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THE SCHOOL GARDEN.

BY

L. C. CORBETT,

HORTICULTURIST, BUREAU OF PLANT INDUSTRY.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., February 25, 1905.

Sir: I have the honor to transmit herewith a paper on The School Garden, prepared by Prof. L. C. Corbett, Horticulturist of this Bureau, and to recommend that it be issued as a Farmers' Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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INTRODUCTION.

Those who are charged with the direct presentation of school garden work to children will recognize that the point of view for city children must be different from that for country children. As a rule, children in rural districts are familiar with the fundamental operations of the garden—preparation of the soil, planting the seed, and the cultivation and harvesting of the ordinary garden and farm crops. To attempt, therefore, to maintain the ordinary type of individual vegetable and flower garden upon the grounds of rural schools would undoubtedly be an unwise expenditure of time and energy.

For city children, however, to whom the growth of the plant is like the discovery of a new world, the application of the simple operations involved in the maintenance of the individual garden containing flowers and vegetables is altogether a different matter. The plan of procedure, therefore, for teachers in rural districts, should be quite different from that followed by those in urban communities. The teachers of the rural schools will find a most fruitful field along the line of laboratory experiments, which will demonstrate the principles of plant growth and of plant nutrition, methods of propagation, etc. In this connection we have therefore outlined two classes of work which will encroach more or less upon each other, but the discriminating teacher will have no difficulty in selecting that which is best suited to the conditions by which he or she is surrounded.

In rural communities, instead of conducting miniature vegetable or flower gardens, it might be better to secure different varieties of grains or grasses for test upon home plats, encouraging the students to undertake small experiments which shall have for their chief end the development of the faculties of observation. Different methods of tillage and fundamental principles of this character will be involved in these experimental or demonstration areas, the results of which will emphasize the importance of certain lines of work.

In some localities it will be possible to bring together upon the school grounds groups of shrubs and trees arranged in an artistic manner, so that the finished work will present an attractive picture and will furnish material of great value for purposes of instruction. The habits and uses of various plants can be brought out and the child led to appreciate the value of such decorative plantings in connection with the home. Such work, however, will not involve any very considerable expenditure of time or energy, neither will it require systematic attention to garden work on the part of the child. It will, however, have a broader and less exacting influence, and will, perhaps, be of greater importance in rural communities than would close attention to the maintenance of the individual garden.

VALUE OF SCHOOL GARDEN WORK.

In any phase of educational work, the first question which presents itself is, What is the effect of the exercise or the study upon the pupil? Those who have had most experience in the school garden movement are emphatic in their statements regarding the educational value of this work. It is claimed that quick discrimination is one of the pronounced qualities resulting from it. Skill with the hands is necessarily an outcome. The handling of small seeds and of various tools naturally develops skill and agility. Systematic methods also follow from the natural order in which the operations conducted in the garden must be taken up. This not only develops a very important faculty, but at the same time teaches the young mind a logical sequence based upon the natural order of things. Industry is not an unimportant result which comes from school garden work. The idea of ownership and the rights of ownership, which come from the possession of a garden, induce the pupil to exercise his ability to make his possession as good or better than that of his neighbor. The natural result of this is industry. Business experience is an important result of harvesting and accounting for the products which are grown. The right of ownership and a respect for property rights are more largely developed from the possession of individual gardens than in community gardens. The idea that "what's mine is my own" becomes very strongly developed, with the natural sequence that such possessions must be properly protected and all rights concerned respected. On the other hand, a party interest in a community garden does not so emphatically develop the idea of individual responsibility, and each one has a tendency to care less for the plants which another has shared in producing, with the result that responsibility is shirked, and there is lack of interest, with a consequent lack of industry. For this reason, in our work from the very inception the individual garden idea has been emphasized and strictly adhered to.

The individual garden has the advantage of allowing each one possessing a garden to perform each and every operation connected with the preparation, planting, and care of the plants grown in that garden. This, as before stated, not only develops system, but it furnishes a basis of very valuable knowledge, if the operations connected with these crops are properly conducted. If the requirements of the different crops in regard to preparation of soil, depth of planting, date of planting, and manner of harvesting and training are all carefully observed, the young mind has indelibly fixed upon it impressions which will be retained throughout life. The cultivation and management of these crops in future years will be looked upon as a sort of instinct, the time and manner of acquiring this knowledge having, perhaps, long ago been forgotten. The skill and ability resulting from the use of various implements connected with the cultivation of crops are of no mean significance.

In connection with these operations, the teacher can illustrate the good and evil effects from certain methods of cultivation, of working soil when in good and bad condition, with the consequent effects upon growing crops; can demonstrate the value of deep and shallow tillage, together with the importance of maintaining a loose soil mulch for the conservation of moisture. In fact, the school garden should be looked upon as a laboratory in which the different steps in the life of the plant are to be illustrated and demonstrated. The nature of soil, the importance of fertilization, and the conditions essential to germination, as well as the conditions conducive to growth, can all be illustrated in a logical and impressive manner in the school garden.

Field excursions may be an ideal way for conducting nature study with reasoning minds that have been trained to a logical system and in a consecutive, systematic fashion, but school gardens offer facilities not to be approached in field excursions. Field excursions give disconnected fragments of the history of natural objects, while the school garden furnishes opportunities for observing plants from seedtime to harvest. In addition to the actual operations in the school garden, a number of schoolroom studies and experiments may be conducted, which will be of decided interest and value.

THE INDIVIDUAL SCHOOL GARDEN.

TYPE OF PLANTS FOR THE GARDEN.

The limited area usually available for school garden work makes it imperative that for individual gardens, at least, which we believe to be best adapted for logical, systematic instruction, plants with a compact bush form or habit of growth are to be preferred. Tall-growing, broad-leaved, as well as climbing plants, must be excluded, except from community gardens or in general decorative plantings. The seed collections which have been assembled by the United States

Department of Agriculture for the individual garden have, therefore, been chosen to meet these requirements.

A VEGETABLE GARDEN.

The following plans are offered as suggestions for teachers:

Plan No. 1 (fig. 1) represents a vegetable garden 5 feet wide by 16½ feet long. The rows, except the tomatoes, are located a foot apart. The distance between the individual plants in the row is indicated after the name of each sort. The tomatoes, it will be noted, are planted 18 by 20 inches apart, thus giving more room for the plants to spread than could otherwise be secured.

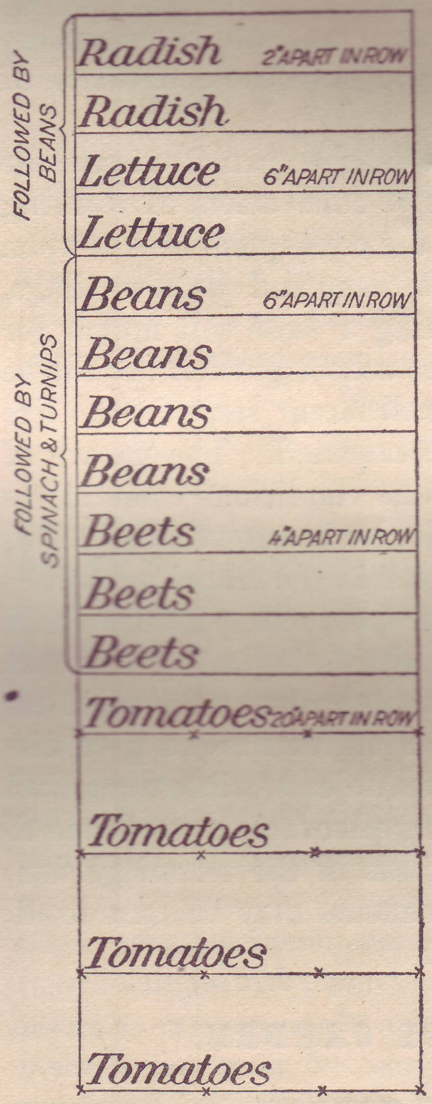

Fig. 1.—Plan of vegetable garden.

ROTATION OF CROPS.

The economical use of the area at one's disposal forms quite as important a part of the value of the instruction to be derived from the school garden as the successful growing of the plants. It will be noted that the quick-maturing crops are planted in groups, which afford a considerable area for replanting as soon as the crops mature. In the accompanying illustrations a bracket incloses the names of such crops, and the sorts which are to follow them are indicated by names outside the brackets. The rotation provides for a continuous use of the land and the growing of more than a single crop—the first lesson to be learned in intensive horticulture.

COMBINATION VEGETABLE AND FLOWER GARDEN.

Figure 2 illustrates a garden of the same area as the vegetable garden illustrated in figure 1, i. e., 5 by 16½ feet. The rows in this case are all 1 foot apart, with the exception of the radishes, which are 6 inches apart. The plants are grouped according to height of growth, so as to place the tall-growing plants in the center of the garden, with low-growing and decumbent plants at the ends. In this case it will be noted that tomatoes are used only as a succession or rotation crop following the radishes and lettuce.

CULTURAL SUGGESTIONS.

If practicable, the children should be allowed to do all the work of preparing the land as well as planting the seed and caring for the plants. The preparation of the soil can be converted into a lesson in soil physics, the teacher explaining the nature of the soil as a source of plant food, as a mechanical support to the plant, and as a storehouse and conveyer of water and air. The influence of fining the soil on the liberation of plant food and water content, the importance of hoeing or cultivating to eliminate competition by the destruction of weeds and to conserve moisture by the maintenance of a soil mulch, and the necessity of thinning the plants in the row in order to reduce competition and increase the feeding area of the individual plant, should be clearly presented. The influence of pruning on tomatoes to lessen competition among the branches and increase the food supply to the fruits retained should be brought out. The plants themselves offer material to use as a basis for discussing their life processes, including germination, growth, the functions of leaves, stems, roots, and flowers, and, finally, the storing of material in the finished product (the seed) to carry the plant over that trying period when its natural function must be suspended.

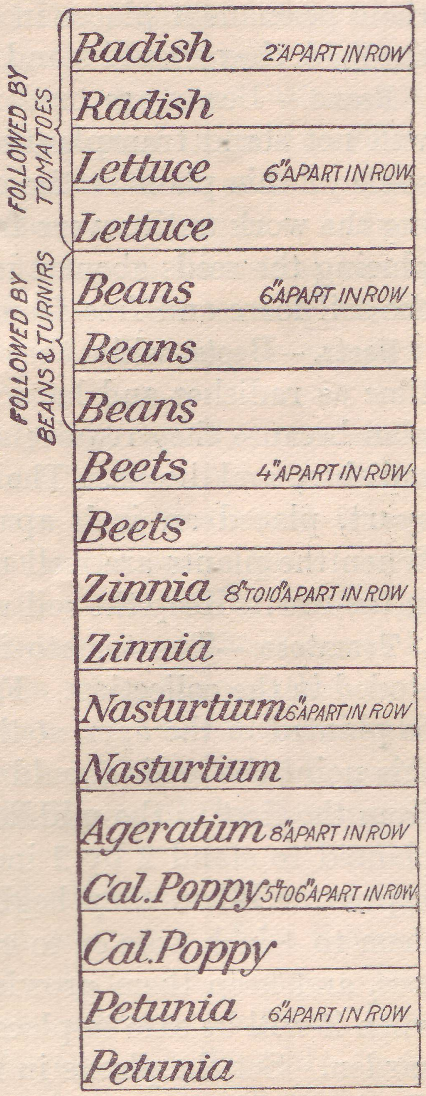

Fig. 2.—Plan of combination vegetable and flower garden.

VEGETABLES.

Radishes.—Radishes are hardy plants and thrive best during the cool weather of early spring and late autumn. In the South they can best be grown during the winter and early spring months. The seeds should be sown in drills, in rich, well-prepared soil, placed about half an inch apart and buried not deeper than 1 inch nor less than one-half inch. When the plants are showing the second set of true leaves they should be thinned to stand from 2 to 3 inches apart in the row.

Lettuce.—Lettuce is a hardy plant and thrives best during early spring and late autumn. The seeds should be sown in drills in the

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and produce a profusion of brush-like flowers throughout the season. The dwarf blue sorts make fine borders and are much used where contrasting color effects are desired. For early bloom the seed should be sown in cold frames or in boxes in the house early in the season (March), but for summer and fall bloom the seeds may be sown in April or early in May in well-prepared beds in the open. Seeds sown in August will produce good plants for winter flowering.

Nasturtium.—The large seeds of the nasturtium require to be planted much deeper than the fine seeds of the petunia. Sow them in rows where the plants are to grow, placing the seeds about 6 inches apart in the row and cover them about an inch deep. When all plants are up, thin so that they stand a foot apart if the soil is rich; if rather thin, it will be as well to allow them to stand at the planting distance. The plants should be given clean cultivation to induce rapid growth. If planted in the open at the same time that beans are planted, very satisfactory results will follow. For earlier bloom plant in advance of this date in hotbeds, cold frames, or window boxes.

Petunia.—While the petunia grows readily and rapidly from seeds sown in the open about corn-planting time, earlier bloom can be secured by sowing the seed in window boxes or hotbeds and transplanting the plants once before placing them in the open. For localities north of New York the most satisfactory method of handling these plants will be to start the seeds in window boxes about April 1, and to transfer the young plants to the open when the weather permits—about the middle of May. The seeds are very small and should not be covered with earth in the ordinary way. They should be sown on the surface and brought in contact with the earth by firming it with a board.

