THE BROOKLYN BOTANIC GARDEN EXHIBIT OF GARDEN OPERATIONS at the TWENTY-SECOND INTERNATIONAL FLOWER SHOW GRAND CENTRAL PALACE, NEW YORK CITY MARCH 18-23, 1935

The exhibit of the Brooklyn Botanic Garden is on the third floor, on the 46th Street side of the “open court,” at the Grand Central Palace. The exhibit is designed to illustrate various garden operations and it is hoped that it will be of especial value to the novice.

Soil is prepared for planting by plowing or by digging and incorporating manure. The work is facilitated if a trench is maintained during the whole of the time digging is in progress. The initial trench is made by removing a strip a foot wide and a foot deep across one end of the plot. The soil thus removed is used for filling the final trench.

For special purposes, and when particularly good results are desired, the soil is prepared by “double digging.” This is accomplished by first opening a trench two feet wide and one foot deep. Manure is scattered on the trench bottom and mixed with the subsoil by the use of a spading fork. The topsoil from the next strip of two feet is now filled into the trench—mixing in manure as the work proceeds. When the trench is more than filled (to make allowance for increased bulk of disturbed soil) the subsoil of the second strip will be accessible for treatment. Proceed in this way until the end of the plot is reached.

The soil is prepared by digging or plowing and incorporating liberal quantities of decayed manure. The application of a 5-10-5 fertilizer, worked into the upper three inches of soil at the rate of 20 pounds to 1,000 square feet, is desirable. A fine seed bed, as shown in the exhibit, should be formed by thoroughly raking the surface—removing all stones, sticks, and trash in the process.

The best time to make a lawn is in early fall, but it may be done in early spring. Choose a calm day for sowing the seed, at the rate of 3 or 4 pounds to 1000 square feet. Consult your State Agri-
cultural Experiment Station or your seedsman regarding a seed mixture adapted to your soil conditions.

Most deciduous trees and shrubs may be planted in fall or spring when they are dormant, if the ground is unfrozen and dry enough so that it does not unduly stick to the tools. Spring planting is preferred for those subjects whose winter hardiness is doubtful, and for beech, birch, dogwood, magnolia, and oak. The hole for the reception of trees and shrubs should be large enough to receive the roots without bending them. Before planting, trim broken roots with a sharp knife. Prune the branches to compensate for the loss of roots left in the ground where the tree or shrub was dug. The amount to cut off is determined by the subject (some plants recover more readily from the effects of transplanting than others), and the degree of root injury. On an average it is desirable to cut off about one-third of the top growth. Make the cuts with a view to improving the shape of the tree or shrub, bearing in mind the desirability of maintaining as far as possible its natural form. (Pruning is illustrated in the exhibit by trees with those branches painted that are to be cut off.) The tree should be set not more than one inch deeper than it was when growing in the nursery. Throw fine soil over the roots, work it in among them with a planting stick, and make firm by trampling. Leave a depression over the roots to facilitate watering. See partly planted and completely planted trees at either end of exhibit.

Usually these are received from the nursery "balled and burlapped." Prepare a hole at least a foot wider than the diameter of the ball. Set the tree in the hole, and when you are satisfied it is at the correct depth, untie the burlap and tuck it in the bottom of the hole. Then fill in with soil and pack firmly by trampling. (Illustrated by partly planted evergreen.)

Two methods of supporting newly planted trees are illustrated. One, applicable to large trees with heavy tops, consists of three guy wires attached to the trunk, and to short stakes driven into the ground at equal distances around the tree. Rubber hose is threaded on the wire at the point of attachment to the trunk to prevent abrasion of the bark. The other method shows a tree supported by a stake. The stake should be driven in the center of the hole before the tree is planted. Two methods are shown of attaching the tree to the stake by the use of old rubber hose.

The tree mulched with peat moss suggests the desirability of applying light material such as salt hay, straw, buckwheat hulls, strawy manure, partly decayed leaves, etc., on the soil over the roots to conserve soil moisture. By using an auger to obtain a sample of soil at a depth of from 12 to 18 inches, it may be determined whether the trees need watering.
When trees and shrubs are planted on steep turf banks, the problem arises of adequately caring for them by conserving the moisture, controlling weeds and, at the same time, preventing erosion. A solution is suggested by a demonstration planting of trailing roses on such a bank. Holes are made just large enough to receive the roots—disturbing the sod as little as possible. After the shrubs are planted the bank is covered with mulch paper, the upper part of each strip covering the lower part of the next strip above. This conserves moisture, kills the grass, and prevents weed growth. In the meantime, the grass roots hold the soil and prevent it from washing away; and by the time they are decayed the shrub roots have taken their place. If the shrubs are planted close together with a view to covering the whole bank, the mulch paper should extend over the whole area. If they are widely spaced and it is designed to allow sod to continue to exist between them, a covering large enough to extend over the shrub roots is all that is necessary.

Various methods are shown of planting seeds: in the case of fine seeds, by raking the surface, scattering the seeds ("broadcasting"), and then again raking to cover them; for larger seeds, by the removal of an inch or less of soil, sowing the seeds and returning the soil; and finally, by planting in "drills" or shallow trenches. A piece of chicken wire-netting placed over the seed patch prevents sparrows from using it for a dust bath and hindering germination. The netting must be removed before the seedlings become entangled in it.

The patch of seedlings thickly spaced serves as a reminder that it is almost invariably necessary to "thin out" the plants originating from seeds sown where the plants are to bloom, in order to allow the remaining plants room to develop. This work should be done after a rain, and preferably on a cloudy day.

