

**MÉMOIRES DU
JARDIN BOTANIQUE DE MONTRÉAL**

**MEMOIRS OF THE
MONTREAL BOTANICAL GARDEN**

No. 1
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**Program for
An Ideal Botanical Garden**

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4101 SHERBROOKE STREET EAST
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Montreal Botanical Garden



The following outline was published in 1933 in the magazine "Parks and Recreation" and under the title: "The Botanical Garden of the Future." Originally it was written for the writer's own use to clarify in his mind what should or might be the aims of a modern botanical garden. He had been called upon to design and to lay out the Montreal Botanical Garden and before starting on such an ambitious undertaking it seemed appropriate to outline everything that an ideal botanical garden might possibly consider to do, since one can choose and select judiciously only from a complete program.

As it later developed, this program was accepted almost in its entirety and was faithfully followed with only insignificant deviations. Therefore the Montreal Botanical Garden, when completed, may serve as a sample for the practical application of the principles here outlined.

In the light of the experience gained during the construction of the Montreal Botanical Garden it is now possible to be more specific in several of the most important chapters of the outline, and, since the original article has long been out of print, it seems desirable to revise and reprint it, not as a guide but as a stepping stone for those who come after us and who should be able to do still better.

INTRODUCTION

A botanical garden is, of course, first of all an educational institution. As long as botanical gardens have existed—and their history is indeed a long one—they always have served education in one way or another. But there can be no doubt that in order to justify its existence in a modern community the modern botanical garden must widen considerably the scope of its educational activities.

Formerly the primary purpose of a botanical garden was to serve the scientist and the student of botany rather than the general public.

The public was admitted—in European gardens usually for an entrance fee—and it was tolerated but was always regarded more or less as a nuisance. This went so far that the very name “Botanical Garden” has fallen rather into disrepute with the public, and it may sometimes be easier to enlist the interest of a community by starting with the establishment of a “Garden Center” which can later be enlarged to a Botanical Garden.

Of course, a botanical garden should be the center of botanical research for the region in which it is located, and have a well qualified scientific staff; of course, it should co-operate closely with the local universities and other institutes of learning and provide courses of scientific instruction. That is self-understood. But I believe that a modern botanical garden should most particularly make it its policy to use its facilities in the widest possible sense for the education of the general public. Not that I propose to make a botanist of every salesman and mechanic and to feed infants on Latin plant names. But with the increased concentration of the population in large cities and therewith unavoidably increased estrangement of man from nature, it seems to me that the botanical garden of the future has a very valuable task to perform by helping the uprooted city dweller to regain or keep a healthful relationship to nature, of which after all he is only a part. Modern man, living in his man-made desert of stone called city, has come more and more to regard plants, trees, shrubs, and flowers, which he sees in the public parks and along the parkways, merely as ornaments. He likes to see them but he does not give them more than a passing thought and is very far from having any feeling of relationship towards them. He breaks and destroys the trees of the roadside in a whim of the moment without knowing what he is doing. He does not have a garden of his own, and, frequently, he does not even want one, considering it only as an added burden in which he can see no sense, or as an expensive ornament which he cannot afford.

The leaders in public welfare work are many who realize how much of the prevailing restlessness, discontent, and unhappiness is due to this ever-widening gap between man and nature, and public parks, play- and recreation-grounds are generally conceded to be an essential part of every city development. Yet, do any of the city parks serve to change the attitude of the city-dweller toward nature? They do not, because they do not educate him. I need only to mention Central Park in New York, which suffers so much every year from thoughtless destruction that only at enormous expense can this park be maintained at all.

It seems as if from our forefathers who had to wrest a precarious existence from nature, yet knew well their place in it, we have taken nothing else into our modern, mechanized mode of living than a misunderstood notion of nature having to be conquered by man; a notion which was gradually still further distorted into the childish doctrine that man, *Homo*

sapiens, was not a part of nature but rather its supreme master. This attitude, this misorientation of man in nature, is at the root of more evils of city life than can be outlined here. A change of it, a reorientation, can be effected only by systematic education; and this education must be so simple and its means so attractive and pleasurable that the public will learn without realizing that it is being taught. Here is where the botanical garden of the future would find a field of work of far-reaching importance; in fact, of such great importance that I could visualize a time in which no city of any size would want to be without its botanical garden.