California poppy (Eschscholtzia).—The eschscholtzia is an annual of striking character both as regards the form and color of its flowers, which are bright and rich in their tints of yellow and orange. The plants average about a foot in height, have attractive silvery foliage, and produce their large poppy-like flowers quite lavishly from early spring until frost. The seeds of eschscholtzia may be sown in window boxes or in a hotbed in March, or in the open where the plants are to bloom as soon as the soil is in fit condition, in April or May in the latitude of New York. In latitudes south of New York the seeds may be sown in the autumn for early bloom. The plants enjoy a rich loam and should be allowed about 5 or 6 inches of space in the row. When used in beds they may be sown broadcast.

Zinnia.—The zinnia is easily grown from seed sown in the open ground. When sown in April the plants will bloom abundantly and continuously through the entire season. During the month of August zinnias are at their best. To secure large flowers and a profusion of bloom the plants must be given ample room for full development, as well as an abundant supply of food. Strong, rich soils suit the zinnia. If the seeds are sown in a dwelling house or in a hotbed in March and the young plants are pricked out once or twice before being placed in their permanent situations, more satisfactory results will be secured than from outdoor-sown seeds unless equal care in thinning or transplanting is given. In addition to their use in the school garden, zinnias can be used for groups, beds, borders, garden lines, and summer hedges. Their average height is 1½ feet.

LABORATORY EXERCISES

STUDIES OF SOIL.

In the first place, the student may be told something about the origin of soil. It can be explained that all soil is the result of the breaking down of rock or of the decomposition of living matter. The character of soil which is formed in any particular case is determined by the kind of rock which was broken in its formation. For instance, the breaking up of sandstone results in the formation of a sandy or gravelly soil.

When the soil is the result of the blending of several materials it is called a loam, and the relative proportion of sand or clay produces what is known either as sandy loam or clay loam, depending upon the predominance of sand or clay. If a large quantity of decomposing vegetable or animal matter is to be found in the soils, such matter is called humus. When humus in large proportions is mixed with sand or clay and is well decomposed it forms a class of soil called muck.

The Relation of Soil to Plants.

The relations which soils bear to plants are interesting and can be illustrated by the objects seen in nature.

In the first place the soil acts as a mechanical support for plants, forming a matrix or mass in which the roots become embedded.

Its second function is a physiological one, acting (1) as a storehouse for water, (2) as a storehouse for food, and (3) as a place to contain air in order to provide congenial conditions for the action of the roots.

Soil as a Storehouse for Water.

As a storehouse for water the soil fulfills one of its most important functions, and from the standpoint of the gardener or farmer the quantity of moisture which is held by the soil determines its fitness or its unfitness for agricultural operations. Soils which are too wet are not congenial to the germination of seeds or the growth of plants.

Exercise 1.—The effect of water upon soil can easily be illustrated by placing a quantity of soil which is rather stiff and retentive in nature in a pot. Plant a few seeds of beans or corn in it to a depth of three-fourths of an inch and make the soil thoroughly wet, keeping it constantly moist by the addition of water. Under these conditions it will be found that the seeds germinate slowly if at all, and if the soil is placed in a cool rather than in a warm room it will be likely that germination will not occur. Too much water, therefore, is as bad as too little. In comparison with this experiment use similar soil, plant the seed as before indicated, but do not apply water in excess, and note the effect.

Exercise 2.—In order to show the movement of water in soils, arrange a series of glass tubes or straight lamp chimneys, such as are used with Argand burners, as shown in figure 3, and in each one place a different character of soil; in one, a pure sand; in another a mixture of sand and clay; in another, a sandy loam, and in still another, some well-decomposed leaf mold. Tie a piece of thin cloth (muslin) over the small ends of the chimneys and place soil in them to a uniform height, preferably up to the bulge.

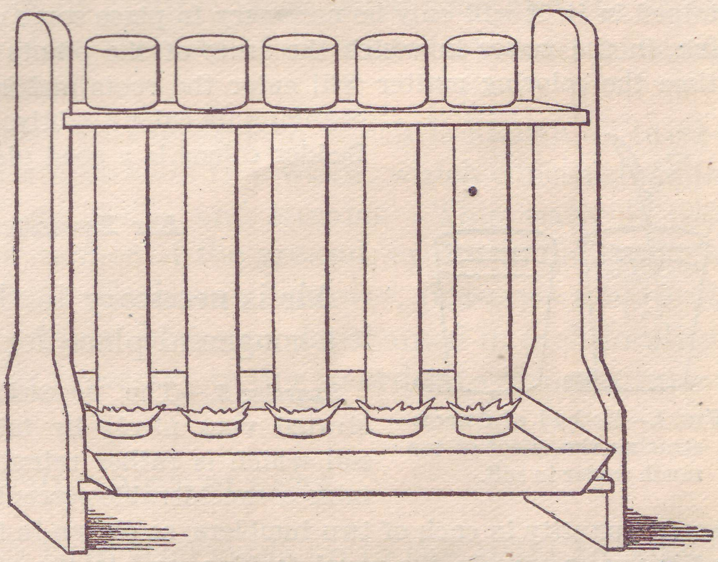

Fig. 3.—Device showing the movement of water in soil.

Place a pan under the small end of each one of these receptacles, and fill the pan with water. Note the time and the distance to which the water rises in each of the chimneys through the different soils. This rise of water through the soil is called its capillarity, and forms one of the most important functions, if not the most important function, of the soil in relation to the growth of agricultural crops. The rate at which the water rises in the soil and the quantity of water which each soil is capable of holding can be determined by weighing the chimneys prior to placing the water in the pan and at intervals up to the time the soil has absorbed all that it will take up. The difference in weight is the amount of water taken up, and gives an index of the water-holding capacity of the various soils. This will give an index to the power of the soil to withstand drought during the growing season.

Plant Foods in Solution.

It is a well-known fact that plants take their food in solution; that is, in order to get food which comes from the soil, the soil must contain more or less water, so as to extract from the soil particles the food necessary for the use of the plant. In very dry times the water supply is reduced, and naturally there is a reduction in the food available to the plant.

Exercise 3.—To prove that plants take up food in solution by their roots, it is only necessary to place a rooted cutting in a bottle containing water, and another one in a bottle containing no water. The one which has its roots immersed in water will keep green and present no unusual appearance, while the one whose roots are suspended in the air will immediately wilt and die. This is sufficient to prove that the roots have the ability to take up water and keep the plant in an apparently normal condition. If, however, the plant were to be continued for an indefinite period with its roots suspended in water only, not only would there be little or no growth, but it would finally die. On the other hand, if the water were supplied with the proper ingredients of plant food to form a so-called water culture the plant could be grown and matured without ever coming in contact with the soil.

Exercise 4.—To prove that roots actually absorb water and the materials contained in it, it will only be necessary to place some coloring matter, eosin or red ink, in the water in which the roots of the plants are suspended. In a short time the coloring matter will enter the roots and be carried to the leaf tissue, changing its color slightly. A rooted cutting of Golden Bedder coleus is a good plant for this test.

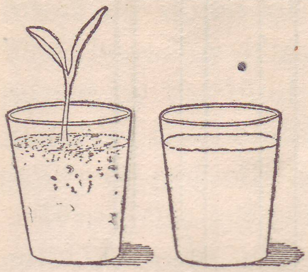

FIG. 4.—Method of demonstrating the effect of too much water in soil.

Air Essential to Growth.

Air is necessary in the soil in order to make it a congenial place for the growth of plants.

Exercise 5.—The necessity for air can be demonstrated very nicely by taking some ordinary garden soil which is rather retentive in nature—that is, contains a considerable percentage of clay—and placing an equal quantity in each of two tumblers, as shown in figure 4. In one, plant seeds of beans or peas in the usual fashion, and in the other plant the same kind of seeds in the same way, but keep the soil constantly saturated with water, so that there is a thin stratum of moisture over the surface of the soil. The seeds in the first tumbler will undoubtedly germinate in a short time, while the seeds in the other tumbler will require a longer time to germinate, and if the temperature of the room in which the two glasses are kept is low the seeds will rot. The tumbler which contains an excessive amount of moisture prevents the access of air that is necessary to the germination of the seed, while the one which is kept only moderately moist allows a sufficient amount of air to come in contact with the seeds to insure germination.

Soil and Water Supply.

In natural soil there are two classes of water. One class is water which is held in close contact with the soil particles, which is merely a film of water surrounding each soil particle. That such a film exists may be shown by dipping a pebble into a dish of water and allowing the water to drain off. The pebble will remain moist for a considerable length of time, and if placed in a closed receptacle in a similar manner to the conditions in which the soil particles exist when packed closely together the film of moisture will remain upon the pebble for a long time. This film of moisture which covers the individual particles of soil is known as capillary water, and forms the great storehouse of moisture upon which growing plants depend. The water-holding power of the soil is in direct proportion to the size of the soil particles. This can be demonstrated by the different grades of soil, ranging from gravel and sandy loam to a clay or muck, which can be placed in the lamp chimney arrangement shown in figure 3. By placing these soils separately in the individual chimneys and pouring water upon them until they become thoroughly saturated, the length of time required for each one to dry out will give an idea of the water-holding power or the retention of moisture by these different qualities of earth. These same soils and the same apparatus can be used to show the rate of movement of water in soils, as has already been suggested.

Besides the class of water just described, which is known as capillary water, there is in all arable soils free water, which constitutes the basis of supply for springs, wells, and streams. This water is not usually found close to the surface of the ground, except in depressions soon after a heavy rainfall. Each soil, however, possesses a natural level or height for water of this character, determined in each locality by the depth to which it is necessary to dig in order to secure a satisfactory well.

STUDIES OF PLANTS.

The observations which have been made up to this point have had for their object the illustration of different functions in connection with soil moisture or plant food. Attention will now be directed to the consideration of some of the simple, yet interesting, features connected with plants themselves.

Seeds.

The seed may be considered as the unit of plant structure and the starting point in the cycle of plant life. Seeds are interesting objects, because they have many different designs. Some are so made that they can take short aerial journeys—that is, they are provided with wings or parachutes which carry them from place to place. The seeds of the maple are provided with wings, and when they become detached from the parent tree a gentle breeze will carry them a considerable distance from the branch to which they were attached. There are many forms and modifications of the winged seed, as illustrated by the linden, the hornbeam, the elm, and the pine. These are all common trees from which seeds for illustrative purposes can be secured.

Some seeds are also provided with parachutes or umbrellas, not for protection from rain and storm, but for purposes of locomotion. The seeds of the thistle, the milkweed, and the dandelion—in fact, the seeds of all plants which have a cottony growth—are provided for these aerial journeys.

Besides these, some seeds are provided with hooked appendages by which they can attach themselves to the clothing of men or to the hair of animals, so that they become transported from place to place. Other seeds have hard seed coats, or shells, which are covered in many cases by edible fruit. The fruits are eaten by birds, but the seeds are not digested, and in this way become distributed from place to place. The groves of cedars which are characteristic of the landscape in many sections of the country, it will be noted are chiefly placed along the lines of fences or fence rows. The fruit of the cedar is an edible one, but the seed is not digestible, and in this way the existence of these hedge rows of cedars is explained. Cherries, grapes, and other fruits are to a considerable extent disseminated in like manner.

The hard nuts of our nut-bearing trees are not used as food by birds or large animals, but are usually sought by squirrels and small rodents, which are in the habit of gathering and burying them in various places or storing them in large quantities for winter use. The result is that a considerable percentage of those which are buried in this manner are never rediscovered by those hiding them, and in time nature causes the hard shell to crack open, and the warmth and moisture of the soil brings the germ contained in the kernel into life and a tree springs into existence. It will be noted that the nuts which were buried by the squirrels did not germinate immediately after being buried, but waited until the warm weather of the spring came before they put forth their tender shoots. This is not because they willed it, but because the hard outer walls of the shell would not admit the air and water to the germ, so as to stimulate its growth. It was necessary that the shell be frozen and broken by the action of the frosts and the weather before moisture could gain an entrance to cause the swelling of the germ. This peculiarity, when taken advantage of commercially, is called stratification. Seeds with hard shells, such as cherries, peaches, plums, and the like, have to be stratified—that is, they must be planted in the fall where the plants are to grow or they must be packed away in boxes of sand in a position where they will freeze and remain frozen during the winter, in order that they may germinate the following spring. If seeds of this character are stored and kept dry during the winter they will not germinate if planted in the spring. Seeds with thin seed coats, however, like peas, beans, etc., if treated in like manner, will be destroyed by the action of the cold, and no plants will result from planting them in the autumn. Such seeds must, from the nature of the case, be retained in a dry and comparatively warm place during the winter season, in order that their vitality may not be destroyed.

Seed Planting.