The technique of using a "draw hoe" and a "scuffle hoe" is illustrated. The cultivation of the surface soil is important for the purpose of killing weeds, of discommoding pests such as cut worms and other larvae, to improve the appearance of the soil, and to conserve moisture. Mulch paper serves the first and last purposes with some plants with good results.

The "top-worked" apple exhibited indicates that undesirable varieties of fruit trees may be exchanged for good ones by the insertion of scions of good varieties. The operation is usually performed with dormant scions in early spring—using the method known as cleft-grafting. The technique is described in almost every book on plant propagation and general gardening.

The presence of a spray tank and a "duster" serves to remind us that often it is necessary to apply insecticides and fungicides in order to protect our crops from the ravages of insect, fungous, and other pests. As a general rule "sucking" insects are combatted by the use of contact insecticides and "chewing" insects by spraying their food (usually
the leaves) with a stomach poison. Bordeaux mixture is the standard fungicide; although sulphur as a dust or spray is preferred to prevent or control mildew, and to combat black spot on roses.

The installation of a manure-heated hotbed and one heated by an electric cable, with a glass panel on the side of each so that the "works" may be viewed, should be of interest to those who raise plants in hotbeds. A manure-heated hotbed is made by digging a pit two feet deep, of sufficient size to accommodate the frame it is proposed to use. The pit is filled with fermenting manure (or 1/3 leaves and 2/3 manure if the latter is scarce), which is packed evenly and covered with 6 inches of sifted soil. The seeds are sown when the temperature of the manure (as determined by a hotbed thermometer) has subsided to 90 degrees. If the seeds are to be sown, and the plants grown, in flats, seed pans, or pots, the manure is covered with an inch or so of sandy soil to form a level base on which they may be stood. Careful attention to ventilation to prevent the temperature from rising too high on sunny days, and additional covering on the sash when the nights are cold, are essentials for success in hotbed management.

An electrically heated hotbed may be made by digging out the soil to a depth of about 1 1/2 feet and placing in the excavation from 8 inches to 1 foot of coarse ashes or clinkers to provide heat insulation and drainage. These are covered with burlap to prevent the soil from washing into them. After the frame is set in place, an inch of soil is put in, and the heating cable placed in loops about six inches apart, after which about 6 inches of sifted soil is placed in the bed and lightly tamped. The soil temperature is maintained between 65 and 70 degrees by adjusting the thermostat.

The method of mixing soil, preparing seed pans for the reception of seeds by sifting the soil and pressing even with tamper, and the operation of repotting, are illustrated here. A "spotting board" is shown—useful for aiding beginners to secure an even placement of seedlings in the flat when they are "pricked off" or transplanted. Underneath the bench is shown storage space for flower pots and soil.

To get the best service from them, garden tools should be kept sharp, and cleaned and oiled after use, as shown here.

This is a fine art, and in order to support herbaceous plants adequately, and so that their natural habit of growth is not distorted, many different methods and materials must be employed to fit the character of the plants to be supported. Plants of floppy habit are shown, held up by twiggy growths, stuck in the ground around them. This is an effective and unobtrusive way of supporting such plants. Twigs suitable for this purpose may be obtained by maintaining a bush or two of California privet, from which they may be cut during the winter. The long shoots produced by Rose of Sharon when it is annually pruned are useful when slender temporary stakes are required.

Montague Free
THE CARE OF CUT FLOWERS*

With the increasing amount of attention which is now being given to the arrangement of cut flowers, it may be in order to say a few words about the subsequent care of the flowers. For, when one has succeeded, after painstaking effort, in making a beautiful arrangement, it is discouraging to see the flowers wilt, or soon wither.

Everyone has, in his mind’s eye, a fairly definite picture of what a “flower” is, but for the purpose of exactness let us see what the botanical text-books say. It is sometimes there defined as a shoot, i.e. stem and leaves, specialized for the purpose of sexual reproduction. The typical flower, such as that of the buttercup or wild rose, has a ring or whorl of brightly colored leaves called petals, beneath which is another whorl, (typically smaller) of usually green or greenish leaves, called sepals. At or near the center of the flower one sees one or more pistils—usually greenish structures. These contain the ovules which, if fertilized, are to form the seeds; and surrounding the pistils are (typically) several stamens, tipped with yellow anthers, the latter containing the pollen. Without going into the details, which may be gleaned from any botanical text-book, the pollen, when transferred to the tips of the pistils, serves to fertilize the eggs contained in the ovules.

Of what use, then, are the petals and sepals—those parts which seem the most essential to the flower lover, but which are termed non-essential by the matter-of-fact botanist? Science tells us that these, as well as the perfumes and nectar of flowers, are the product of long ages of evolution—of variation, struggle for existence, and survival of the fittest. Apparently the sole function of the petals, as well as of the perfume and nectar, is to attract the attention of insects (or other animals, e.g. humming birds) so that they may visit the flower, and in so doing, get some of its pollen on their bodies, to be later carried to other flowers where it may be lodged on the stigmas (i.e. the tips of the pistils), and thus consummate cross pollination (and cross fertilization.) The function of the sepals, when green or inconspicuous, is said to be that of protection of the inner parts of the flower in the bud stage.

