipment for Studying Plants

In order to solve easily and accurately the many problems he is certain to encounter in identifying plants, the botanizer should have a certain amount of working equipment. This equipment consists partly of books and partly of tools.

Books.—The botanizer will need at least three kinds of books. First, he will need a good textbook of elementary botany, from which he can obtain details relating to plant structure. Second, he will need at least one good botanical manual that covers the region in which he works. And, finally, he will need books of a more general nature, in which, for example, he may read about the uses to which plants are put, the history of botany, the habits of plants or the lives of great botanists. A book list from which he may choose is given in the section headed "Useful Books."

Tools.—The tools most useful to the botanizer are a good magnifier, a ruler and several dissecting needles, forceps, watchglasses, test tubes and, perhaps, scalpels.

Magnifiers, commonly called lenses, can be purchased in a variety of forms, the commonest of which are illustrated in fig. 4. Most botanizers like to have two magnifiers, one to carry on field trips and one, with some kind of support, to

use on the study table. A good magnifier need not cost much, and an excellent magnifier can be purchased for less than ten dollars. In the field most botanizers use a 10× magnifier, that is, one that magnifies 10 times. A high quality triple aplanatic magnifier of 12× magnification is often more useful. In general, the best magnifiers can be used at higher magnifications than the poorer ones.

A satisfactory magnifier to use on the study table is the tripod dissecting magnifier. The lens in this instrument can

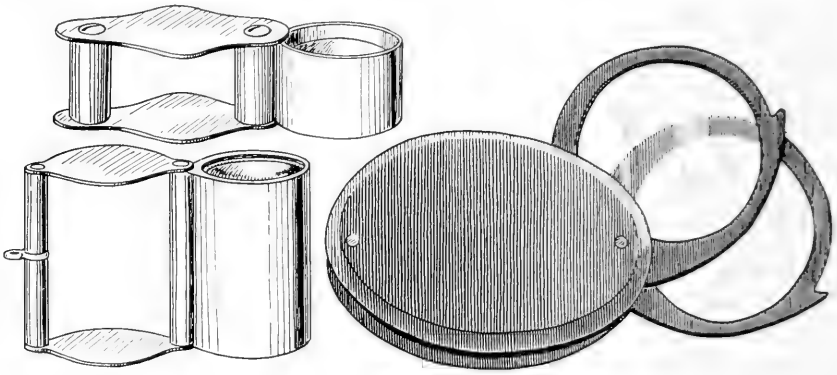

FIG. 4.—Suitable magnifiers for field use. Above, a "triple aplanatic" of the highest quality. Below, to the left, a "doublet" of good quality; to the right, a serviceable low-cost lens combination.

be focused by being screwed up or down in its supporting tripod. Costly dissecting microscopes and binocular dissecting microscopes with interchangeable sets of lenses of different magnifying powers are not necessary, although they are very convenient when fine work must be done.

A ruler is a necessity. It should be small and light and it should have scales for measuring by inches and by millimeters and centimeters. A thin, white celluloid ruler about 6 inches long is easily obtainable and is in common use. Flexible, transparent rulers are available also and they possess some advantages.

Dissecting needles are almost indispensable for examining flowers and other minute plant parts and are especially useful for manipulating objects under magnifiers. They can be purchased at small cost, or they can be made. A factory-made dissecting needle is obtainable, the handle of which is provided with jaws so that needle points of various convenient shapes

can be used as needed. Homemade dissecting needles, constructed by forcing the eye-end of an ordinary sewing needle into the end of a 4-inch piece of wooden dowel, the pointed end of a wooden meat skewer or any other piece of rounded wood, are satisfactory for almost all needs.

Forceps are useful in handling plant parts that are too small or too fragile for the fingers. Their small cost encourages the botanizer to have them at hand in a variety of sizes and shapes.

Watchglasses are convenient dishes in which to examine boiled-up flowers and other plant parts. They are obtainable in a number of forms; but the beginning botanizer should avoid those with round bottoms.

Test tubes are useful vessels in which to boil up dried blossoms for examination. They can be purchased in desirable sizes at local drug stores or from biological supply houses. A metal test tube holder is also a convenience, but a folded piece of paper will do quite well. Test tubes can be heated over a gas burner on the kitchen stove or over an alcohol lamp on the study table. But, if the botanizer does not mind the inconvenience, he can use a cup of nearly boiling water in which to soften his specimens.