After all, it is the plant life of this globe on which all human and animal life depends, directly or indirectly. To penetrate with loving interest into the whys and wherefores of plant life means to come closer to an understanding of the sources of our own existence. It means to fathom the mysterious oneness of all nature which never loses anything and in which we too find our place. It means to learn that plants and animals are neither our adversaries which have to be mastered, nor our tools which are just there for our use, but are just as much a part of nature as we are—our brothers and sisters under the sun. This realization will teach us tolerance and love toward our fellow-beings, whoever they are; and tolerance and love, the children of wisdom, are the parents of happiness and contentment.

Now, let us see in what ways a botanical garden might help modern man to become a better citizen of nature's kingdom, and, therewith, also of his own community.

If it is understood that the policy of a botanical garden is first of all to further or to awaken the general public's interest in plant life, it seems to me that the keystone of the whole problem would be, not just to try to teach people, but to present the material for learning which is displayed in the garden in such a manner that it will make the people eager to learn. We must realize that we are dealing not only with beginners who, although they know nothing of the subject, yet are anxious to learn, but with a majority which is quite indifferent. To attract such people and also to hold them, we should consider in particular two points from which a deeper interest in plant life usually takes its beginnings. These are: first, the native flora of the vicinity, and secondly, the flower garden.

GEOGRAPHICAL AND ECOLOGICAL GROUPS

Modern teachers of languages quite generally agree that, to start teaching a language by teaching its grammar means to render the subject unnecessarily dry and difficult. The grammar will be mastered easily and quite without effort after an ear for the language and a feeling for its soul

have been developed. The same holds true with the science of botany. If we start teaching botany by teaching taxonomy—which is just as much the skeleton of the science of botany as grammar is the skeleton of a language—we are starting at the wrong end and usually succeed only in killing the interest of most of our students forever. The live end of the science of botany, where we come nearest to its soul, is plant ecology, which teaches of plant associations and their underlying causes, and which therewith takes us right into the heart of nature.

If we can reproduce in a botanical garden in truly natural manner and in large enough samples to assure of a good effect some of the most characteristic types of vegetation of the vicinity, and if we can explain in simple, clear language and in not too many sentences how the various plants are adapted to the conditions under which they grow and on which they depend, we shall always meet with deep interest. A babbling brook, a pond, a swamp area, a flowering meadow, and various types of forest associations, stocked with the plants which we meet in woods and meadows of the vicinity, will always attract people, and the information given with such displays will be accepted eagerly. The labeling of the plants in these groups must, of course, be thorough and careful and should supply not only the botanical but also the common name of each variety. Whether any additional information, like, for instance, the origin of the common name and the translation of the botanical name, should be given on the label or rather in a special guide-book, need not concern us here.

To broaden the scope of these ecological groups, some foreign types of vegetation which live under conditions similar to those affecting the native flora might be added. A sample of a Siberian-Manchurian forest and meadow and of a Central European forest and meadow would prove particularly instructive, since they would offer interesting parallels and would, in spite of their similarity of appearance, be conspicuously distinct in composition. Besides, it would be possible to show in these three groups, the American, the Asiatic, and the European, a great many plants in their natural environment which in improved forms are the occupants of all gardens.

Since a knowledge of the conditions under which plants grow in nature always gives us the best hints for their treatment in cultivation, it may easily be seen to what a large extent garden culture is essentially applied plant ecology and how the study of plant ecology will lead us without effort to a clearer understanding of the art of gardening. We learn to appreciate the effort it takes to grow beautiful plants successfully, and are easily led into a desire to know by name those plants which interest us, and to understand the differences which distinguish similar ones. The study of their relationships, which is plant taxonomy, is then a natural step forward.