*Broadcast (in part) over WNYC, New York City, February 21, 1935. This is one of the subjects discussed in the course for nurses-in-training, which has been given by the Brooklyn Botanic Garden for the last eight years.
For those of us who are sentimentally inclined, it is a bit shocking to be thus told that flowers were not formed for man's edification. As a matter of fact, however, paleontologists tell us that man has been on this earth only about one million years—that is, if we go back as far as his erect, ape-like, but bipedal, troglodytic prototype—whereas flowers have wafted their "sweetness on the desert air" since the Cretaceous era, or for nearly one hundred million years. But man has appropriated flowers for his own uses, such as ornament and manufacture of perfumes; just as, in the course of his occupation of the earth, he has appropriated countless other plant products and parts of plants for his food, shelter, clothing, medicine, etc.

As the young apprentice-doctor, in his novitiate, must acquire a thorough knowledge and understanding of the structure and functions of the human body, in order to be able, as a full-fledged physician, to deal as intelligently as possible with whatever human ill he may be called upon to treat, so a knowledge of the fundamental nature and workings of the flower is essential to the successful care of it.

Since the primary function of the whole flower is to produce seed, it is wise to prevent the formation of seed, if a continual supply of flowers is desired. And so we keep cutting our sweet peas, violets, pansies, and the like, in order to preclude seed formation, and to be assured, by this method, of a succession of blooms. Flowers cut in the bud stage, or just after opening, will last the longest. Since the function of the pollen is to fertilize the ovules, florists have a trick of removing the anthers from the stamens of those gorgeous Easter lilies. Lilies so treated are said to last longer. Lack of pollination is apparently one reason why orchids keep so long. In general, pollination shortens the life of the flower.

Because a cut flower is a part of a living organism, namely the plant from which it was cut, the individual cells of which the flower is composed are, or should be, still alive, and should remain so if the flower is to continue in a healthy condition. In cutting the flower from the plant, we sever its connection with the roots, the organs which obtain its water supply, and substitute for these the water of the container in which the stem of the flower is plunged.

For our purposes, then, we may say that to have fine, upstanding, cut flowers, two things are necessary; first, an adequate supply of water, and second, (which depends primarily on the first) a healthy condition of the petals. A few words about these requisites may be helpful.

1. The water which is delivered to the petals is conducted through the stem by bundles of tubes or of tube-like cells. When the passage through these bundles becomes blocked in any way, the supply of water delivered to the flower diminishes or stops entirely, and hence the flower begins, as we say, to "wilt." The water absorbed from the soil by the roots is of course not pure water, but contains dilute
solutions of various salts which are used by the plant for its growth. But since flowers, when picked, are usually no longer growing, such solutions are unnecessary; and, in any case, the water in the container possesses a certain amount of nutrient salts in very dilute form.

2. A healthy condition of the petals means that they must be in a turgid condition, i.e. not soft and flabby, or "wilting." For we must bear in mind that the petals of a flower (as well as all its other parts) are continually losing water by evaporation to the outer air (transpiration\(^1\)). If they are firm or "turgid," this means that the cells of which they are composed are filled to capacity with water (and dissolved substances) which is being supplied to them by the stem. Such turgid cells are like so many tiny footballs—of course filled with water instead of air—and it is mainly due to their collective force that the whole petal which they compose is stiff and firm. A good illustration of such stiffness imparted by water pressure is seen in the familiar fire hose.

Although bearing in mind the interrelation of these two conditions, i.e., turgidity of floral parts and the conduction of water through the stem, let us enumerate under the two headings the various methods in use for keeping cut flowers fresh.

I. METHODS RELATED DIRECTLY TO THE CONDUCTION OF WATER

1. In gathering the flowers, use a sharp knife, and make a long, slanting cut. If a dull knife is used, the cut surface may become clogged with particles of plant tissue; and, furthermore, a rough, abraded surface is apt to decay more quickly. A long slanting cut is best because more of the conducting cells in the interior of the stem are thus exposed; also, if the stems are cut off at right angles, the cut surfaces may come to rest flat on the bottom of the container and thus hinder the entrance of water into the conducting cells.

2. Use deep containers and bowls, so that as much water as possible may come in contact with the outside of the stem and prevent evaporation.\(^2\)

3. Cut the stems a little above their ends every few days, in order to get a fresh surface for entrance of water into the conducting cells of the stem, for these tend soon to become clogged with bacteria and other micro-organisms. At the same time it is advisable to pour out the stale water and put in a fresh supply. White\(^3\) recommends changing the water daily.

4. "The Japanese have studied for years the treatment various types of cut flowers should be given to lengthen their keeping qual-

\(^1\)Transpiration and evaporation are not strictly identical, but for our purposes it is unnecessary to go into the finer distinctions.

\(^2\)See Haberlandt, G. Physiological plant anatomy. pp. 479,480. Macmillan & Co. 1914.—This refers, of course, to woody stems, with lenticels, but the case of herbaceous stems, with stomata, is similar.

\(^3\)White, Edward A. The principles of flower arrangement, pp. 30 ff. A. T. De La Mare Co. N. Y. 1926.
ties. If the Wistaria is used in decoration, its cut stem is burned and then immersed in spirits. The Hydrangea and the Lespedeza should have the stem ends burnt to charcoal before immersing in water." The reason for this treatment appears to be that the cut ends are rendered aseptic, so that bacteria, etc. do not readily enter.

5. In general, leaves which happen to be immersed in the water of the container should be removed from the stem, particularly in hot weather. They decay faster than the stem, promoting a growth of bacteria in the water, and at the same time they tend to crowd the stems too closely. Schling\(^2\) says also, "chrysanthemums, snap-dragons, etc. should have two leaves out of every three above water removed."