Scalpels are conveniences rather than necessities, since the blade of a penknife generally will serve the same purpose. The blade of a good scalpel can be honed to a keen edge for fine cutting. This fact, together with the comfortable, balanced handles provided on better grades, makes scalpels as convenient to the botanizer as they are necessary to the surgeon.

How to work with dried blossoms.—In the drying of a plant specimen the flowers upon which identification so greatly depends are pressed flat. To study them it is necessary to restore them to something like normal condition. The procedure commonly followed is to break off a blossom from the dried specimen, drop it into a test tube one-third full of water and hold the test tube over a flame until the water in it has boiled for a short time. This boiling should not proceed so violently as to injure or seriously disarrange any of the flower parts, but it should continue until the blossom is flexible and easily cut.

When the specimen has been boiled enough, it and the water are poured into a watchglass and allowed to cool. If the watchglass is placed under a magnifier while the water still

is hot, steam will cloud the lens. A little time may be saved by transferring the blossom to a watchglass of cold water, but then there is danger of losing anthers or other small parts sometimes dislodged during boiling.

Some botanizers preserve dissected blossoms. This can be done by re-drying the dissected blossoms very carefully and gluing them to small pieces of cardboard. Mounts thus made may be covered with cellophane tissue and attached directly to the herbarium sheets from which the flowers were taken or they may be placed in envelopes glued to the sheets. Dissections can also be preserved in small vials containing a preserving fluid, such as glycerine, that evaporates slowly.

A botanizer's work table is shown in fig. 5.

The Herbarium

In the building of a herbarium the botanizer satisfies his desire to amass a collection. Also, he preserves the most exact record possible of his studies, accumulates reference material more concrete than the most detailed botanical descriptions and builds for himself a tangible expression of all that he learns about plants. As he progresses, he finds his herbarium constantly becoming more useful, for, serving as a convenient and always available means of comparing new and old collections, it contributes increasingly to the accuracy of his determinations.

There are two essentials to a good herbarium: carefully prepared specimens and suitable cases in which to store them.

Preparing a herbarium specimen.—When a specimen has been pressed and named, it is ready to be incorporated in the herbarium. Some botanizers prefer to keep their specimens loose in paper folders, but the majority prefer to mount their specimens on sheets of heavy paper. The first method is less costly, and requires less labor, but the second gives more protection to specimens and makes them more convenient to use.

If specimens are to be kept in folders, the folders in which they are pressed may serve well enough. A degree of neatness may be achieved, however, if the specimens are transferred to fresh folders cut to herbarium sheet size. The folder itself may be labeled with the name of the specimen, or special label forms may be used as suggested later. Some botanizers spend con-

siderable amounts for folders, which they select for durability and niceness of appearance.

If specimens are to be mounted on sheets, the sheets and the mounting methods should conform to those used in established herbaria. The standard herbarium sheet measures 11½ by 16⅜ inches. The paper should be white and of a quality

FIG. 5.—Equipment on a botanizer's work table. The articles on the table include dissecting needles, forceps, a scalpel, a ruler, watchglasses, test tubes and test tube holders, an alcohol lamp, a tripod magnifier and two dissecting microscopes.

that will not disintegrate or become discolored with age. It should also be so heavy and rigid that, with a specimen mounted on it, a sheet can be handled without buckling and thus damaging the specimen. A 56-pound ledger bond paper meets these requirements well, but heavier grades are often used.

If possible, specimens should be attached to the herbarium sheet with glue. Care in selecting the glue is very necessary. Pastes, mucilages and glues intended for paper work generally do not hold specimens permanently. Fish glues and others used in woodworking have proved more or less satisfactory. The glue used by canning factories to stick paper to tin cans is perhaps the best that can be obtained.

Round stems and fruits and waxy leaves often will not adhere to the sheet, even when the best glue is used. But small strips of gummed cloth tape, properly applied, will hold these