The city-dweller is frequently interested also in the adventive flora of waste lands which he sees so much on the vacant lots of the city. A natural arrangement of the most common cosmopolitan weeds on a small piece of land which is artificially kept in the condition of waste land can be rendered very instructive, if not only the names and the distribution or origin of the plants are given, but also, where known, the history of their introduction. This would offer probably the only attractive way in which these most unattractive plants can be displayed. In the guide-book to the garden a chapter might be included here on the simplest and most effective means of combating weeds in the garden. References to near relatives which are not weeds but are in general cultivation because of their economic or ornamental value would lead again imperceptibly to plant taxonomy.

THE FLOWER GARDEN

The beauty appeal of the flower garden should, it seems to me, be utilized in botanical gardens to a much larger extent than has been done heretofore. Large or even complete collections of all the known varieties of iris, peonies, chrysanthemums, gladioli, etc., are, of course, of the greatest importance for horticultural and botanical study, but the general public will stand before such a display only with bewilderment or even with fear. I have often mingled with crowds viewing such plantings to see their reaction. Most frequently the reaction was awe, but not the awe inspired by entrancing beauty which breeds the desire to know more about these plants and, perhaps, to have them in one's own garden, but the awe which uneducated people feel toward something they do not understand and which, they realize, they never will understand.

A few visitors who had come for the special purpose of selecting some good varieties for their own gardens were taking notes. Either they filled pages upon pages, since they could not decide which they liked best, or they noted down varieties which took their fancy because of their unusually large or brilliant flowers but which were poor growers or unreliable bloomers.

It has seemed quite evident that the public display of a large collection of varieties of one flower does much more harm than good. If the interest of the public is considered, only careful selections of the best and most recommended varieties, tastefully arranged as to color combinations, should be displayed. Naturally, in order to make selections one must have collections first. But these should be grown in the nursery or in a special testing field where advanced students might be given permission to view them. As soon as these collections have served their purpose they may be discarded or by gradual elimination diminished, and later on only the newest varieties which come out every year need be grown until they have proved their worth.

Beauty appeal as an attraction on the road to learning should be the motto of every botanical garden and might be applied in particular in the following forms:

The perennial flower garden: Here should be displayed not only attractive combinations of carefully selected best varieties of perennial flowers, but also samples of various kinds of flower borders, such as the spring border, the summer border, the fall border, the continuously blooming border. Furthermore, a selection of the best ornamental flowering plants for shady places: *a*, those which also stand drought; *b*, those which need moisture. A selection of the perennials which will stand drought in full sun. A selection of the best plants for a green groundcover, *a*, in the shade; *b*, on a dry, hot bank where grass does not succeed, etc. A special corner where newly introduced varieties are displayed might also be included in this garden.

For best effect as well as for easiest reference one should consider to provide also a series of individual gardens, which may be blended into one harmonious unit through the use of mixed borders, and each of which may contain only one or two types of flowers. One might provide, for instance: an iris garden, phlox garden, peony and poppy garden, dahlia garden, canna and gladiolus garden, lily garden, astilbe and fern garden, primula and viola garden, etc.

This is the scheme which has been adopted with satisfactory results at the Montreal Botanical Garden, where even such special groups as hardy orchids, gentians, and ornamental grasses have been accommodated in specially prepared beds. This arrangement has the advantage that it makes it easy for visitors to find the particular type of flower they may be looking for and to compare similar varieties; while on the other hand it provides a brilliant display in each of the individual gardens at one particular time.

All such selections should, of course, not be considered as permanent and final but must be constantly checked against newer varieties and improved upon as necessary. One must also bear in mind that only careful long-time observations can truly establish the worthiness of an ornamental plant and that each individual set of local climatic conditions will force a different selection of first grades.

The labeling of such a display garden, which must be very thorough to attain the end in view, is not an easy problem. The labels must be easy to read, yet not so conspicuous that they give a note to the garden which might spoil its beauty. The possibility of doing away with labels altogether and of displaying instead an outline map of the various groups with the names written in seems to be worthy of consideration.

The annual flower garden: This garden also should not display large and bewildering collections of as many different varieties as can be brought together, but rather should show attractive color combinations of a representative selection of some of the best and most recommendable kinds. The selection of varieties in this garden as well as its color scheme should vary from year to year, and a record should be kept of the combinations which have proved particularly pleasing and satisfactory.