6. Cutting the stems under water when gathering, or again after the flowers are brought into the house, is recommended by some authorities. We do not feel, however, that this is as important as is generally supposed, although it is of course detrimental to have the stems out of water for a long time.\(^3\)

7. With some flowers, immersing the cut ends of the stems in hot water for about a minute is said to be beneficial. Heliotrope, Dahlias, Hollyhocks, Mignonette, and most shrubs are difficult to cut and arrange without wilting. White states that if the cut ends of the stems of these flowers "are plunged into boiling water for about a minute, then placed in cold water, the keeping qualities will be increased in a remarkable degree. The hands should be held about the flowers to protect them from the hot steam, otherwise they will blacken."\(^4\) A friend who has won prizes for flower arrangement tells me that in cutting ordinary garden poppies she finds that if the ends are dipped at once in hot water for a minute the flowers will revive immediately when taken into the house, otherwise they droop. Just what the hot water does in these cases is not clear. The higher temperature quickens the molecular activity of the water, and thus may facilitate its ascent in the stem.

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1White, Edward A. l.c., p. 32.
3The recommendation of cutting the stems under water is based on the "Dixon hypothesis" that the water-conducting tubes in a healthy plant are filled with solid columns of water. Cutting the stem, therefore, breaks the continuity of these columns, introduces bubbles of air, and hinders the upward transport of water and solutes. But according to the most modern theory, the water does not so rise in stems—that is, in most cases. There is evidence that its usual method of ascent is by means of films which line the tubes, and slide upward. "Within these hollow cylinders of water there is water vapor, the freedom, amplitude, and speed of movement of which are greater than those of liquid water; but the constituent molecules of which, as they move more or less swiftly up a tree, may become alternately parts of liquid, parts of vaporous water, remaining always part of the continuous wet mass of the tree until they fly off into the air." Peirce, George J. Observations on sap hydraulics. Amer. Jour. Botany 21: 226. 1934.—The practical value of cutting stems under water, as a means of reviving flowers, would be a good subject for someone to investigate experimentally.
4White, Edward A. l.c., p. 31.
II. METHODS RELATED DIRECTLY TO THE TURGDITY (NON-WILTING) OF THE FLOWERS

It goes without saying that the petals soon wilt if the stem does not conduct water to them. The methods for preserving and prolonging this function in the stem have already been discussed under 1. Under the present heading we classify all methods or conditions by which the water tends to be directly retained in the petals, thus preventing wilting.

1. The best time to cut flowers in the outdoor garden is in the early morning, for then the tissues contain a maximum of water, the relative humidity of the air is higher, and the temperature lower than later in the day.

2. After cutting, or after obtaining cut flowers from the florist, it is best to place the stems in a deep receptacle of cool water, and leave them for a few hours in a cool room. Under these conditions the cells of the petals should receive a good supply of water, evaporation will be at a minimum, and the petals should therefore become turgid.

3. To prevent wilting and to prolong the life of flowers as long as possible, the room in which they are placed for decoration should never be hot and dry; for dry air and high temperature increase evaporation from all moist surfaces, so that, naturally, flowers in such an environment will not last long.

A few years ago Dr. A. E. Hitchcock and Dr. P. W. Zimmerman, of the Boyce Thompson Institute for Plant Research at Yonkers, N. Y. tried out the effect of chemicals, temperature, and humidity on the lasting qualities of cut flowers.\textsuperscript{1} Using carnation, rose, cosmos, and dahlia, they found that although there was considerable individual variation among the flowers, a low temperature was beneficial in practically all cases. For this reason, the florist keeps his flowers in a refrigerator or cool chamber; and it is best to place those in the house in a cool room during the night, or even near an open window provided the outside air is not too cold.

As most of us realize, one of the worst enemies with which we have to cope in the winter time in this latitude is the excessively dry air of the dwelling house or apartment interiors. The air is dry because it is the outdoor winter air which has been heated and has not had an opportunity to take up moisture during the heating process. Hence the avidity with which it takes the moisture out of everything at hand. There are numerous appliances on the market for making this moisture readily available, such as various steam radiator attachments, and we strongly recommend using one of them.

The delicate tissues of flowers are easily affected by this fierce dryness, and wilt under its continued action. Hence the admission of plenty of outside air at night to the room where flowers are kept, not only helps them by lowering the temperature, but brings in an air which has a much higher relative humidity.

Perhaps you have known the ruddy-faced housewife in the farmer's cottage who has "great luck with plants." In her kitchen window throughout the rigorous, northern winter, are thrifty begonias, gorgeous geraniums, and all kinds of wonderful, green, growing things. From the bubbling kettle on the range a stream of vapor is poured forth into the atmosphere of the room all day long. Here we have the ideal conditions: plenty of moisture in the air and a fairly low temperature.

4. In line with what has been said above, we repeat: the practice of removing flowers to a cool room at night or placing them near an open window, if the air is not too cold outside, is a good one.

5. There is scientific proof for the statement that flowers are injured by (what would seem) almost infinitesimal amounts of illuminating gas in the atmosphere. Coal gas is also detrimental.

6. As a rule, do not keep cut flowers in bright sunlight. This increases the transpiration, and although the flowers may not wilt, their life is shortened.

Summary

These recommendations may be briefly summarized as follows:

1. With garden flowers which are prolific bloomers, such as sweet peas, pansies, violets, constant cutting promotes a constant succession of bloom.

2. When gathering the flowers, use a sharp knife and make a long, slanting cut.

3. Use deep containers and bowls, filled with water.

4. Cut the stems a little above their ends every few days and replace the water in the container with a fresh supply.

5. In some cases burning or charring the ends of the stems has been advised.

6. In general, especially in hot weather, remove the leaves which happen to be immersed in the water.

7. We do not believe that cutting the stems under water when the flowers are being gathered, or again, after they have been brought into the house, is as important as is generally supposed.