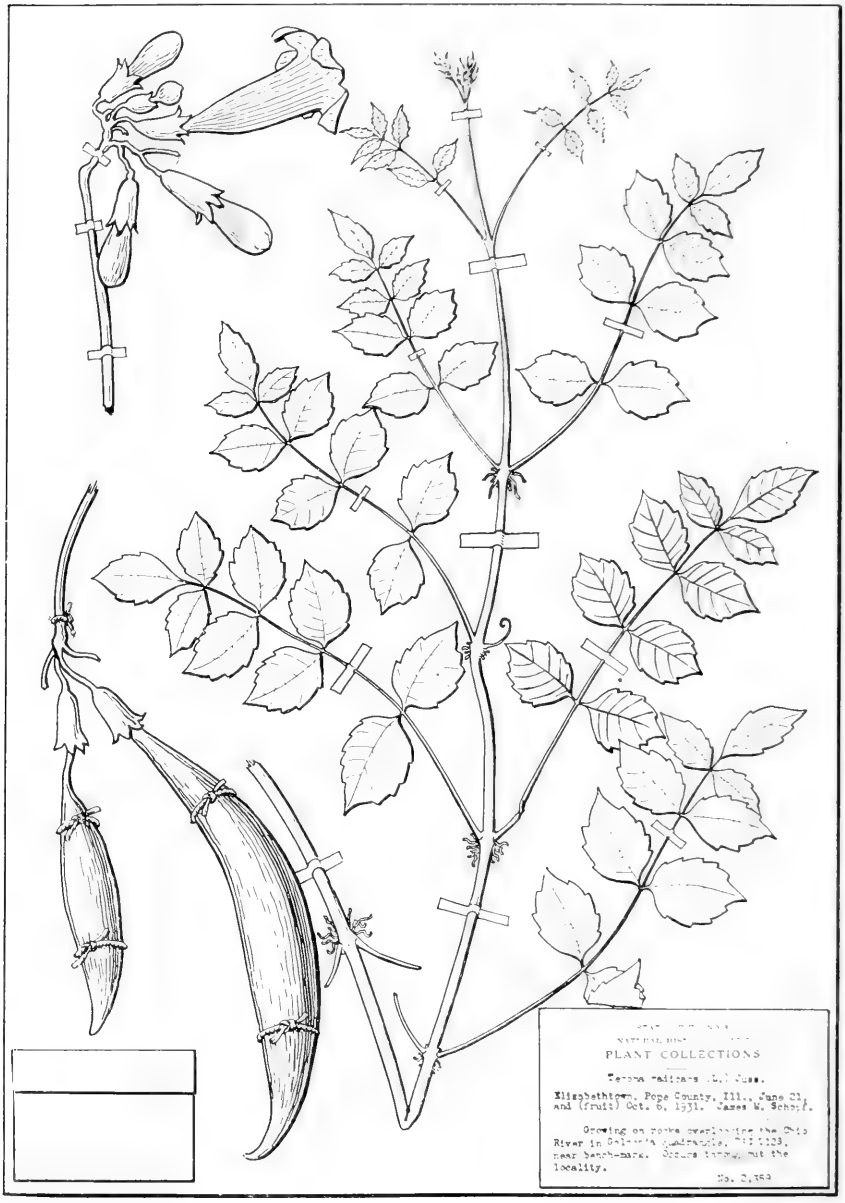

FIG. 6.—A complete herbarium specimen, with stem, leaves (one turned bottom up), flowers and fruit. The leaves and flowers are glued to the sheet, the stems are taped down and the pods are tied down with floss. The packet provides for keeping loose seeds.

plant parts firmly. To attach a strip so that it will not break away from the paper, moisten it carefully (it must not be made too wet), lay it on top of the stem and bend it down and around both sides until it nearly surrounds the stem; then press its free ends flat on the herbarium sheet, fig. 6.

Grasses and other plants with slender cylindrical stems and narrow leaves, and also bulky specimens, are hard to mount permanently with glue. It sometimes is possible to tape them, as directed above. But a more effective procedure is to tie them to the sheets. Floss that harmonizes with the green of dried specimens is threaded in a needle and run through the sheet, first from the top and then from the bottom, so that when the ends are tied a tight loop holds the specimen to the sheet. As many loops may be made as are necessary to attach the entire specimen firmly. Knots should always be tied on the upper side of the herbarium sheet to avoid damaging specimens on sheets that may be stacked beneath. Tying may be used along with gluing and taping to assure additional security.

Large, hard fruits, such as nuts and acorns, may be put in small cardboard boxes glued to the herbarium sheet or stored separately. Loose seeds and small fruits may be placed in envelopes or folded paper packets glued to the herbarium sheet.

As soon as a specimen has been glued and placed on a herbarium sheet, the new mount thus made should be covered with a sheet of waste paper (a half-sheet of newspaper, perhaps) and placed under a weight until the glue sets. When a number of new mounts are made at the same time, they may be stacked between plant press lattices, each mount separated from the one above it by a sheet of paper and a dryer. The stack can be pressed down by weights set on the top lattice.