The method of planting has much to do with the results. Seeds which are small and fine must not be deeply covered with earth, for, if they are, the weak germ which they contain will not be strong enough to reach the light and air. Large seeds, however, which contain a considerable quantity of stored material, as in the case of peas and beans, may be planted quite deeply. In fact peas, which do not force the seed leaves out of the ground should, for best results, be planted from 3 to 5 inches in depth, while beans, which have a different method of germination, forcing their seed leaves out of the ground, should not be planted so deeply, for, as in the case of soils which are clayey and compact in nature, there will not be sufficient power in the growing stem of the bean to force the seed leaf from the soil and out into the light. The depth of planting, therefore, must be regulated by the habit of growth of the plant.

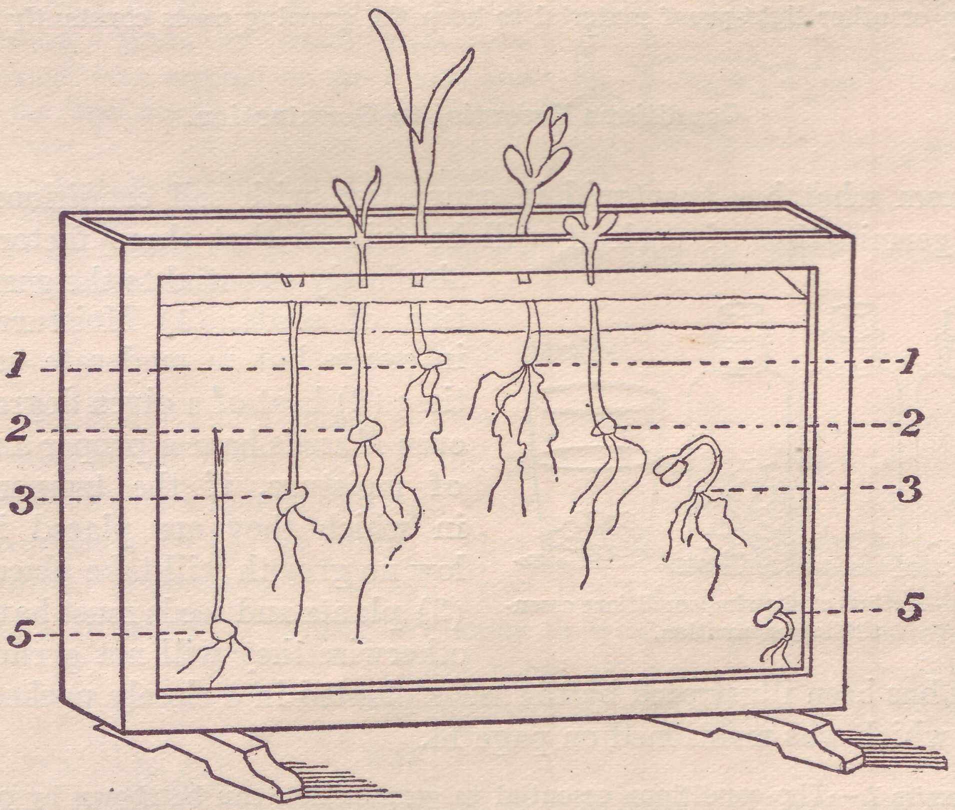

Fig. 5.—Device showing proper depth to plant seeds.

Exercise 6.—The proper depth of planting can be nicely illustrated by the device shown in figure 5, which consists of two panes of glass placed about

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one-half inch apart and held in this position by a wooden frame, the space between the two panes being filled with earth into which the seeds are dropped and held against the glass. Beginning at a distance of 5 inches from the top of the glass, place a kernel of corn, on top of this place a layer of earth, and continue at intervals of 1 inch until a series of seeds rest against the glass from 5 inches below to within one-half inch of the surface. Try seeds of beans and peas in like manner and note the ability of the different seeds to reach the surface of the soil when proper moisture and temperature conditions are maintained. This apparatus will give an idea of the rate of germination at different depths of soil, and of the power of the different plants to force their way to the light.

The panes of glass of which the device is constructed should, except in times of observation, be kept covered with dark-colored blotting paper or by sheets of tin or other light-proof material to keep the growing seeds constantly in the dark.

Conditions Essential to Germination.

From what has been said in connection with soil conditions and the germination of seeds it will be evident that three factors are absolutely essential to the germination of seeds: (1) Moisture, not in excess but in moderate quantities; (2) heat of a given degree, for even if seeds have a proper amount of moisture, if the temperature in which they are placed is too low no growth will take place, and (3) plants and seeds must have air, otherwise they will not germinate. This has been illustrated by the seeds planted in a closely packed wet soil, which was mentioned on page 14.

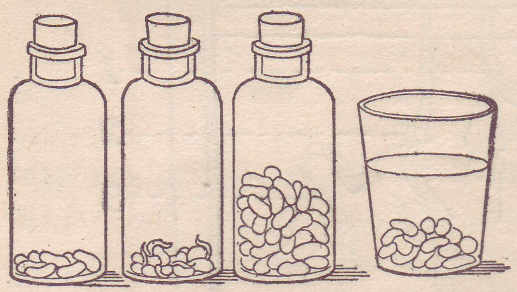

FIG. 6.—Method of showing conditions essential to germination.

Exercise 7.—The conditions essential to germination can be shown by putting a quantity of seeds in a bottle, as suggested in figure 6, covering them with an inch or more of water, and then tightly corking the bottle. Seeds under these conditions will be deprived of air and will germinate, if at all, only in a weak, unsatisfactory manner. The skillful farmer or gardener, in preparing the soil, attempts to approach as closely as possible the ideal conditions for the germination of the seed. He selects a time when the soil is dry, warm, and friable.

Seed Testing.

The exercise in seed testing can be made to serve two purposes: (1) The selection or separation of mixed and impure seeds, and (2) the determination of the number as well as the time required for the germination of various kinds of seeds. The percentage of live seeds can thus be learned.

Exercise 8.—Select several sorts of seeds of large size which are distinctive in character, such as corn, beans, peas, beets, radishes, and tomatoes, and put these all together; then allow the pupils to separate them. After they have separated the mixture into its several parts give them labeled samples put up in vials or packets for purposes of identification.

Exercise 9.—Take 10 or 20 seeds of the sort to be tested and place them between moist blotters or folds of canton flannel, as shown in figure 7. Place the device in a warm situation and see that it does not lack moisture, although it must not be kept too wet, otherwise the seed may rot. Observe the condition of the seeds every twenty-four hours. When all viable seeds have germinated, take account of the whole, and determine the percentage of those which have grown.

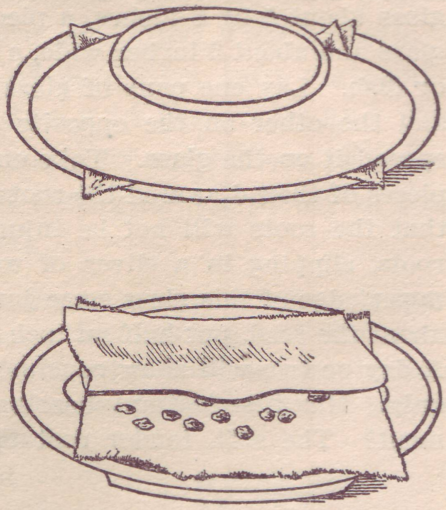

FIG. 7.—Device for seed testing.

Exercise 10.—Make sketches of the seeds of beans, peas, and squashes twenty-four hours after placing them in the germinator, and similarly after the lapse of forty-eight, sixty-four, and seventy-two hours.

STUDIES OF ROOTS.

The roots of plants subserve two important offices: (1) They act as a mechanical anchorage to the plant, holding it firmly in the soil, and (2) as a mouth through which the crude plant foods of the soil are taken up by the plant. That the roots of plants serve as a mechanical anchorage is evident from the ability of trees with tall trunks and broad spreading branches to withstand heavy winds.

That roots act as a means for gathering food can only be shown in an indirect way.

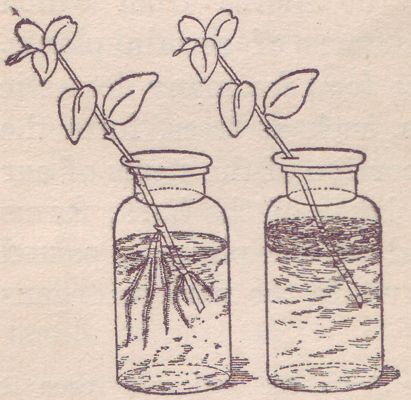

FIG. 8.—Arrangement for showing the effect of the exclusion of air on plant growth.

Exercise 11.—To prove that roots take up substances in solution, take two bottles, and place in each a rooted cutting or a branch of some plant, such as tradescantia, which will quickly throw out roots. In one of the bottles place a few grains of saltpeter, and in the other a few grains of common salt, and note the effect on the plants.

Exercise 12.—The necessity for air for the development of roots can be demonstrated by using two bottles similar to those shown in figure 8. After filling them two-thirds full of water, place a cutting of coleus, geranium, or tradescantia in the receptacles, as indicated, but over the surface of the water in one bottle pour a thin layer of oil—castor oil or sweet oil—and observe the behavior of the cuttings.

Exercise 13.—To show that roots increase in length, and to see where the growth occurs, place some kernels of corn or other large seeds between the folds of a piece of wet cloth. Keep the cloth wet till the seeds have sprouted and the young plants have roots 2 or 3 inches long. Have at hand two panes of glass about 5 by 8 inches, a piece of cloth a little longer than the width of the glass and about 3 inches wide, a spool of dark-colored thread, and a shallow pan or dish. Lay one pane of glass in the pan, letting one end rest on the bottom and the other on the opposite edge of the pan (fig. 9). Wet the cloth and spread it on the glass. Take one of the sprouted seeds, lay it on the cloth, tie pieces of thread around the roots at intervals of one-fourth inch (tie carefully so that the roots will not be injured); place the second pane of glass over the roots, slipping in a sliver of wood to prevent crushing them, and letting the upper edge of this glass come just below the seed. Fold the corners of the cloth about the seed, put half an inch of water in the pan, and leave for development. A day or two will show conclusively that the lengthening takes place at the tip only. Has this fact any bearing on the relation of soil texture to root development? The soft, tender root tips will force their way through a mellow soil with greater ease and rapidity than through a hard soil, and the more rapid the root growth the more rapid the development of the plant. Here is the lesson of deep plowing and thorough breaking and pulverizing of the soil before the crop is planted.

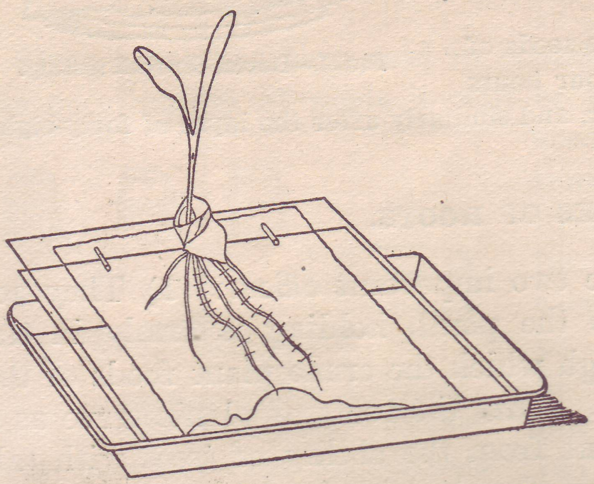

FIG 9.—Device for measuring root growth.

STUDIES OF STEMS.

The stems of plants are of interest in several respects. The stems of large trees are of value commercially, because they are the source from which material for construction is derived. The stems of certain plants, together with their leaves, form a part of the food for many domestic animals. The stems of tall-growing plants, such as trees, form the main framework of the plants. The outer portion of the stems of our broad-leaved trees, together with the inner layer of the bark, forms passages or canals through which the food of the plant is passed from the roots to the leaves or from the leaves to the various organs of the plant.

Exercise 14.—That the roots pump up moisture from the soil and force it up through the stem can be demonstrated by severing the stem of a geranium 3 or 4 inches from the surface of the soil, placing over the cut end of the stem a short section of soft rubber hose and in the other end inserting a small-bore glass tube several inches long, and keeping the root of the plant normal by supplying it with water. Note what happens inside the glass tube, making observations every few hours.

STUDIES OF LEAVES.

The leaves are the workshop of the plant. In them, under the normal conditions of nature, wonderful transformations take place. The materials supplied by the root are here combined with materials taken from the air, under the influence of sunshine, into materials which give the tints to the flowers, the flavor to the fruit, and the sweetness to sugar. These intricate and complex operations can not be demonstrated in a simple way, but that sunlight is a factor in the life of the plant can easily be demonstrated.

Exercise 15.—Plant two pots with corn. Place one in a window where it may make a normal growth. Give the other the same temperature and the same attention as regards watering, but place it under a paper cone or box through which light can not penetrate. Contrast the appearance of the two sets of plants grown under these conditions. After the plants under the cone or box have attained a height of 2 or 3 inches, remove the covering and note what takes place when the pot is placed in full sunshine.

The leaves of the plant throw off the excess moisture supplied by the roots.

Exercise 16.—That moisture is thrown off by the leaves of growing plants can easily be demonstrated, as indicated in figure 10, by placing a cardboard around the stem of a thrifty nasturtium, bean, or corn plant, and confining the leaves of the plant under an inverted glass. A tumbler will answer for small plants and a fruit jar for larger ones.