8. With some flowers, such as the Heliotrope, Dahlias, Hollyhocks and Mignonette and the common Garden Poppy, immersion of the cut ends for a minute in hot water is said to be beneficial.
9. The best time to cut flowers in the outdoor garden is in the early morning.
10. Flowers cut in the bud stage or just after opening will last the longest.
11. It is best to leave cut flowers, either those just gathered or those obtained from the florist, in a deep container filled with water, in a cool room, for a few hours before bringing them into the living room.
12. Keep the air of the room in which the flowers are used as decoration, as cool and moist as is consonant with comfort.
13. It is a good practice to remove flowers to a cool place at night.
14. Even minute amounts of illuminating gas or of coal gas in the air of the room are injurious to plants.
15. Do not allow bright sunlight to shine upon the flowers.

The Use of Chemicals for Prolonging the Life of Cut Flowers

There seems to be a firmly fixed, popular notion that aspirin, or some other substance, when added to the water in which the stems of flowers are placed, will lengthen the life of the flowers. It is said that the idea originated with someone who had so added aspirin, and observed that the flowers, thus treated, kept for a long time. This is one of those *post hoc, ergo propter hoc* cases of reasoning which cannot be proved or disproved. Thus, when we are sick we call the doctor and we recover. *Therefore* the doctor cured us. We put aspirin in the water and the flowers last a long time. *Therefore* the aspirin is the cause of their prolonged life. The difficulty with this line of reasoning is that we never can know what would have happened had the doctor *not* been called, or if the aspirin had *not* been added. The only way out of the difficulty is to use what scientists call a “control.” In the case of the flowers, this is simple enough. The flowers are divided into two or more lots; one lot is treated, the others (the controls) are not. If, after repeated experiment, the control flowers behave in the same way as those experimented upon, then, obviously, the result is not due to the treatment.

Drs. Hitchcock and Zimmerman have done all this for us.\(^1\) They have tried out 51 different chemical substances—among them aspirin, quinine, common table salt (sodium chloride), and have found that *none* of the chemicals used was noticeably effective in prolonging the life of the flowers experimented upon. Carnation, rose, cosmos, and dahlia were the kinds used. It was noticed, however, that there was considerable *individual variation* among the flowers: “some would remain in perfect condition for from one to several days longer than others, even though all flowers had opened from bud within

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\(^1\)Hitchcock, A. E., and P. W. Zimmerman, l.c.
the same period (16 or 24 hours) and were selected to be comparable in external appearance." . . . "Although many treatments appeared to be beneficial, the variation in response among lots receiving similar chemical treatment at different times was as great as that between treated and untreated lots."

It is interesting to note that Mr. N. C. Thornton, also working at the Boyce Thompson Institute, found that under certain conditions carbon dioxide treatment, i.e., a content of carbon dioxide, in the atmosphere considerably in excess of the normal, was effective in prolonging the life of cut flowers (roses).

The Longevity of Flowers

Besides varying individually, flowers vary specifically, generically, and even, it seems, as to families, as regards their keeping qualities. Many of the Compositae or Sunflower Family have a long life. This last fall a bouquet of chrysanthemums of the smaller, quilled sort (White Doty and Pink Doty) remained in fine condition in my apartment in Brooklyn for more than 3 weeks. During this time the leaves faded, but the flowers, up to the end of the period, retained their color and nearly all of their original freshness. Everyone knows the Everlasting or Helichrysum, commonly known as the Straw Flower, which belongs to the same family, the flowers of which last practically indefinitely—hence the common name. Perhaps some characteristic of the tissues, possibly an inherent firmness of the cell walls, or of the make-up of the plant, is in some way bound up with this keeping quality. However, the flowers of the common (blue) chicory, and of the dandelion, also composites, are notably short-lived. In the last two, however, the ray flowers (which are of petal-like nature) are of rather fine, soft consistency. Evidently there are exceptions.

The flowers of the Sea Lavender (Limonium carolinianum and vars.), often used in winter bouquets, are also famous for their lasting qualities. On the other hand, some flowers are only ephemeral. I well remember trying, as a boy, to get flowers of the Rockrose, Helianthemum canadense, also known as Frostweed, for pressing as botanical specimens. Always, when I returned home and opened my collecting case, the petals would be found to have dropped off. So with the Day-Flower or Commelina communis, the Common Poppy, and others. An experienced florist probably knows in a general way the limits for each kind of flower. A list of the various kinds of flowers, based on their longevity under controlled conditions, would be interesting and valuable from a practical standpoint.

Arthur Harmount Graves

PREPARATION OF HERBARIUM SPECIMENS

Printed descriptions and especially pictures are well-recognized ways of finding out the identity of plants; but in the last analysis and wherever critical judgment is required, files of dried herbarium specimens are the only solution. With good preparation, flowers of herbarium specimens will generally retain their color for many years. If photographs, descriptions, notes, and drawings are incorporated with the specimens, the herbarium collection, especially of cultivated plants, becomes not only an unending first-hand means of identification but also a source of information as to what may or may not be desirable for planting.

The primitive way of pressing plants, by placing them between the pages of a book or magazine and forgetting them, is not recommended. There are a number of ways of drying botanical specimens, but all methods depend on the principle of rapid drying under suitable pressure.