Specimen labels.—Labels for herbarium sheets are almost as varied as are the botanizers who use them. The label commonly used is a small printed blank such as those illustrated in fig. 7, upon which can be written the name of the species, the date and place of collection, the name of the collector, altitude of the habitat and any other desired information. The size of the label, the type used in printing it, and the completeness with which the items to be written on it are indicated, are all matters of individual preference.

Arranging the herbarium.—In the herbarium, all specimens representing the same species, all species belonging to the

same genus and all genera belonging in the same family should be kept together. Families may then be arranged to correspond with their order in the manual the botanizer uses, or they may be arranged alphabetically. The manual order is preferred by most botanizers, since it tends to keep similar plants together. The genera and species of each family, on the other

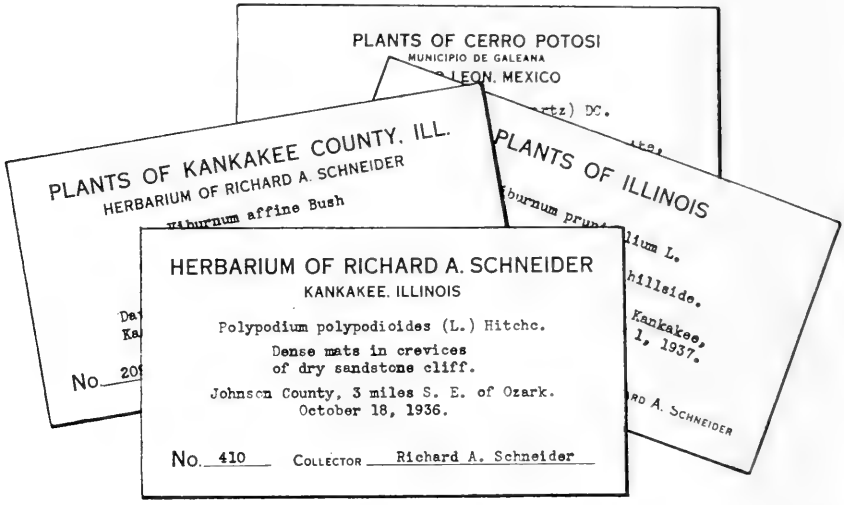

FIG. 7.—Typical specimen labels. These labels, all used by an amateur for his collections, only suggest how labels may be printed and filled in. The individual botanizer may design his labels to suit his own needs and taste.

hand, usually are arranged alphabetically. Except in large herbaria, there is little need for a special arrangement of individual specimens.

Herbarium specimens should be filed in genus covers, which are made by folding single sheets of heavy manila paper crosswise. A sheet measuring 23¾ by 16½ inches makes the genus cover a little larger than a standard herbarium sheet and gives protection to the edges of the herbarium sheets filed in it.

Because of the weight of the specimens attached to herbarium sheets, it is desirable to lay genus covers horizontally on shelves rather than to stand them vertically in drawers.

The herbarium case.—Specimens can be stored in any available box, cupboard or cabinet, but a well designed herbarium case will give them greater protection and make them

more easily accessible for use. Herbarium cases may be purchased, made to order or constructed at home. The cost ranges from a great deal for the finely manufactured steel cases used in institutional herbaria to only a very little for serviceable cases that can be made at home.

The botanizer should make certain that his herbarium case has the following qualifications. It should be practically dust- and insect-tight when closed. The shelves in it should measure 12½ inches wide by 17 inches deep, in order to accommodate standard herbarium sheets, and should be spaced 5 to 6 inches apart, so that each shelf will accommodate a reasonable but not unwieldly stack of genus folders. The case should be sturdily made, so as to give long service, and it may be finished as attractively as the botanizer desires.

For the amateur botanizer who wishes to build his own herbarium case, a plan is shown in fig. 8 on the following page. The total cost of materials for this case, including lumber, hardware and finish, should not exceed ten dollars; usually it will run between seven and eight dollars. It will be less, of course, if the case is made with one tier of shelves instead of two. The following materials are needed to construct the case shown in the plan.