The annual flower garden lends itself particularly well to serve as a sort of show-window display for the garden to attract visitors. At the Montreal Botanical Garden, for instance, it is located in front of the administration building and is oriented in such a manner that it can be freely seen from the street. With three plantings: spring, early summer and summer-fall, it provides a brilliant splash of color all through the growing season, which even passing motorists cannot help but notice.

The water- and bog-garden: With waterlilies and other water- and bog-plants in stone basins, this may be laid out in such a manner that the various basins are raised two feet or so above ground level or, better still, the paths between them lowered accordingly. Observation of the plants then is rendered much easier than when the paths as well as the basins are level with the ground. The so-called sunken garden offers splendid opportunities for the water and bog garden, where one upper path could lead along the basins at ground level, while a lower path on the other side of the basins could bring the plants closer to the eye. If layed out in a formal manner, framed by a planting of tall evergreens, and with the judicious use of Siberian or Japanese iris or other ornamental bog-plants in larger, well-balanced beds or groups, this garden can be made as attractive as it will be instructive.

Drains and water supply are, of course, the most important needs to consider when laying out a series of basins arranged in rows. The drains must be accessible, since the soil in the basins may cause them to get blocked occasionally in spite of all precautions. For water supply it is not necessary to equip each basin with a faucet. In fact, it is preferable to place only one faucet at the end of the row and to supply the water by means of a small channel or gutter, running along one side of the row of basins. From this channel the water enters the basins without pressure through individual openings which may be equipped with a valve for opening or closing. The overflow in each basin must be adjustable so that the water level can be controlled and can be changed as required.

The natural arrangement of such a collection around a pond, which is frequently preferred, has the following practical disadvantages. First, rare and tender bog-plants, especially of foreign origin, can be given much more careful attention and individual care in basins than in the free bog.

Second, the water level in basins can be controlled at will, which is quite impossible in the bog or pond, yet of the greatest importance for the well-being of many plants. Third, half-hardy or tender waterlilies, if in basins, can be grown in tubs which are stored inside during the winter. This is rather difficult in a pond. Fourth, muskrats and turtles show a very annoying preference for rare waterplants which they chew off above the roots. They can easily be kept away from basins, but it is quite difficult to control them in a pond.

The rock garden: Most botanical gardens lay out their rock garden in a natural manner and frequently they achieve very pleasing and attractive results. However, such a natural arrangement has the disadvantage that the best and most desirable varieties lose themselves among the multitude of only botanically interesting species, and it is very difficult for the layman to select from such a planting the forms which are most amenable to cultivation and which will give in his own garden the effect he desires.

Those of the visitors who have observed alpine plants in their native haunts and now would like to see them again in the garden, find themselves baffled by the indiscriminate mixture in which it is impossible to find anything except by chance.

The best solution seems to be to make a strict separation between the natural species of alpine plants—which should be shown in naturally designed habitat groups—and the true rock garden plants (including particularly the newest improved horticultural forms and hybrids) which are displayed to best advantage in a rock garden of formal design.

In the natural groups—for which the term “alpinum” is more appropriate than “rock garden”—a geographical separation into American, Asiatic, and European alpine plants will probably always prove most interesting. Still more instructive is a division into separate mounds on which the distinct alpine flora of the various mountain ranges of the world may be shown. The Alps, the Pyrenees, the Balkans, the Altai, the Himalayas, the mountains of Japan, the mountains of eastern North America and the Rocky Mountains are distinct enough in their flora to render their separate representation interesting, and it is not necessary to attempt to recreate faithfully the plant associations which are typical for certain individual mountains.

To build an extensive alpinum is an expensive undertaking which is not possible everywhere, but every botanical garden should at least make an effort to give as complete a representation as is at all possible of the alpine flora of its own region. Such a collection of native alpine plants, which in each case could be unique, would alone justify the existence of many small botanical gardens.

A formal layout is suggested for the display of the true rock garden plants as a contrast to the alpinum; and, since the plants shown here are suggested for the use of man, it seems only appropriate to display them in a distinctly man-made garden. The irregular and picturesque outlines of most alpine plants offer pleasing contrasts to the straight stone edge of raised beds; besides, viewing the plants for study as well as taking care of them is, of course, rendered much more convenient on straight beds than on mounds of irregular shape.