Good specimens depend on careful selection of material in the field. They should be arranged and pressed when collected, if facilities are available, because many tender-leaved plants, such as Impatiens (Touch-me-not), are usually beyond help by the time they arrive in the laboratory. A tin box (vasculum) keeps most plants in condition for a whole day, and is indispensable during windy or rainy weather. In collecting plants it must be remembered that mounted sheets of herbarium specimens have a standard size (11½ x 16½ inches) and that specimens should fit into these limits. Folding of the stems is therefore frequently necessary; for example, most goldenrods will require two sharp foldings of the stem when they are placed in the drying papers. In the case of small plants a number should be chosen to show the variation in size.

In the drying process the specimens are laid in once-folded newspaper (approximately 11½ x 16½ inches in dimensions when folded). Unprinted stock is highly desirable. In preparation for drying, the specimen should be folded or otherwise arranged as it is to appear on the mounted sheet, for no changes can be made after the specimen is dry. The leaves should be straightened out, one or two with the reverse side up (the lower surface of the leaf is often important for identification), and the flowering portion arranged.
The color of flowers, height of the plant if only a portion is represented, the kind of place in which it was growing, the locality and date of collection, and other data which may be of interest should be enclosed with the specimen on a slip of paper, or written directly on the newsprint. Specimens without data are worthless.*

The folded sheet containing the specimen is then placed between two felt driers which are of the same dimensions as the folded sheet. These are sold by scientific supply dealers and cost in the neighborhood of $4.00 a hundred. For large quantities of plants these driers are stacked up with corrugated pasteboard (ventilators) between the driers, the arrangement being as follows: drier, specimen, drier, ventilator, drier, specimen, drier, ventilator. A copper-riveted wooden-slat frame (procurable at dealers) is placed at the bottom and on top of the stack, and the entire bundle bound up with two trunk straps. The stack can thus be built up to as much as three feet in height: the weight of a person sitting on the stack gives approximately the right pressure, and the straps are then readily tightened. Too much pressure may mash the softer portions of the plants. The bundles should then be exposed to the sun and wind, or may be placed near a stove, but should not be placed directly over a steam radiator. If plants have been put into the press in the morning the driers should be changed the same evening. An equal number of sun-dried or heat-dried driers should be at hand to replace the moist driers in the stack. In this process, the newsprint sheet should be opened and plant parts rearranged if necessary, but the specimens should not be removed. A second change of driers will be necessary the next day. The great majority of specimens will be perfectly dry in 36 to 48 hours after putting the plants into the press; but if the specimen feels moist to the palm of the hand, the drying process should be continued. When the specimens are perfectly dry, the folded newsprint sheets containing them are removed from the stack, tied up in bundles, and stored until the material can be labeled and mounted.

Modifications in procedure will suggest themselves to the worker. If only one or two specimens are at hand, they can be dried beneath heavy books or similar weedboard. In some cases the use of double-faced corrugated pasteboard in stacks without driers has proved entirely satisfactory. In a damp or rainy climate artificial heat is usually required. Even in our own climate the use of boxes heated by electric light bulbs, in which the stacks of driers may be placed, is a common procedure. A simple apparatus of this sort is described and illustrated by H. S. Jackson, N. Y. State Museum Bulletin No. 266, 1925. A good general account entitled “Directions for Collecting Plants” is given by P. L. Ricker in U. S. Dept. Agriculture, Bur. Plant Industry Circular No. 126, 1913.

In mounting dried specimens for filing, the material is attached either by glue or by short strips of adhesive linen or paper, or by a combination of both methods. Large herbaria use special types of glue, but for a small collection ordinary liquid glue will be found adequate. Plants are mounted on a good quality of rag paper which does not discolor with age and which can be purchased from dealers in botanical supplies. The general run of specimens can be mounted by placing the specimen on a glass plate covered with a thin layer of glue diluted with water, and then transferring it, with glue adhering to the lower surface, directly to the mounting paper. With delicate specimens it may be necessary to put the glue on individual leaves, flowers, etc., with a small knife. The mounted sheets should be stacked up between driers for a day under a little pressure to insure the adherence of looser fragments to the sheet. A label (printed, written, or typed) should be placed in the lower corner of the sheet (usually at the right), giving the scientific name of the plant, height, color of flowers, type of soil, locality of collection, date, collector's name, and other useful information. As previously mentioned, specimens without data are worthless.

In herbaceous plants the roots or a portion of them should be included. They show whether the plant is an annual or perennial, and the character of any stolons or tubers which may be present. Fleshy roots, bulbs, and corms should be sliced so that they will not be too thick when mounted. The coverings of bulbs or corms should be carefully saved, since in such genera as Allium and Crocus they are indispensable for identification.

In like manner fruits and nuts may be sliced or sawed and mounted in sections on the sheet. Sometimes, with huge herbaceous plants such as large sunflowers (Helianthus), only fragments of the plant should be dried, including the rootstocks, flowering portion, and small pieces of the stem, each with a few leaves.

Some flowers should be placed face down on the drying sheet (for example, peonies, water-lilies); the petals can then easily be flattened out. Petals may often be held down by small strips of paper soaked in water. These strips dry out with the flowers. Individual flowers should be dried in many cases to serve for dissections, etc. Seeds and fruits should accompany specimens whenever possible; a second collection of the species later in the season is frequently necessary. The leaves of succulents, such as Crassula, Sedum, and Kalanchoe, should be plunged into boiling water for 4 or 5 seconds—not long enough to cause discoloration. Cacti make good specimens if properly handled, but they require a considerable amount of ingenuity in cutting the thin slabs or cross-sections of stems necessary for showing the arrangement of spines.
According to A. J. Sharp (Rhodora 37: 267. 1935) specimens of hemlock, spruce, and other coniferous trees which tend to lose their leaves, may be glued to herbarium sheets while fresh, the specimens protected by a layer or two of cheesecloth placed above them, and the whole placed in press while the glue is still moist.