2 4×8 ft. sheets of ¼ in. fir plywood
1 4×6 ft. sheet of ¼ in. fir plywood
1 2½×4½ ft. sheet of ¼ in. fir plywood
10 ft. of 1×4 in. clear white pine
50 ft. of 1×2 in. clear white pine molding
16 ft. of ½×1 in. clear white pine molding
40 ft. of ¼×¼ in. clear white pine stripping
3 cabinet door hinges
1 bar sash lift, for door pull
3 friction door catches
1 lb. no. 4 finishing nails
1 pkg. 1 in. brads
1 pkg. ½ in. brads
1 pt. walnut varnish stain

In measuring and cutting the wood pieces for this case, and in fitting them together, it is necessary to work carefully, so that the joints will be tight enough to exclude dust and insects. Care in fitting the door is especially necessary.

Preventing insect damage.—Herbarium specimens are liable to severe damage by insects which feed on dried fruits, fleshy roots, stems, flowers and leaves, and by other insects which feed on the paper and glue used in mounting specimens. Steps should be taken at the very beginning to prevent insect damage, for large numbers of specimens can be ruined before the presence of insects is detected.

The first precaution to take against insect damage is, as has been emphasized above, to make certain that herbarium

cases, when closed, are tight enough to prevent the entrance of insects. It is necessary, also, to kill insects that may be carried in with specimens and to prevent development inside the case of those that enter when the doors are opened.

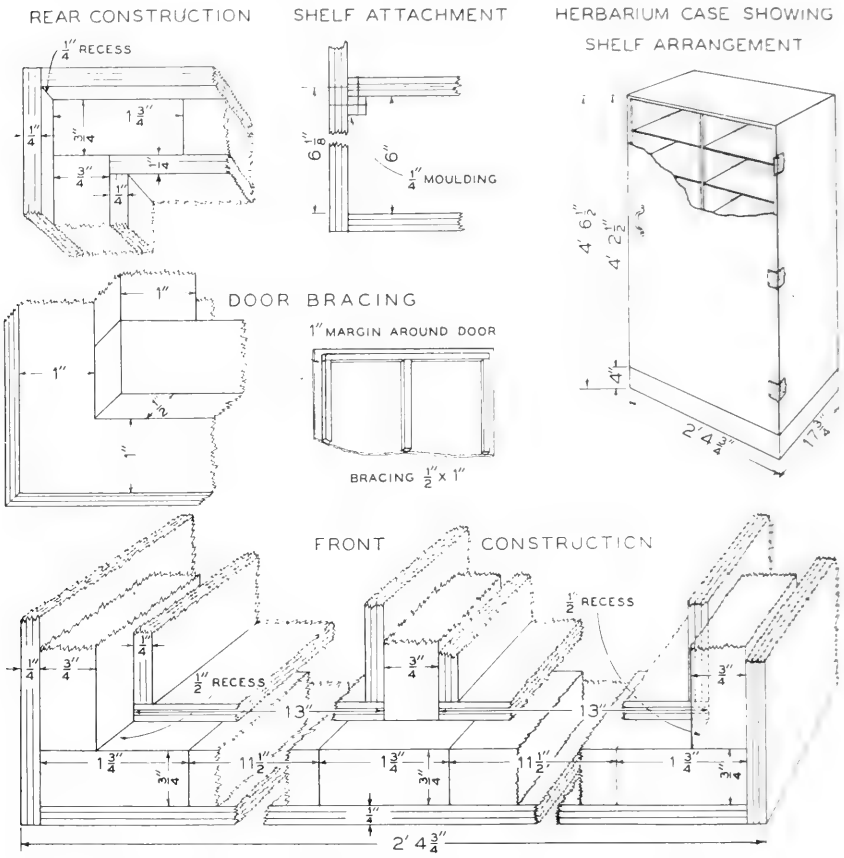

FIG. 8.—Working drawings for a satisfactory herbarium case that can be made at home.

Specimens may be "insect-proofed" with corrosive sublimate (**a deadly poison**). Before specimens are mounted on herbarium sheets they are painted or sprayed with a 1/1000 solution of corrosive sublimate (this material is also known as bichloride of mercury and mercuric chloride) in 50 per cent alcohol. The treatment dampens the specimens and a second drying in the plant press is necessary. Although this treat-

ment is not wholly effective, it is employed as a standard procedure in almost all large herbaria. Specimens already mounted will be protected to some extent, if the exposed side is treated.