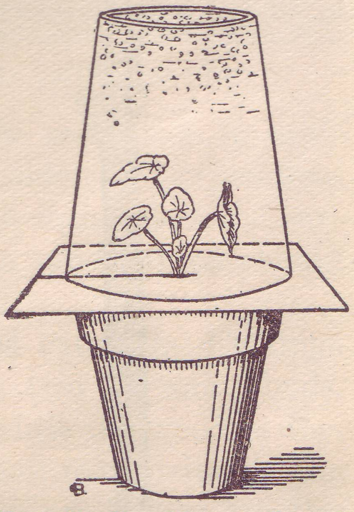

Fig. 10.—Tumblers and cardboard showing that moisture is thrown off by the leaves of plants.

STUDIES OF CUTTINGS.

Plants increase normally by seeds, stolons, or root sprouts. These natural processes subserve the necessities of nature in providing a succession of vegetation upon the earth. For man's uses, however, it is desirable for many purposes that there be large numbers of plants which are similar in the character of their growth or which produce fruits or flowers that are alike. Plants in nature conform to these requirements in part only. It therefore becomes necessary to use methods for increasing certain plants which will insure uniformity. The reproduction of plants by cuttings is one of the methods employed to accomplish this result.

A cutting is a detached portion of a plant inserted in soil or water for the purpose of reproducing a plant with characters like that from which the cutting was taken. There are several types of cuttings, such as herbaceous cuttings, those made from the soft growing wood, and hard-wood cuttings, made from the growth of the season after the growing period is past and the wood has become matured. Grapes, currants, privet, and plants of that character are readily increased from hard-wood cuttings of this nature. Leaves of plants, such as the begonia and hoya (wax plant), are largely used to increase their kind.

Hard-wood Cuttings.

Simple cuttings.—The most common form of hardwood cuttings is that usually employed in propagating the grape and currant (fig. 11, *a*). Such a cutting consists of a straight portion of a shoot or

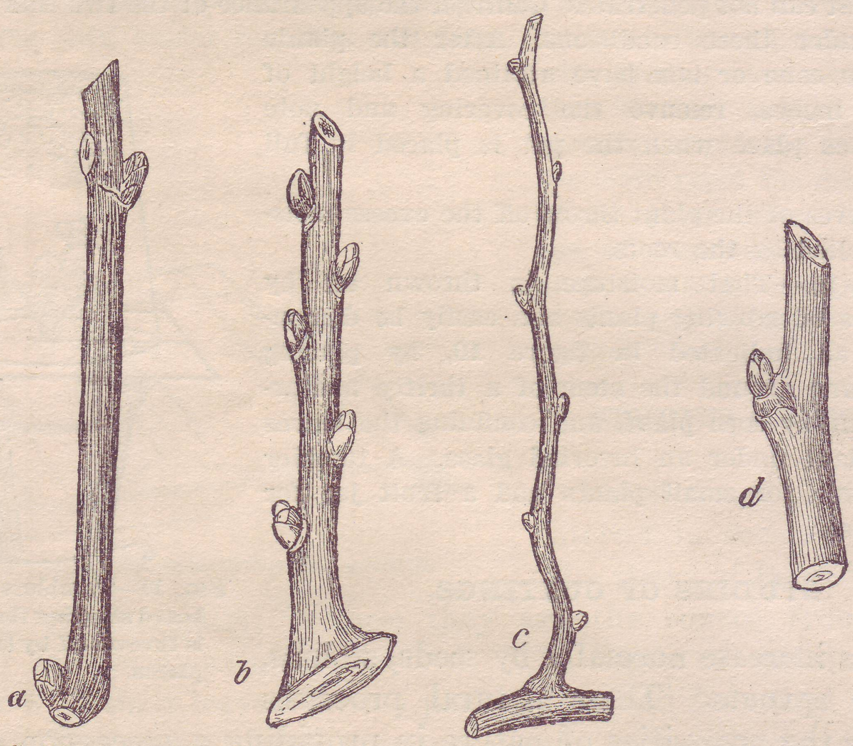

FIG. 11.—Cuttings: *a*, simple cutting; *b*, heel cutting; *c*, mallet cutting; *d*, single-eye cutting.

cane, nearly uniform in size throughout, and containing two or more buds. At the lower end it is usually cut off just below a bud, because roots develop most readily from the joints. At the top the cut is usually made at some distance above the highest bud.

Exercise 17.—Make simple cuttings.

Heel cuttings.—A cutting of the heel form (fig. 11, *b*) consists of the lower portion of a branch containing two or more buds, cut from the parent branch in such a manner as to carry with it a small portion of that branch, forming the so-called "heel."

Exercise 18.—Make heel cuttings.

Mallet cuttings.—A cutting of mallet form is produced by severing the parent branch above and below a shoot, so as to leave a section of it on the base of the cutting (fig. 11, *c*).

Exercise 19.—Make mallet cuttings.

The principal advantage in the use of heel cuttings and mallet cuttings lies in the greater certainty of developing roots. The principal drawback is that only one cutting can be made from each lateral branch.

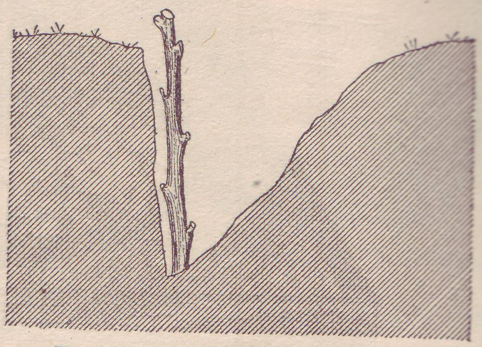

FIG. 12.—Cutting set in trench.

Single-eye cuttings.—When it is desired to make the largest possible number of cuttings from a limited supply of wood, cuttings are made containing but one bud each (fig. 11, *d*). Such cuttings are commonly started under glass with bottom heat, either in greenhouse or hotbed. They may be set either in horizontal position, with the bud on the upper side, or perpendicularly. In either case the bud is placed about an inch below the surface, preferably in clean sand, which should be kept uniformly moist.

FIG. 13.—Leaf cutting—part of leaf.

Treatment of hard-wood cuttings.—Cuttings are usually made with two or more buds. The cuttings are made while the wood is dormant during the autumn or early winter. As fast as made, the cuttings are tied in bundles of 25 or 50, with butts all one way, and are buried bottom end up in a trench, being covered to a depth of 2 to 6 inches with sand or mellow soil. This protects the top buds from freezing and gives the butts the benefit of the warmth of the sun in the spring, thus stimulating root development. Cuttings may also be kept over winter in a cool cellar, buried in sand, sawdust, or moss.

The following spring the bundles are taken up and the cuttings set about 3 inches apart, with only the topmost bud or buds above the surface of the ground (fig. 12). The soil is then replaced and thoroughly packed. In planting, the cuttings should be exposed to light and air as little as possible.

Herbaceous or Soft-wood Cuttings.

This class of cuttings is exemplified in the "slips" used to increase the numbers of house plants. Many greenhouse plants, including roses, carnations, geraniums, chrysanthemums, fuchsias, begonias, and

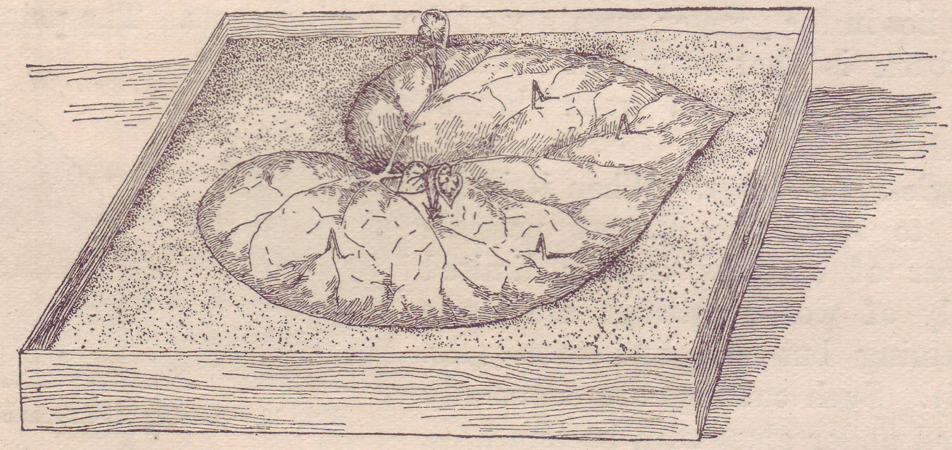

FIG. 14.—Leaf cutting—whole leaf.

the like, are propagated by soft-wood cuttings. One of the chief advantages of this method of propagation is that it can be employed in the winter under glass.

Herbaceous cuttings may be made from the leaf or stem.

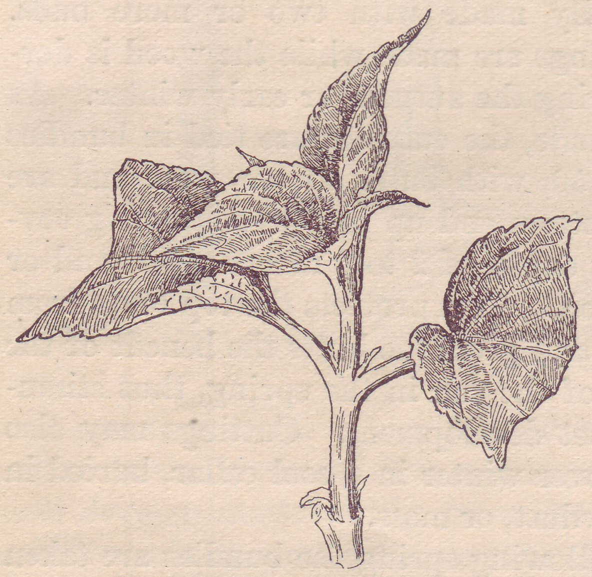

FIG. 15.—Stem cutting or "slip."

Leaf cuttings.—These are commonly employed in multiplying hoyas (wax plants), begonias, and other plants having thick fleshy leaves containing a large quantity of plant food either in the body of the leaf or its larger ribs. Such cuttings may be made from parts of a leaf (fig. 13), or a whole leaf may be employed (fig. 14). In either case a leaf which has reached its full development and is in a vigorous, healthy condition is essential.

Stem cuttings.—A stem cutting, or "slip," is a portion of a branch containing two or more nodes, with leaves attached (fig. 15). Stem cuttings of coleus, geranium, and allied plants strike root very freely. As a general rule, in preparing slips the leaf area should be reduced to a minimum in order to lessen evaporation of the moisture contained in the cutting, and thus prevent wilting.

Tuber Cuttings and Root Cuttings.

Tuber cuttings.—Tubers (fig. 16) are thickened portions of either roots or stems in which starch is stored. Irish and sweet potatoes are familiar illustrations of tubers. Roots do not commonly arise from the tubers themselves, but from the bases of young shoots or sprouts. When these sprouts have developed roots, they may be removed from the tuber cutting and planted independently, when the cutting will then send out new sprouts. This practice is sometimes employed with new varieties of Irish potatoes in order to secure a maximum yield from a small stock of seed potatoes.

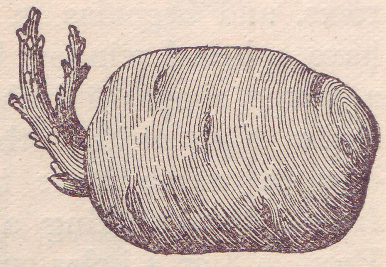

Fig. 16.—A tuber—Irish potato.

In cutting Irish potatoes, there should be at least one eye on each piece; but in cutting such roots as sweet potatoes and dahlias, which have no eyes, it is only necessary that each piece should have upon it a portion of the skin or epidermis from which adventitious buds may develop.

Tuber cuttings may be planted in hotbeds for the production of sprouts or sets, which are then removed to be set in the field or garden, or, as is customary with Irish potatoes, the cuttings may be planted in furrows in the field or plot which is to produce the crop.

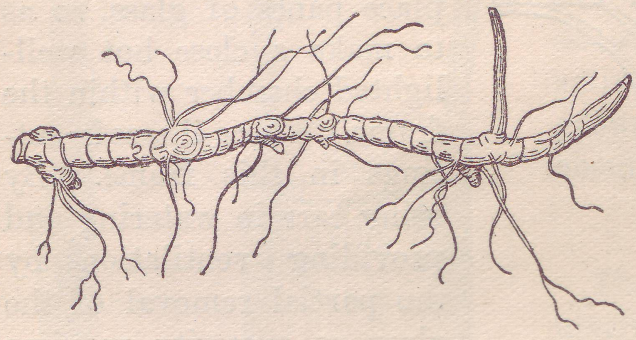

Fig. 17.—A rootstock.

Exercise 20.—Make and plant tuber cuttings of Irish potatoes.

Root cuttings.—Short cuttings of the roots may be used in the propagation of many plants, especially those which show a natural tendency to sucker. Rootstocks (fig. 17) of Johnson grass, Bermuda grass, and some other grasses can be cut into short pieces and used in setting fields to grass. With root cuttings of many plants bottom heat is useful, but root cuttings of the blackberry do well with ordinary outdoor treatment.