Rubber sponge has been used successfully by J. F. Collins (Rhodora 34: 247. 1932) for equalizing the pressure of bulky specimens, such as those with acorns, etc.

H. K. Svenson.

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NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays from 10 a. m. until dark. The Laboratory Building, containing the Library, Herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9-12). The Conservatories are open April 1-September 30, 10 a. m.-4:30 p. m. (Sundays, 2-4:30); October 1-March 31, 10 a. m.-4 p. m. (Sundays, 2-4).

The Garden may be reached in the following ways: Flatbush Avenue trolley to Empire Boulevard; Franklin Avenue or Lorimer Street trolleys to Flatbush Avenue; St. John's Place trolley to Sterling Place and Washington Avenue; Ninth Avenue, Union Street, Vanderbilt Avenue, or Smith Street trolleys to Grand Army Plaza and Union Street; Brighton Beach Express, Broadway (B.M.T.) Subway to Prospect Park (north exit). From Pennsylvania Station, Manhattan, take Broadway-Seventh Avenue Subway to Eastern Parkway-Brooklyn Museum Station. From Grand Central Station, Manhattan, take Lexington Avenue Subway, changing at Nevins Street, Brooklyn, to Broadway-Seventh Avenue Subway, getting off at Eastern Parkway-Brooklyn Museum Station. By Automobile from points on Long Island, take Eastern Parkway and turn left at Washington Avenue; from Manhattan, take Manhattan Bridge, follow Flatbush Avenue Extension and Flatbush Avenue to Eastern Parkway, turn left following Parkway to Washington Avenue; then turn right.

Entrances—On Flatbush Avenue (1) near Empire Boulevard, and (2) near Mt. Prospect Reservoir; on Washington Avenue, (3) south of Eastern Parkway, and (4) near Empire Boulevard; on Eastern Parkway, (5) west of the Museum building.

The Street entrance to the Laboratory Building is at 1000 Washington Avenue, between Eastern Parkway and Empire Boulevard and opposite Crown Street.
Characteristics of Families of Dicotyledons Except Sympetalae

This outline aims to present principal characters of families of dicotyledons, restricted for the most part to those which grow outdoors in the Brooklyn Botanic Garden. The Sympetalae are not included. In the following synopsis, these families are classified into several main groups, with exceptions as noted below.

**Carpels Not United**

Sepals separate
- Carpels many
  - Magnolia
- Carpel one
  - Protea

Sepals united
  - Rosa

**Carpels United**

Apetalous trees and shrubs
- Betula

Petals separate, or apetalous herbs

Stamens many
- Cistus

Stamens few
- Placentation parietal
  - Viola
- Placentation central or basal
  - Dianthus
- Placentation axile
- Ovary superior
  - Herbaceous plants
    - Geranium
  - Trees and shrubs
    - Acer
- Ovary inferior
  - Aralia

1. Carpels united in Nymphaea and some Annonaceae.
2. Herbaceous in part: Moraceae and Urticaceae.
3. Apetalous trees: Liquidambar, some Acer.
4. Stamens few in Cleome and Mollugo.
5. Placentation axile in Aristolochiaceae (parietal in bud).
I—MAGNOLIA GROUP

Sepals and petals usually many, often intergrading
Magnolia Family (Magnoliaceae) Trees or shrubs, sepals and petals similar.
Water-Lily F. (Nymphaeaceae) Water plants.
Strawberry-shrub F. (Calycanthaceae) Lvs. opposite, fr. like rose-hip.
Moonseed F. (Menispermaceae) Climbing shrubs, dioecious; sepals, petals similar.
  Sepals few, distinct from petals
Buttercup F. (Ranunculaceae) Mostly herbaceous, often apetalous, lvs. typically 3-parted.
Custard-Apple F. (Annonaceae) Trees or shrubs, sepals 3, petals 6.

II—PROTEA GROUP
Barberry Family (Berberidaceae) Perianth in several whorls, stamens 6.
Laurel F. (Lauraceae) Aromatic trees or shrubs, apetalous, seed 1.
  (Proteaceae. Calyx tubular, 4 stamens opposite calyx-lobes; Southern Hemisphere.)
Oleaster F. (Elaeagnaceae) Stamens 4 or 8, ovary inferior, lvs. silvery, scurfy.
  (Casuarinaceae. No perianth, fls. small, unisexual; Australia and Malayan region.)
Leitneria F. (Leitneriaceae) Dioecious, seed 1, shrub; S.E. U.S.

III—ROSA GROUP
Carpels many
Rose Family (Rosaceae) Stamens many, lvs. usually with stipules, alternate.
Apple F. (Pomaceae) Ovary apparently inferior, carpels separate in bud.
Orpine F. (Crassulaceae) Fleshy herbs, stamens 5-10, carpels 5.
  Carpel single
  Fruit one-seeded
Plane Tree F. (Platanaceae) Wind pollinated, monoecious, lvs. palmately veined.
Plum F. (Drupaceae) Insect pollinated, stamens many, perigynous, ovules 2.
  Fruit a legume
Pea F. (Leguminosae) Lvs. mostly compound, corolla papilionaceous, stamens typically 10.