Many of the insects that infest herbarium cases can be killed with "PDB" (paradichlorobenzene). A quantity of crystals may be kept in a net or cheesecloth bag fastened inside the case at the top of each tier of shelves. Directions on the container indicate the weight of crystals necessary for any cubic space, and, if the treatment is to be continuously effective, the quantity of crystals must be replenished periodically.

Cyanide fumigation, which is sometimes practiced in large herbaria, **should never be attempted by an amateur botanizer. It is too dangerous for anyone but an expert to use** and is, moreover, only temporarily effective.

Useful Books

The list below represents only the writer's opinion as to which books are likely to prove most useful to amateur botanizers in Illinois. Many other books might have been listed. Among the manuals, "Gray's Manual" and "Britton and Brown" have been used so generally that one of them is almost a necessity. The list of handbooks could have been extended almost indefinitely. The textbooks suggested are modern and comprehensive, but many older texts, available perhaps in local libraries, will also serve the botanizer well. Only a few other books have been suggested, for the botanizer's own inclinations are almost certain to lead him into fields of reading that could not be foreseen.

Manuals

An Illustrated Flora of the Northern United States, Canada, and the British Possessions. By Nathaniel Lord Britton and Addison Brown. Charles Scribner's Sons. 1913.

Field Manual of the Flora of Ohio and Adjacent Territory. By John H. Schaffner. R. G. Adams & Company, Columbus, Ohio. 1928.

Flora of the Prairies and Plains of Central North America. By Per Axel Rydberg. Published by the New York Botanical Garden, New York City. 1932.

Gray's New Manual of Botany (Seventh Edition, Illustrated). By Benjamin Lincoln Robinson and Merritt Lyndon Fernald. American Book Company. 1908.

Manual of Cultivated Plants. By L. H. Bailey. The Macmillan Company. 1924.

Manual of the Flora of the Northern States and Canada. By Nathaniel Lord Britton. Henry Holt & Company. 1910.

Manual of the Grasses of the United States. By A. S. Hitchcock. U. S. Government Printing Office, Washington, D. C. 1935.

Manual of the Trees of North America. Second Edition. By Charles Sprague Sargent. Houghton Mifflin Company. 1922.

Handbooks and Local Floras

Annotated Flora of the Chicago Area. By H. S. Pepoon. Published by the Chicago Academy of Sciences. 1927.

Handbook of Illinois Wild Flowers. Published by the Illinois Natural History Survey. 1936.

Native and Naturalized Trees of Illinois. By Robert Barclay Miller and L. R. Tehon. Published by the Illinois Natural History Survey. 1929. Now out of print but available in most libraries.

Plant Materials of Decorative Gardening. The Woody Plants. By William Trelease. Published by the author, Urbana, Illinois. 1926.

Shrubs of Indiana. By Charles C. Deam. Published by the Indiana Department of Conservation, Indianapolis. 1924. [Equally fine handbooks of Indiana trees and Indiana grasses, by the same author, will be found useful throughout Illinois.]

The Grasses of Illinois. By Edna Mosher. Illinois Agricultural Experiment Station Bulletin 205. 1918.

Winter Botany. By William Trelease. Published by the author, Urbana, Illinois. 1918.

Textbooks

Botany. By William J. Robbins and Harold W. Rickett. D. Van Nostrand Company, Inc. 1929.

Elements of Botany. By Richard M. Holman and Wilfred W. Robbins. John Wiley and Sons, Inc.

Fundamentals of Botany. By C. S. Gager. P. Blakiston's Sons and Company. 1916.

Strasburger's Textbook of Botany. Macmillan & Company, Ltd. 1930.

Other Books

How to Know Wild Fruits. By Maude Gridley Peterson. The Macmillan Company. 1914.
Methods of Descriptive Systematic Botany. By A. S. Hitchcock. John Wiley & Sons, Inc. 1925.
Taxonomy of the Flowering Plants. By Arthur Monrad Johnson. The Century Company. 1931.
The Book of Wild Flowers. Published by the National Geographic Society. Washington, D. C. 1933.
The Common Names of Plants and Their Meanings. By Willard N. Clute. Willard N. Clute & Company. Indianapolis. 1931.
Wild Flowers. By Homer D. House. The Macmillan Company. 1935.