Horse-radish is almost universally propagated by root cuttings. The small lateral roots may be cut into pieces 3 inches in length and planted. Care should be taken to place them in the ground either horizontally or right end up. In order to avoid mistakes in placing the roots in the ground, cuttings may be made with a slanting cut at the base and a square cut at the top.

Facilities for Rooting Cuttings.

In order to successfully root cuttings of coleus, geraniums, fuchsias, roses, and begonias in the schoolroom it will be an advantage to have a broad window box constructed somewhat as follows: Make a frame about 15 inches wide, 6 inches high at one side and 10 inches high at the other, and as long as the width of the window in which it is to be used. Place a tight bottom in the frame, thus making a box similar to that shown in figure 18. Provide 3 or 4 holes one-half inch in diameter in the bottom of the box to allow the escape of any excess moisture. Place about one inch of broken pots, coarse gravel, or clinkers in the bottom of the box, and on top of these place a layer of clean sand free from clay or decaying organic matter, about 2½ to 3 inches thick. Over the top place panes of glass, so as to make a close but well-lighted chamber within the frame. Place the soft cuttings in this frame. By using care in watering and providing ventilation by the partial removal of the glass as necessity requires under such treatment, fair results should follow. Some experience will be necessary to successfully root plants even with this device, but much better results may be expected than without it.

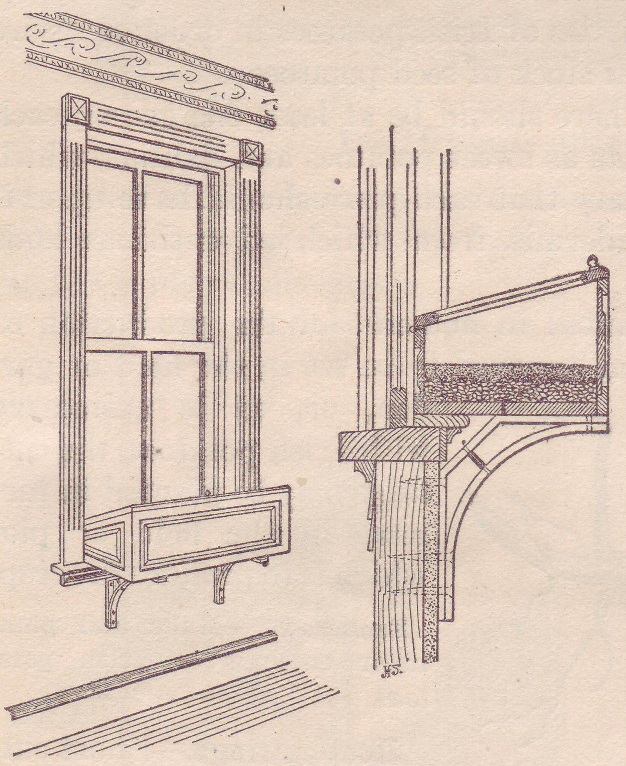

FIG. 18.—Frame for rooting cuttings.

STUDIES OF GRAFTS.

Were all forms of the art of grafting and budding to be taken from the horticulturists to-day, commercial fruit growing in its high state of perfection would decay with the orchards now standing.

Scion.

A scion is a portion cut from a plant to be inserted upon another (or the same) plant, with the intention that it shall grow. Except for herbaceous grafting, the wood for scions should be taken while in a dormant or resting condition. The time usually considered best is after the leaves have fallen, but before severe freezing begins. The scions are tied in bunches and buried in moist sand, where they will not freeze and yet will be kept cold enough to prevent growth. Good results often follow cutting scions in the spring just before or at the time the grafting is to be done. If cleft grafting is the style to be employed, this practice frequently gives good results, but the cutting of scions for whip grafting is not desirable at this season, as not enough time is given for a proper union to take place before planting time in the spring.

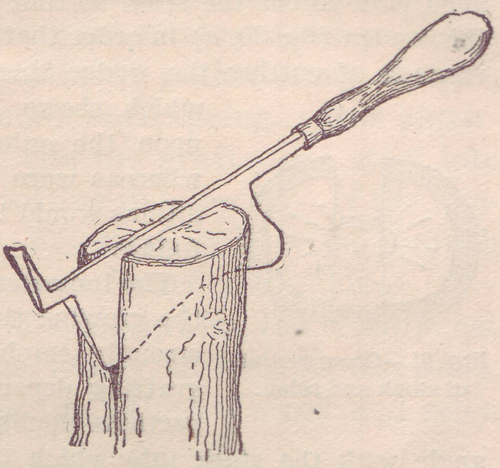

FIG. 19.—Grafting tool.

Stock.

The stock is the plant or part of a plant upon which or into which the bud or scion is inserted. For best results in grafting it is essential that the stock be in an active condition, or so that active growth can be quickly brought about.

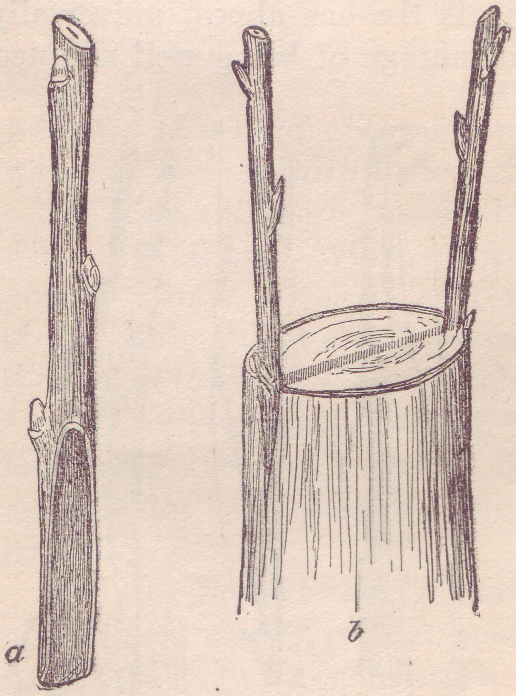

FIG. 20.—Cleft grafting. *a*, scion; *b*, scions inserted in cleft.

Cleft Grafting.

The cleft style of graft is particularly adapted to large trees when for any reason it becomes necessary to change the variety. Branches too large to be worked by other methods can be cleft grafted.

Exercise 21.—To make a cleft graft select a branch 1 or 1½ inches in diameter and sever it with a saw. Care should be taken that the bark be not loosened from any portion of the stub. Split the exposed end with a broad thin chisel or grafting tool (fig. 19). Then with a wedge or the wedge-shaped prong at the end of the grafting tool spread the cleft so that the scion (fig. 20, *a*) may be inserted (fig. 20, *b*).

The scion should consist of a portion of the previous season's growth and should be long enough to have two or three buds. The lower end of the scion, which is to be inserted into the cleft, should be cut into the shape of a wedge, having the outer edge thicker than the other (fig. 21). In general, it is a good plan to cut the scion so that the lowest bud will come just at the top of this wedge (fig. 20, *a*) in order that it will be near the top of the stock. The advantage of cutting the wedge thicker on one side is illustrated in figure 21, which shows how the pressure of the stock is brought upon the outer growing parts of both scion and stock, whereas were the scion thicker on the inner side the conditions would be reversed and the death of the scion would follow.

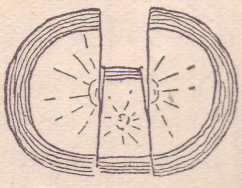

Fig. 21.—Cross section of stock and scion.

The importance of having an intimate connection between the growing tissues of both scion and stock can not be too strongly emphasized, for upon this alone the success of grafting depends. To make this contact of the growing portions doubly certain, the scion is often set at a slight angle with the stock into which it is inserted in order to cause the growing portions of the two to cross.

After the scions have been set, the operation of cleft grafting is completed by covering all cut surfaces with a layer of grafting wax.

Whip Grafting.

The style known as whip grafting is the one almost universally used in root grafting. It has the advantage of being well adapted to small plants only 1 or 2 years of age, as well as the other important consideration that it can be done indoors during the comparative leisure of winter.

Exercise 22.—To make a whip graft, cut the stock off diagonally—one long smooth cut with a sharp knife, leaving about three-fourths of an inch of cut surface, as shown in figure 22, *a*. Place the knife about one-third of the distance from the end of the cut surface, at right angles to the cut, and split the stock in the direction of its long axis. Cut the lower end of the scion in like manner (fig. 22, *a* and *b*), and when the two parts are forced together, as shown in figure 22, *c*, the cut surfaces will fit neatly, and one will nearly cover the other if the scion and stock are of the same size. A difference in diameter of the two parts to be united may be disregarded unless it be too great. After the scion and stock have been locked together they should be wrapped with five or six turns of waxed cotton to hold the parts firmly.

Fig. 22.—Whip grafting: *a*, the stock; *b*, the scion; *c*, stock and scion united.

While top grafting may be done in this way, it is in root grafting that the whip graft finds its distinctive field. When the roots are cut into lengths of from 2 to 5 or 6 inches to be used as stocks, the operation is known as piece-root grafting. Sometimes the entire root is used.

The roots are dug and the scions are cut in the autumn and stored. The work of grafting may be done during the winter months. When the operation has been completed the grafts are packed away in moss, sawdust, or sand, in a cool cellar, to remain until spring. It is important that the place of storage be cool, else the grafts may start into growth and be ruined, or heating and rotting may occur. If the temperature is kept low—not above 40° F.—there will be no growth except callousing and the knitting together of stock and scion.

In ordinary propagation by means of whip grafts, the scion is cut with about three buds, the stock being nearly as long as the scion. The grafted plant is so set as to bring the union of stock and scion below the surface of the ground.

When whip grafting is employed above ground the wound must be protected, as in cleft grafting, either with a mass of grafting wax or a bandage of waxed muslin.

Grafting Wax.

A good grafting wax may be made of the following ingredients: Resin, 4 parts; beeswax, 2 parts; tallow or linseed oil, 1 part—by weight. If a harder wax is needed, 5 parts of resin and $2\frac{1}{2}$ of beeswax may be used with 1 part of tallow.

The resin and beeswax should be broken up fine and melted together with the tallow. When thoroughly melted the liquid should be poured into a vessel of cold water. As soon as it becomes hard enough to handle it should be taken out and pulled and worked until it becomes tough and has the color of very light-colored manila paper. If the wax is applied by hand, the hands should be well greased, tallow being the best material for this purpose. The wax may be applied hot with a brush, but care is necessary in order to avoid injury.

The wax should be spread carefully over all cut or exposed surfaces and pressed closely, so that upon cooling it will form a sleek coating impenetrable to air or moisture.

Waxed string may be prepared by putting a ball of No. 18 knitting cotton into a kettle of melted grafting wax. In five minutes it will be thoroughly saturated, after which it will remain in condition for use indefinitely.

STUDIES OF BUDDING.

There are numerous styles of budding, but only the one in most common use will be described here. Budding is one of the most economical forms of artificial reproduction, and each year witnesses its more general use. Some nurserymen go so far as to use it as a substitute for all modes of grafting save whip grafting in the propagation of the dwarf pear. Budding is economical in the amount of wood used from which to take buds. In this method a single bud does the work of the three or more upon the scion used in grafting. But while it is economical of wood, it is expensive in the use of stocks, a seedling being required for each tree, while, with the piece-root system of grafting, two, three, or more stocks can be made from a single seedling.


Fig. 23.—A bud stick.

The operation of budding is simple, and can be done with great speed by expert budders. The expense of the operation is, therefore, not more than that of whip grafting, although the work has usually to be done in July, August, or early September. The usual plan is for a man to set the buds and a boy to follow closely and do the tying.

The Bud.

The bud should be taken from wood of the present season's growth. Since the work of budding is done during the season of active growth, the bud sticks are prepared so that the petiole or stem of each leaf is left attached to serve as a handle to aid in pushing the bud home when inserting it beneath the bark of the stock. This is what is usually called a shield bud, and is cut so that a small portion of the woody tissue of the branch is removed with the bud. A bud stick is shown in figure 23. The operation of cutting the bud is illustrated in figure 24.

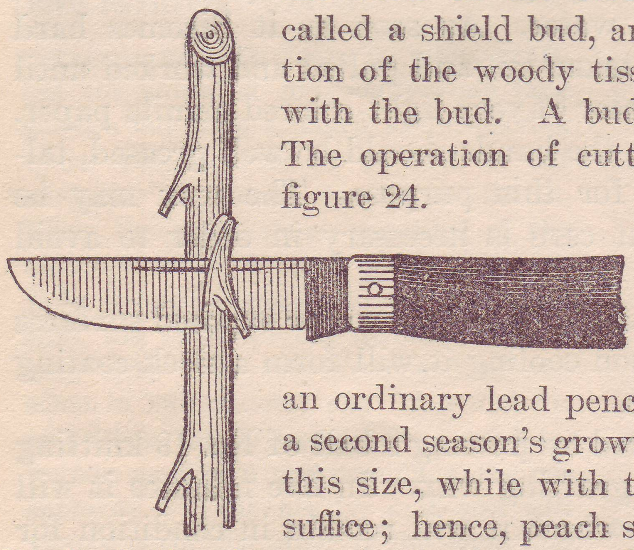
Fig. 24.—Cutting the bud.