IV—BETULA GROUP
Fls. not in catkins
Elm Family (Ulmaceae) Trees; fruit winged or a drupe.
Nettle F. (Urticaceae) Mostly herbaceous; monoecious or dioecious; carpel 1.
  Fls. in catkins
    Juice not milky
    Fls. monoecious
Birch F. (Betulaceae) Ovary superior, styles 2, seed 1.
Bayberry F. (Myricaceae) Lvs. resinous, fruit drupe-like.
Beech F. (Fagaceae) Ovary inferior, styles 3, ovules several, seed 1.
Walnut F. (Juglandaceae) Lvs. compound, ovary inferior. (Juglans pistillate fls. have corolla.)

Fls. dioecious
Willow F. (Salicaceae) Placentation parietal, seeds many, hairy tufted.

*Juice milky* (except in Humulus, Cannabis)
Mulberry F. (Moraceae) Fls. unisexual, sepals usually 4.

**V — CISTUS GROUP**

*Ovary superior*

*Placentation parietal*
Cactus Family (Cactaceae) Succulents, sepals and petals many.
Rockrose F. (Cistaceae) Sepals persistent, typically 5, unequal.
Flacourtia F. (Flacouriaceae) Often unisexual; receptacle large, ovules many.
Poppy F. (Papaveraceae) Sepals 2, herbs; milky or colored juice.
Caper F. (Capparidaceae) Ovary usually on stipe.
Mignonette F. (Resedaceae) Fls. irregular, stipules gland-like.

*Placentation central*
Purslane F. (Portulacaceae) Sepals 2, (Portulaca ovary inferior.)

*Placentation axile*
Carpet-Weed F. (Aizoaceae) Succulents; lvs. opposite, mostly apetalous.
Mallow F. (Malvaceae) Stamens form a column, anthers 1-celled.
Linden F. (Tiliaceae) Stamens in clusters, anthers 2-celled.
Tea F. (Theaceae) Sepals 5, much imbricate, petals 5.
St. John’s-Wort F. (Hypericaceae) Lvs. opposite, with translucent dots.

*Ovary inferior*
Hydrangea F. (Hydrangeaceae) Fruit a capsule, lvs. opposite.
(Myrtle F. Myrtaceae, Fls. 4-parted. Mostly from Australia, tropical Asia.)

**VI — VIOLA GROUP**

*Sepals separate*
Mustard F. (Cruciferae) Stamens 6; 4 long, 2 short.
Fumitory F. (Fumariaceae) Lvs. dissected, petals 4, in 2 pairs.
Violet F. (Violaceae) Fls. zygomorphic, carpels 3, one petal with spur.

*Sepals united*
Birthwort F. (Aristolochiaceae) Apetalous, ovary inferior.
Frankenia F. (Frankeniaceae) Lvs. opposite, entire, nodes swollen, stamens typically 6.
VII — DIANTHUS GROUP

Polypetalous; seeds typically many
Pink F. (Caryophyllaceae) Lvs. opposite, entire, nodes swollen. Apetalous; seed 1.
Buckwheat F. (Polygonaceae) Stipules sheathing swollen nodes, fls. 3-angled.
Pepper F. (Piperaceae) Perianth none, fls. small.
Knotwort F. (Illecebraceae) Low, diffuse herbs, fls. greenish.
Goosefoot F. (Chenopodiaceae) Fls. small, greenish.
Amaranth F. (Amarantaceae) Perianth of dry scales, often colored.
Four-o-clock F. (Nyctaginaceae) Ovary apparently inferior, calyx colored.

VIII — GERANIUM GROUP

Saxifrage F. (Saxifragaceae) Stamens perigynous, 10-5, carpels typically 2.
Geranium F. (Geraniaceae) Stamens 10, carpels 5.
Woodsorrel F. (Oxalidaceae) Lvs. 3-foliate, stamens 10, carpels 5.
Flax F. (Linaceae) Lvs. entire, stamens 5, united at base, carpels 5.
Jewel-weed F. (Balsaminaceae) Fls. zygomorphic, calyx petaloid, spurred.
Loosestrife F. (Lythraceae) Lvs. opposite, sepals form a tube.

IX — ACER GROUP

Stamens opposite sepals
Lvs. simple (Lvs. compound in Boxelder and Dipteronia)
Witch-hazel Family (Hamamelidaceae) Carpels 2, fr. a woody capsule.
Maple F. (Aceraceae) Lvs. opposite, fr. double, winged.
Holly F. (Aquifoliaceae) Fls. 4-parted, small, axillary.
Bitter sweet F. (Celastraceae) Fls. small, disk present, seed typically arillate.
Mezereum F. (Thymelaeaceae) Calyx tubular, petals none, seed 1.
Lvs. compound (Lvs. simple in Cotinus)
Cashew F. (Anacardiaceae) Carpels 3, ovary 1-celled, 1 seed.
Rue F. (Rutaceae) Lvs. dotted, pistil on disk.
Horse-chestnut F. (Hippocastanaceae) Lvs. opposite, palmately compound.

Stamens opposite petals
Buckthorn F. (Rhamnaceae) Shrubs or small trees, carpels 3.
Grape F. (Vitaceae) Climbing shrubs, fr. a 2-celled berry.

X — ARALIA GROUP

Evening-Primrose F. (Onagraceae) Style single, stigmas 4.
Dogwood F. (Cornaceae) Fls. 4-parted, stamens on disk, fr. a drupe.
Ginseng F. (Araliaceae) Fls. in umbels, carpels 5-3, fr. fleshy.
Carrot F. (Umbelliferae) Fls. in umbels, carpels 2, fr. dry.

Alfred Gundersen.