Maps

Maps for use in conjunction with field work are obtainable from various sources. A variety of local maps may often be obtained from county surveyors' offices at small cost. County plat books, such as those published by W. W. Hixson & Company of Rockford, Illinois, contain folded county maps and page-size township maps on a larger scale, which show roads, creeks, rivers and farm boundaries. Topographic maps for many Illinois quadrangles may be obtained from the Illinois Geological Survey at Urbana. These are the most detailed maps available for large areas. Soil maps, obtainable from the Illinois Soil Survey at Urbana, frequently are useful for habitat studies.

A map too large for convenient use in the field can be cut into sections of uniform size (perhaps 6 by 6 inches). The sections can then be glued to a substantial cloth, with perhaps one-fourth inch of space between them. Thus cut and mounted, the map can be folded compactly for carrying and also be folded so as to expose any desired section.

Conclusion

The preceding pages have dealt almost exclusively with the mechanics of botanizing. Little has been said of what may be learned about plants or of how living may be enriched

through study of them. In so much, our title may have promised more than our pages have given. Yet the botanizer's real purpose is to learn about plants. In accomplishing it, he will encounter difficulties and face hard problems; and from overcoming the difficulties and solving the problems he may derive some of the keenest pleasures the study of plants can give.

The Jack-in-the-Puplit, *Arisaema triphyllum* (L.) Schott.

RECENT PUBLICATIONS

of the Illinois State Natural History Survey

A.—ILLINOIS NATURAL HISTORY SURVEY BULLETIN.

Volume 21, Article 1.—The Effect of Petroleum-oil Sprays on Insects and Plants. By M. D. Farrar. November 1936. 32 pp., frontis. + 21 figs., bibliog. Contents: Foreword; Properties of oil emulsions; Effect of petroleum oils on plants; Insecticide tests with the emulsions; Oils with fungicides.

Volume 21, Article 2.—Responses of the Large-mouth Black Bass to Colors. By Frank A. Brown, Jr. May 1937. 23 pp., frontis. + 10 figs., bibliog. Contents: Problem of color vision in fishes; Materials for the experiments; Training and responses of large-mouth black bass; Interpretation of the responses; Summary. 50 cents.

Volume 21, Article 3.—Studies of Nearctic Aquatic Insects. By H. H. Ross and T. H. Frison. September 1937. 52 pp., frontis. + 86 figs., bibliog. Contents: I. Nearctic alder flies of the genus Sialis (Megaloptera, Sialidae) by H. H. Ross; and II. Descriptions of Plecoptera, with special reference to the Illinois species, by T. H. Frison. 50 cents.

Volume 21, Article 4.—Descriptions of Nearctic Caddis Flies (Trichoptera) with special reference to the Illinois species. By Herbert H. Ross. March 1938. 83 pp., frontis. + 123 figs., foreword, index. $1.00.

B.—ILLINOIS NATURAL HISTORY SURVEY CIRCULAR.

28.—Rout the Weeds! By L. R. Tehon. August 1937. 34 pp., color frontis. + 8 figs. Contents: The importance of weeds; Weeds as economic factors; Weeds as harborers of plant diseases; Relation of weeds to public health; Control methods; Eight pernicious weeds of Illinois—common ragweed, giant ragweed, poison ivy, poison sumac, wild parsnip, white snakeroot, pokeweed, common burdock.

29.—Windbreaks for Illinois Farmsteads. By J. E. Davis. April 1938. 18 pp., frontis. + 12 figs. Contents: Planning the windbreak; Planting the windbreak; Care of the windbreak; What the windbreak trees are like.

30.—Outwitting Termites in Illinois. By W. E. McCauley and W. P. Flint. June 1938. 20 pp., frontis. + 19 figs. Contents: Termites and their habits; Structural control of termites; Chemical control of termites; Unified action against termites.

31.—The Peach Tree Borers of Illinois. By S. C. Chandler. February 1939. 36 pp., frontis. + 22 figs. Contents: The peach borer; Peach borer life history studies; Control of the peach borer; The lesser peach borer; The peach bark beetle and the shot-hole borer.

C.—ILLINOIS NATURAL HISTORY SURVEY MANUAL.

1.—Fieldbook of Illinois Wild Flowers. By the staff. March 1936. 406 pp., color frontis. + 349 figs., index. Contents: Introduction; Key to families; Description of species (650). $1.50.

Address orders and correspondence to the Chief

ILLINOIS STATE NATURAL HISTORY SURVEY

Natural History Bldg., Urbana, Ill.

Payment must accompany requests for publications, in the form of U. S. Post Office money order made out to State Treasurer of Illinois, Springfield, Illinois.