The Stock.

The stock for budding should be at least as thick as an ordinary lead pencil. With the apple and pear a second season's growth will be necessary to develop this size, while with the peach a single season will suffice; hence, peach stocks can be budded the same season the pits are planted. Consequently the peach is left until as late in the season as is practicable in order to obtain stocks of suitable size. The height at which buds are inserted varies with the operator. In general, the nearer the ground the better.

Exercise 23.—To bud a plant, make a cut for the reception of the bud in the shape of a letter T (fig. 25, *a*). Usually the crosscut is not quite at right angles with the body of the tree, and the stem to the T starts at the crosscut and extends toward the root for an inch or more. Loosen the flaps of bark caused by the intersection of the two cuts (fig. 25, *b*) with the ivory heel of the budding knife, grasp the bud by the leaf stem as a handle, insert it under the flaps and push it firmly in place until its cut surface is entirely in contact with the peeled body of the stock (fig. 26, *a*). Tie a ligature tightly about it, above and below the bud, to hold it in place until a union shall be formed (fig. 26, *b*). Bands of raffia or wrapping cotton, about 10 to 12 inches long, make a most convenient tying material. As soon as the buds have united with the stock the ligature should be cut in order to prevent girdling the stock. This done, the operation is complete until the following spring, when all the trees in which the buds have "taken" should have the top cut off just above the bud (fig. 26, *c*).

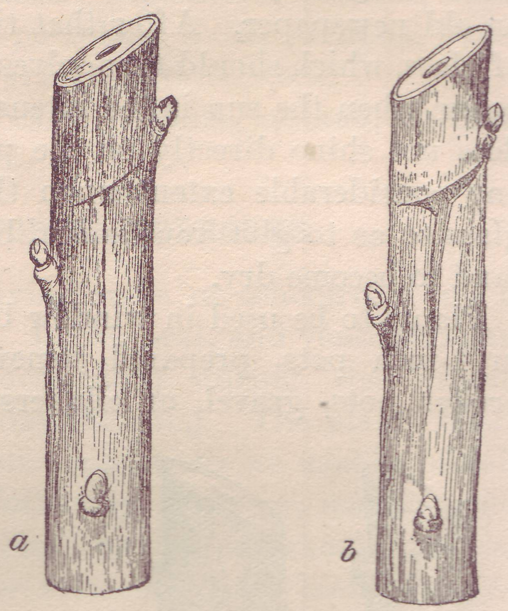

Fig. 25.—Budding: Preparing the stock.

WINDOW BOXES FOR SCHOOLROOMS.

Because of the conditions which prevail in a schoolroom, window boxes must be made comparatively deep and must contain a larger quantity of soil than is commonly necessary for the growth of plants in greenhouses in order that the adverse conditions may in part be counteracted. Boxes intended for window gardens should therefore be made at least 6 to 8 inches in depth, should be rather broad, and of a length to conform to the window opening. The soil should be rich garden loam or a compost consisting of rotted sods and stable manure thoroughly mixed together and screened through a screen with at least a half-inch mesh.

Before filling the box a layer of broken pots, or coarse gravel, or clinkers from the ash heap should be placed over the bottom of the box to the depth of 1 inch. If the box is made air-tight, holes should be provided in the bottom, in order that any excess of moisture which comes from watering the plants may escape from the bottom. After placing this drainage material in the bottom of the box fill it to within 1 inch of the top with the soil above described. Window boxes which are to be used for propagating plants from cuttings need not be more than 6 inches deep, and should have the drainage material above mentioned, with about 3 inches of clean sand placed over the clinkers.

The cuttings may then be prepared as suggested and planted in rows about 3 inches apart, with the ends of the cuttings inserted about

1 inch deep in the sand. Thoroughly moisten the sand after placing the cuttings in position, and cover the box for twenty-four hours with an old newspaper. After that time replace the newspaper by panes of glass, which should themselves be shaded by a single sheet of newspaper when the sun is too intense. Remove the shade when the sun does not shine directly on the plants, and if moisture condenses to any considerable extent upon the glass, lift or partly remove the glass so as to give ventilation, but do not allow the cuttings or the sand to become dry.

Plants to be used in window boxes can be grown from seeds sown in 4-inch pots, prepared somewhat as follows: Place a layer of broken pots, gravel, or clinkers in the bottom of the pot, and on top of this fill the pot to within about an inch of the surface with a compost similar to that suggested for filling window boxes. If the seeds to be sown are small and fine, like the begonia, sprinkle a thin layer of sand over the surface of the soil in the pot and sow the seeds in the sand. Moisten the earth by setting the pot for a minute in a receptacle which contains water of sufficient depth to bring it to within an inch of the surface of the soil in the pot. Lift the pot from the water as soon as the soil is moistened; place it in a warm, sunny situation, and cover it with a piece of glass. As soon as the seeds begin to germinate, remove the glass to a slight extent by placing under one edge a match, or by slipping it partly off the surface of the pot. Judgment must be used in regard to the amount of air to be given to prevent the plants from becoming drawn and yet keep them from being injured by becoming too dry.

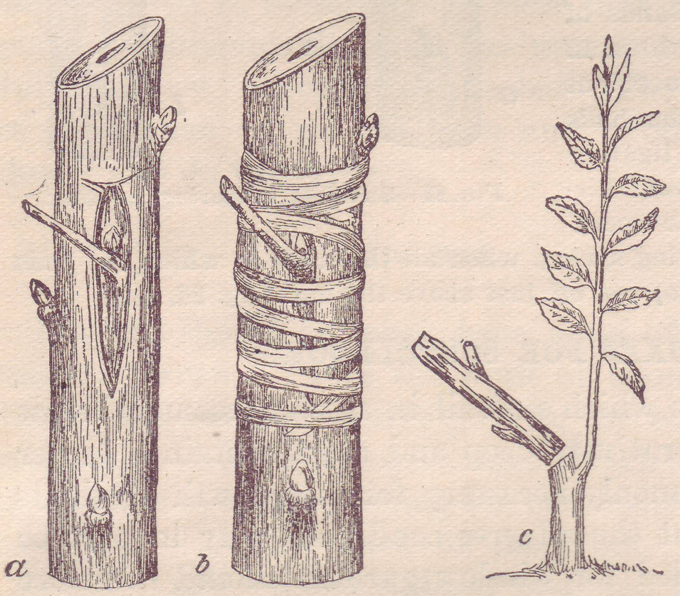

FIG. 26: Budding: *a*, inserting the bud; *b*, tying; *c*, cutting off the top.

Large seeds, like seeds of the nasturtium, should be planted about an inch deep in the soil of the pots, prepared as above described, but no layer of sand need be used with plants of this character.

The character of plants to be used in a box will be determined by the preferences of the cultivator, but in general they should be small and compact in habit of growth, or those which can be trained readily on strings. The following list will serve as a guide in their selection.

PLANTS SUITABLE FOR WINDOW BOXES.

Plants which can be grown from seed.—Ageratum, petunia, sweet alyssum, mignonette, *Lobelia erinus*, portulaca, *Bellis perennis*, *Primula obconica*, coleus, nasturtium (dwarf), dianthus, stock.

Other plants.—Geranium, fuchsia, calla, begonia, lantana, abutilon, German ivy, tradescantia, vinca.

SPECIMEN PLANTS FOR SCHOOLROOMS.

The conditions obtained in the living room or schoolroom are as a general rule very trying to plants. Light, heat, and ventilation are very uncertain in schoolrooms, particularly during the interim between Friday afternoon and Monday morning. The plants which are capable of enduring such adverse conditions as usually obtain during this period are few. The following, however, may be mentioned as among those possessing most merit for schoolroom use: *Aspidistra lurida; Aspidistra elatior* var. *variegata;* lantana; geranium; begonia; cactus; umbrella plant; amaryllis; sword fern; Jerusalem cherry; *Ficus elastica;* abutilon; oleander; screw pine (Pandanus); oxalis; *Primula obconica;* German ivy; *Asparagus sprengeri;* peperomia; *Sansevieria zeylanica.*

THE DECORATION OF SCHOOL GROUNDS.

Two primary objects should be kept in view in the decoration of school grounds: (1) Instruction; (2) beauty and utility.

The primary object of the school is instruction. The work of beautifying the school grounds should also carry with it an element of instruction. The grounds should serve as an object lesson for the residents of the community in which the school is located. They should be laid out on sound principles of landscape gardening, and be so well executed as to induce residents of the vicinity to copy the general idea of the plan and possibly the details of the shrubbery groups. The idea of beauty can be emphasized in the proper grouping of trees and shrubs in relation to walks, drives, and vistas, and utility can be subserved by so placing the heavy plantings as to serve as a shield from the wind or sun. Shrubbery groups can be arranged so as to separate one portion of the grounds from another and yet not to interfere with large open spaces which can be used as playgrounds, such as ball fields, tennis courts, etc.

THE PLAN.

The first essential for the work of beautifying the grounds will be a plan, as suggested in figure 27. The beginning of this plan may be a rough sketch of the area on which the school building stands, with directions and distances marked upon it. Next, locate the permanent objects, such as trees and buildings. Determine next the main lines of travel leading to the schoolhouse and use these as a basis for the permanent walks, unless there is some good reason for changing the main paths. The walks and drives should be straight, if distances are less than 100 feet, and gently curved if longer, so as to admit of the use of trees and shrubs along the border. The outlook from each door and window should be carefully inspected before determining which objects in the landscape should be retained in view and which hidden or concealed by the use of trees and shrubs.

Trees and shrubs should be confined chiefly to the borders of the place, an open and unbroken lawn being preserved in front and at

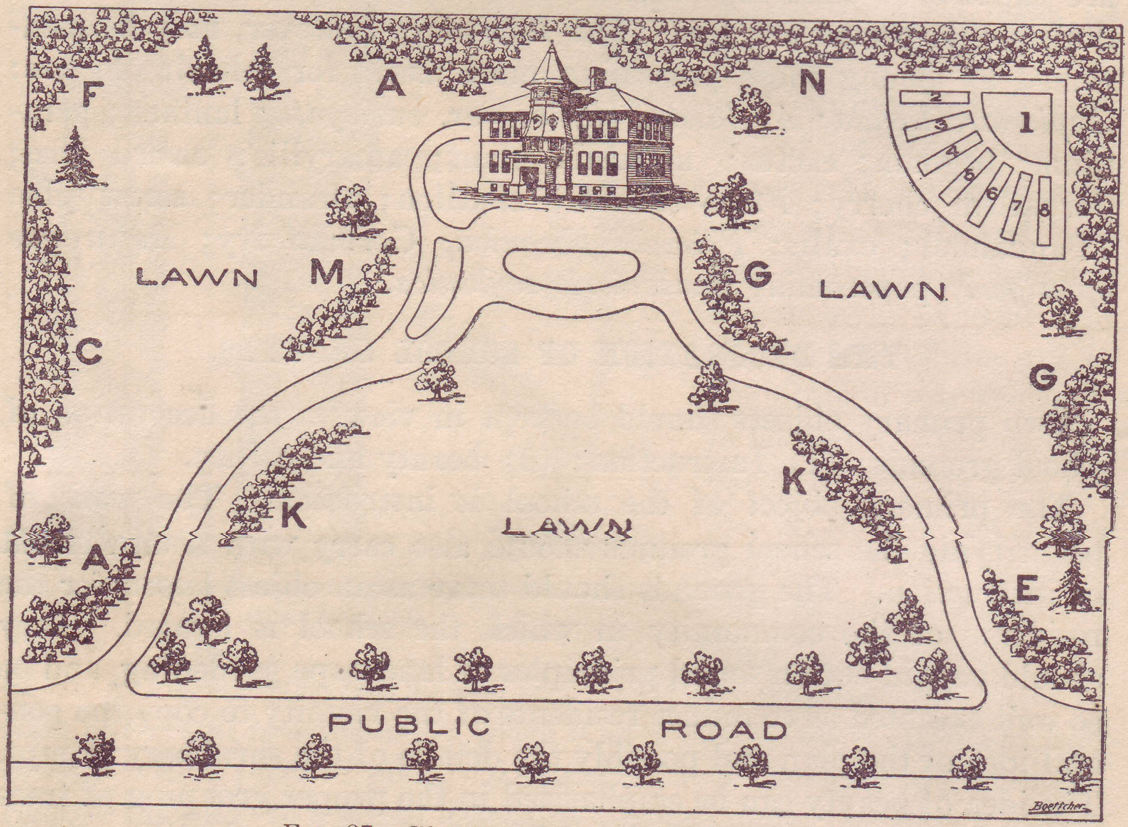

FIG. 27.—Planting plan for school grounds.

the sides or rear where playgrounds are to be maintained. The difference between indiscriminate planting and conformity to this plan is well exemplified in figures 28 and 29. In rural districts the trees should be so located as to give protection from storms in winter and from the sun in summer, and at the same time to produce a pleasing effect. Shrubs may be employed to advantage in screening unsightly objects, as suggested in figures 30 and 31. The plans of the grounds will serve both as an exercise in geography and in arithmetic, and if the pupils are encouraged to make such designs their interest in the work will be assured and a practical application of the principles taught in the schoolroom will be a result of no little value.

WALKS.

The walks leading to and from the school should be direct, but where space will permit they should have gentle and pleasing curves

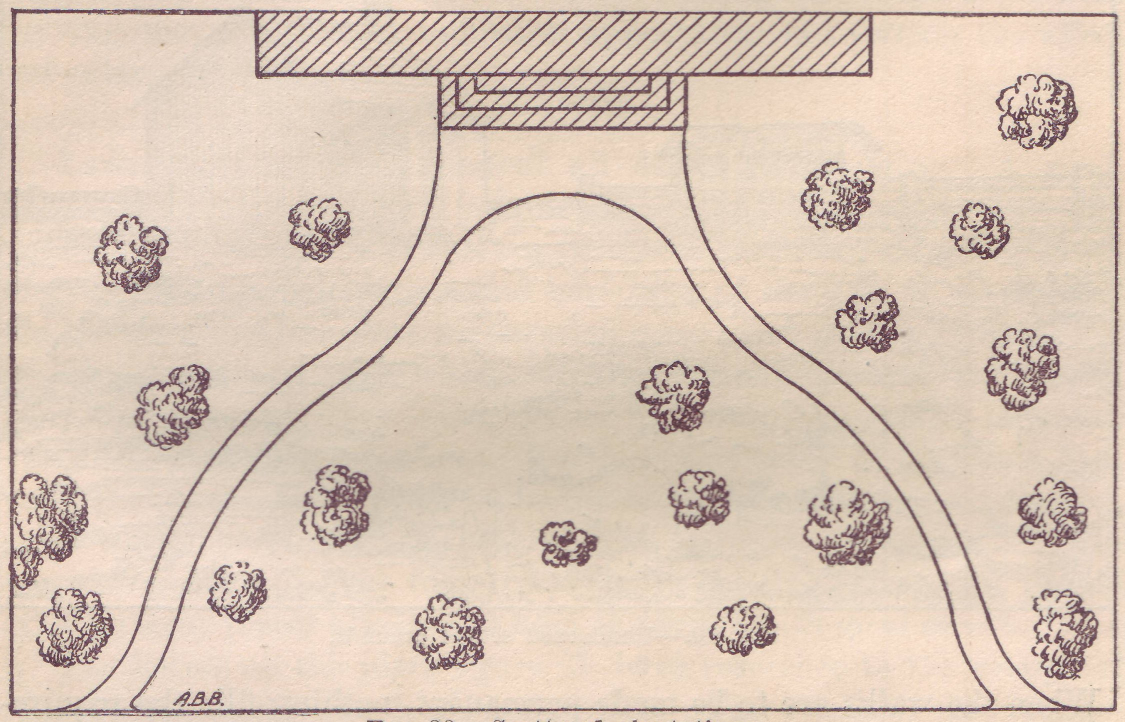

FIG. 28.—Scattered plantations.

which conform to the contour of the ground. Upon level areas it is well to allow an artistic use of shrubs in groups in the bays, which

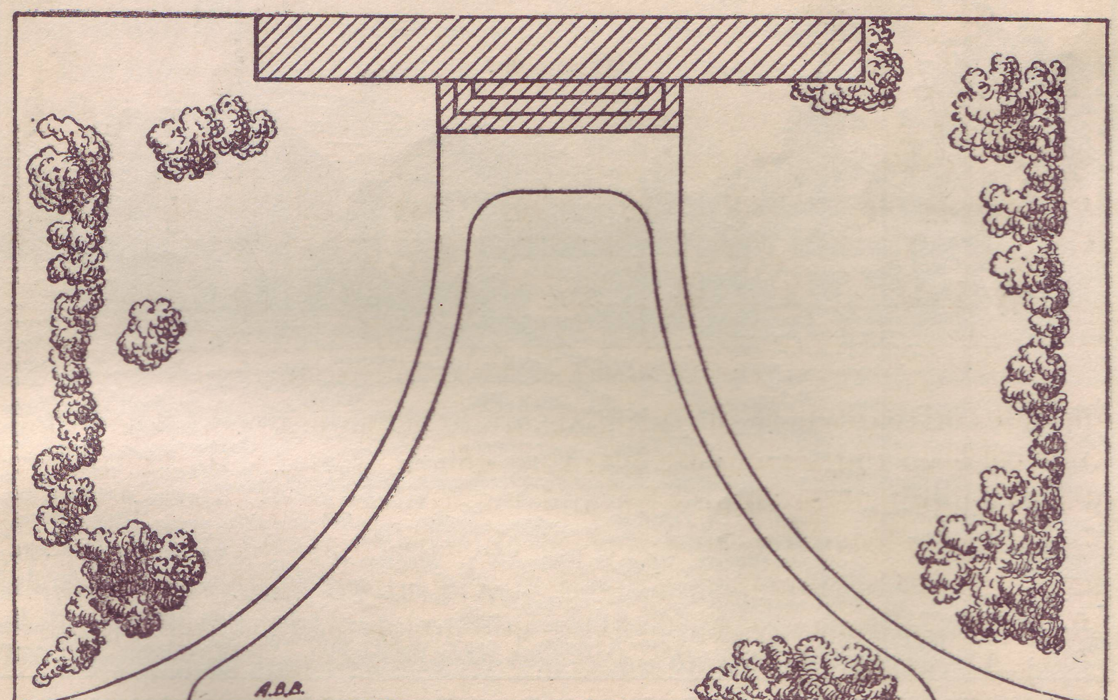

FIG. 29.—Group planting.

shall serve to break the monotony and obtrusiveness of an unscreened straight walk across an open lawn.

The material used in the construction of walks will be determined by circumstances and by the locality in which the work is to be done.

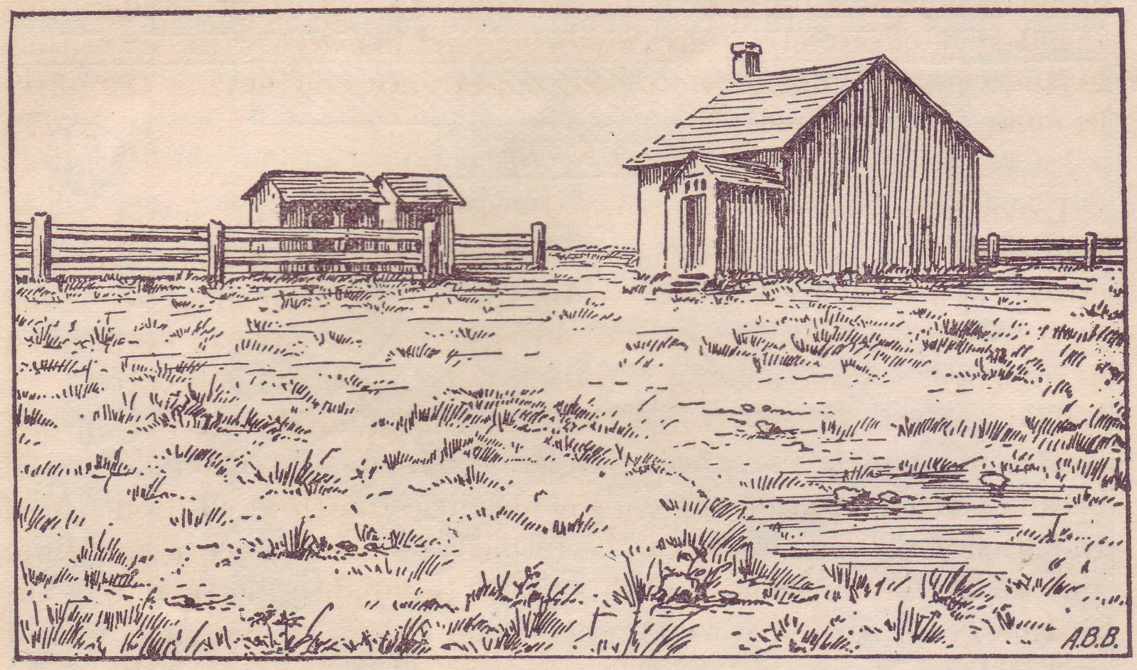

FIG. 30.—Unadorned school grounds.

When the walks are to be made permanent, nothing fills the requirements better than cement or artificial stone. When gravel or cement

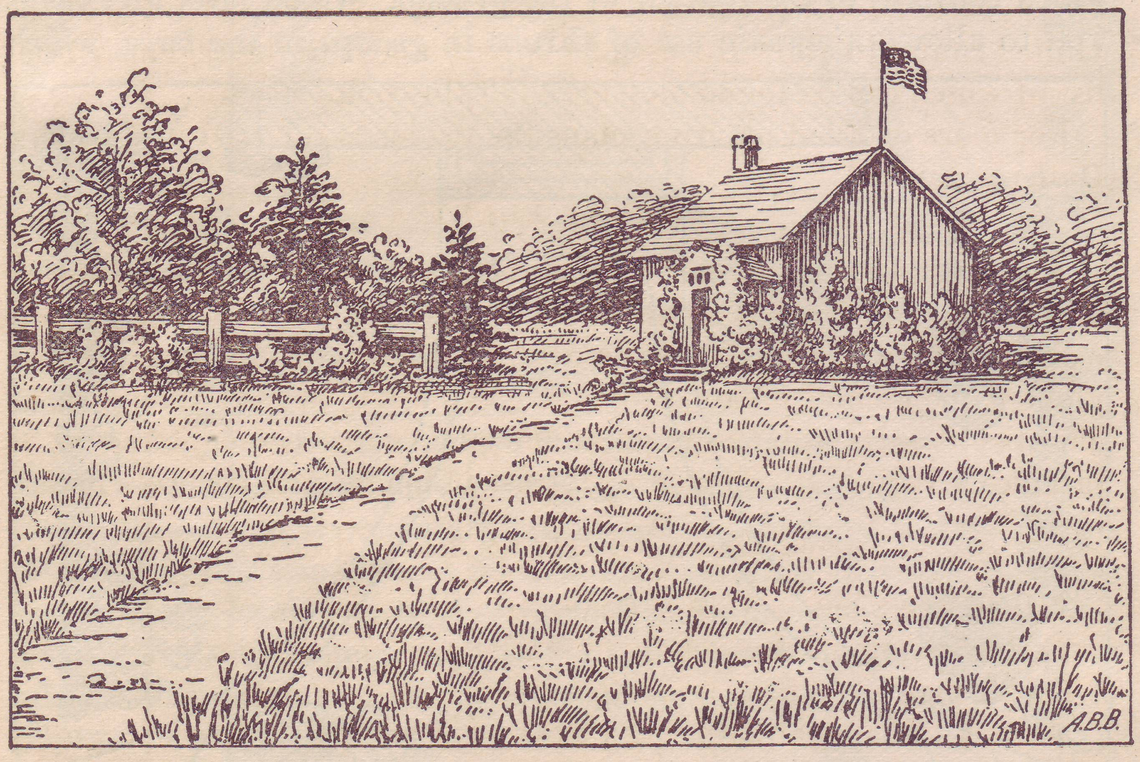

FIG. 31.—The school grounds shown in figure 30 softened by trees and shrubs.

is used the walks should be made slightly crowning, and the highest point in its surface should be at least 2 inches below the general level of the greensward. No coping or borders should be allowed, and the grass should be brought up to the edge of the gravel or cement. A slightly sunken walk makes the care of the lawn easier, besides hiding it very effectively from view when looking across the lawn, thus giving the grassplot an unbroken appearance and having the effect of enlarging its extent.

LAWNS.

Lawns are the foundation of all decorative planting. A good, well-kept lawn contributes more to the beauty of grounds than any other single factor. For this reason special attention should be given to the grading, cultivation, and enriching of the area to be devoted to the lawn. After good preparation come good seed and care.

The variety of soils which will be encountered and the special treatments which they need render it possible to make only the broadest generalizations here. For localities north of St. Louis, Mo., and Richmond, Va., lawns can be formed chiefly of bluegrass, redtop, and white clover. South of this point Bermuda grass and St. Augustine grass will have to be relied upon chiefly, although it is said that in some places alfalfa has been employed with good results.

The letters on the plan, figure 27, have reference to the groups of shrubbery indicated in detail in figure 32. The details of the arrangement of the groups, as well as names of the plants composing them, are suggested, but must of necessity be varied in different parts of the United States to allow the use of plants adapted to the region, a brief list of which can be found on page 40 of this publication.

For more detailed planting plans the reader is referred to Farmers' Bulletin No. 185.

ANNUAL PLANTS.

Annual flowering plants, such as those mentioned in the following list, may be used to give immediate effects in place of the more permanent trees and shrubs. Even after the trees and shrubs have been planted the annual plants can, with good effect, be used among them. The list is self-explanatory, and the plants can be so placed as to produce a variety in color or a contrast in height and general effect.

Annual Plants Suitable for School Grounds.

Tall foliage plants.—Castor bean, caladium, canna.

Tall flowering plants.—Cosmos, scarlet sage, sunflowers.

Border plants.—Alternanthera, alyssum, ageratum, coleus.

Medium-tall annual flowering plants.—Geranium, California poppy (Eschscholtzia), zinnia, marigold, aster, petunia, cockscomb, larkspur, nasturtium.

Climbing annuals.—Cobæa scandens, moonflower, Japanese morning glory.

For a more comprehensive list of annual flowering plants see Farmers' Bulletin No. 195.

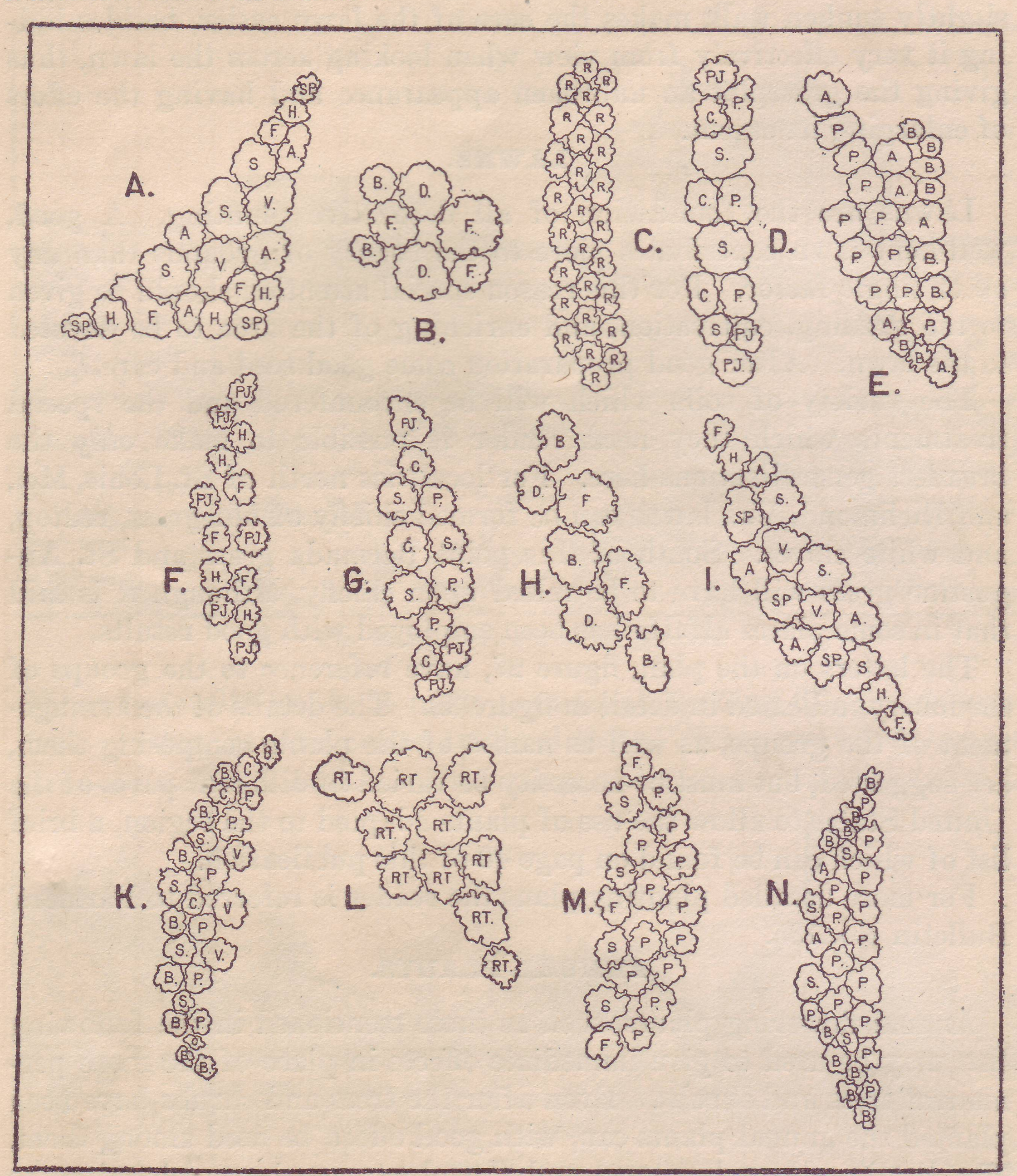

Fig. 32.—Detail of shrubbery groups shown in figure 27. Group A.—F, 3 Forsythia (May); S, 3 Syringa (May); V, 2 Viburnum (June); SP, 3 Spiræa (July); A, 4 Althea (August and September); H, 4 Hydrangea (August and September). Group B.—D, 2 Deutzia crenata (June); F, 3 Forsythia; B, 2 Berberis. Group C.—R, 27 Roses in variety. Group D.—C, 3 Calycanthus; P, 3 Philadelphus; S, 3 Syringa (white); PJ, 3 Pyrus japonica. Group E.—A, 6 Althea; B, 8 Berberis; P, 10 Privet. Group F.—F, 3 Forsythia; H, 4 Hydrangea; PJ, 6 Pyrus japonica. Group G.—C, 3 Calycanthus; P, 3 Philadelphus; S, 3 Syringa (white); PJ, 3 Pyrus japonica. Group H.—D, 2 Deutzia crenata (June); F, 2 Forsythia; B, 3 Berberis. Group I.—F, 2 Forsythia (May); S, 3 Syringa (May); V, 2 Viburnum (June); SP, 3 Spiræa (July); A, 4 Althea (August and September); H, 2 Hydrangea (August and September). Group K.—V, 3 Viburnum plicatum; S, 4 Syringa (white and purple); C, 4 Calycanthus; B, 9 Berberis; P, 6 Privet. Group L.—RT, 10 Rhus typhina (sumac). Group M.—P, 12 Privet; S, 4 Syringa; F, 3 Forsythia. Group N.—P, 14 Privet; S, 4 Syringa; A, 2 Althea; B, 9 Berberis.

TREES AND SHRUBS.

The cultural directions here given are not ideal by any means, but are offered in the way of suggestion and should be so considered.

Cultural Directions.

The beauty of a shade tree depends upon its normal and symmetrical growth. In order to insure this, before planting cut off the ends of all broken or mutilated roots; remove all side branches save upon evergreens, so that a straight whip-like stalk alone remains. Dig holes at least 2 feet in diameter and 1 foot deep in good soil, and make them 4 feet across in poor soil. The sides of holes should be perpendicular and the bottom flat. Break up soil in the bottom of the hole to the depth of the length of a spade blade. Place 2 or 3 inches of fine top soil, free from sods or other decomposing organic matter, in the bottom of the hole. On top of this place the roots of the tree, spread them as evenly as possible over the bottom of

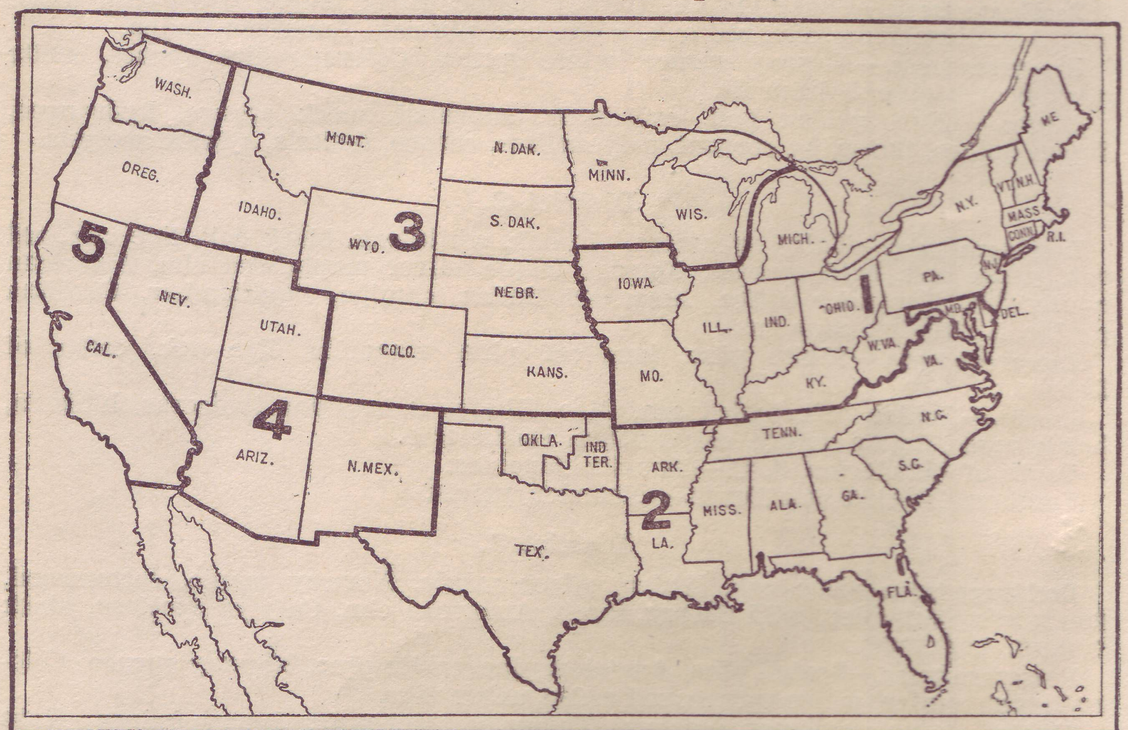

FIG. 33.—Map of the United States showing districts suited to the growth of various trees.

the hole, and cover with 2 or 3 inches of fine top soil as before. Tramp firmly with the feet and fill the hole with good earth, leaving the surface loose and a little higher than the surface of the surrounding soil. When the work of planting is completed, the tree should stand about 2 inches deeper than it stood in the nursery.

In order to insure symmetry of growth, trees must be allowed unrestricted area for development. At least 40 feet should be allowed between trees intended to occupy the ground permanently. Quick-growing nurse or temporary trees may be planted between the long-lived ones to produce immediate results, but these should be removed as soon as they interfere with the development of the permanent plantations.

The lists of trees and shrubs contained in this publication are merely suggestive, but in all cases they include such sorts as are well adapted to the particular locality for which they are recommended. Because of the great differences existing in the soil and climatic conditions of the several parts of the United States, the country has been partitioned into five sections, and a list of trees and shrubs suitable for school grounds or for home adornment is enumerated for each section. The section in which any particular school is located can be determined by a glance at the map (fig. 33), and reference to the list of trees and shrubs will assist in selecting suitable decorative material for the grounds.

Trees and Shrubs Suitable for School Grounds.

District 1.

Deciduous trees.—Sugar maple, Norway maple, silver maple, green ash, white ash, American white elm, red oak, white oak, pin oak, American linden.

Evergreen trees.—Norway spruce, white spruce, Colorado blue spruce, white pine, Scotch pine, balsam fir.

Shrubs.—Lilac, golden bell, exochorda, snowball, mock orange, hydrangea, Japan quince, flowering currant, calycanthus, cornus, deutzia, spiræa, weigela.

District 2.

Deciduous trees.—Tulip, sycamore, pin oak, white oak, black oak, live oak, red oak, white ash, bald cypress, Norway maple, silver maple, red elm, American white elm, Kentucky coffee, American linden, catalpa, liquidambar, Carolina poplar, hackberry, sour gum.

Evergreen trees.—White pine, long-leaf pine, magnolia, live oak, cedar of Lebanon.

Shrubs.—Golden bell, hydrangea, lilac, *Elæagnus longipes*, loniceras, hibiscus, hardy roses, Japan quince, calycanthus, smoke tree.

South of Charleston, S. C.—Camellia japonica.

Southern Florida and Texas.—Oleander, privet.

District 3.

Deciduous trees.—Bur oak, linden, silver maple, Norway maple, cottonwood, green ash, box elder, wild cherry, larch, American elm, *Catalpa speciosa*, black walnut, hackberry.

Evergreen trees.—Scotch pine, Austrian pine, white pine, Norway spruce, Colorado blue spruce, white spruce, red cedar, arbor vitæ.

Shrubs.—Lilac, barberry, cornus, *Tamarix amurensis*, Japan quince, *Rosa rugosa*, cratægus, *Elæagnus hortensis*, snowdrop, *Shepherdia argentea*.

District 4.

Deciduous trees.—Valley cottonwood (*Populus fremontii wizlizenia*), mountain cottonwood (*Populus angustifolia*), mountain ash (*Fraxinus velutina*), box elder (*Acer negundo*).

Evergreen trees.—Arbor vitæ, *Cedrus deodara*, box, euonymus.

Shrubs.—Althea, snowball, mock orange, wild rose, crape myrtle, spiræa, flowering currant, elder, lilac.

District 5.

Deciduous trees (Coast region).—Large-leaved maple, tulip tree, mountain ash, European linden, sycamore, weeping willow.

Shrubs (Coast region).—Roses, weigela, European holly, lilac, laburnum, deutzia, *Hydrangea paniculata*, mock orange, Japan quince.

Trees (Columbia Basin).—Scotch elm, American elm, Norway maple, European linden, sycamore, green ash, silver poplar, Russian poplar, white willow.

Shrubs (Columbia Basin).—Lilac, hardy roses, Philadelphus, *Elæagnus hortensis*, laburnum, spiræa, *Tamarix amurensis*, *Rosa rugosa*, barberry.

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