Mass plantings of certain particularly showy alpine plants in carefully studied combinations should be the feature of such a rock garden but samples of dry wall and flagstone path planting as well as a well-constructed moraine bed and dry scree might also be displayed here.

The arboretum: The arboretum offers the following possibilities for garden-like displays:

1. *The rose garden*, which again should contain a selection of the best and hardiest varieties grouped in attractive color combinations rather than a large collection.

If species of roses are to be included in the rose garden it seems best to select only the most ornamental kinds and to relegate the majority to a hot and stony slope in the arboretum. Most of the rose species require considerable space for full development and many look their best only if planted in groups of more than one of a kind. If these are crowded together on narrow beds they soon assume a weedy aspect and will be a credit neither for the garden nor for their kind.

2. *The spring flower garden*, a collection of the most ornamental of the spring-flowering shrubs and trees, perhaps in combination with spring-flowering bulbs.

3. *The autumn garden*, a collection of the trees and shrubs which are outstandingly attractive and ornamental in fruit or in the autumn coloring of their leaves, perhaps in combination with autumn-flowering perennials. A collection of berry-bearing shrubs which are of importance for bird food in the winter might be included in this garden. The names of the birds which are attracted by the fruits of these shrubs should be given on the label.

4. *The winter color-garden*, a collection of trees and shrubs which are attractive in the winter through their conspicuously colored branches.

These may be included in garden number 3 and may be combined advantageously with some of the berried shrubs which hold their fruits for a good part of the winter. Or they may be displayed in a corner by themselves against a dark green hedge of *Taxus cuspidata*.

5. *The color garden*, a collection of the best of the trees and shrubs with colored foliage.

Much abuse has been heaped by certain landscape architects upon this type of plants of which the red Japanese maple is the most notorious example. The ill favor which these varieties have suffered in consequence for some time past is, however, entirely undeserved, since they become objectionable only if they are employed in the wrong way and especially if they are grouped together with normal green varieties. In proper combination they lend themselves to brilliant effects which will please the most exacting taste yet cannot be achieved in any other way. A botanical garden should have a representation of these varieties anyhow, since it must make every effort to show all the various shapes and forms which plants may assume. Since, like the freakish forms mentioned under number 6, the varieties with colored foliage are too conspicuous to be scattered freely all through the arboretum, they should be grouped together in a garden of their own where, when displayed against a neutral background of dark green evergreens, they will look as attractive as they are interesting.

6. *The form- or freak-garden*, a collection of the weeping, fastigate, and globe-headed varieties of trees and shrubs. These abnormal forms are always best gathered together in a special group or garden-like arrangement, since, if scattered through the general collection, they invariably spoil the pleasing, park-like effect which without them may easily be obtained. Their study is rendered much more convenient if they are kept to themselves, and, besides, it will be possible then to obtain with them very striking or even grotesque garden effects.

7. *The collection of vines*, which may be arranged attractively on trellises or pergolas around one of the above gardens.

The general collections of trees and shrubs should be arranged in such a manner that it will be easy to find any one variety one may be looking for. At the same time the aim should be to give the arboretum a pleasing, park-like appearance and to avoid having it look like an orchard or a nursery.

Since for the sake of clearness and to facilitate the study of the plants it seems absolutely necessary to keep all the species of one genus together, it is desirable, in the interest of appearance, to separate these genus groups clearly from one another by plantings. Where native woods are present, these, of course, will give the best separation, especially if against them and around each genus group a background planting is placed of one particularly satisfactory member of the genus. Where natural woods are missing, the background planting alone has to serve and will then act also in the valuable function of a wind break.

Such a background planting around each genus, consisting of one member of the genus, has the further advantage that it will give each group a somewhat finished appearance from the very beginning. Without it the arboretum will look half empty for a long time, since it is sure to take many years before all the species and varieties which are wanted can be brought together, and since ample space must be allowed for each group to make sure that later additions will never lead to a crowding or a scattering of the collections. With the gradual extension of the collections more and more of this background planting may be removed, to be replaced by plants of additional species or varieties. I suggest, for instance, to surround the oak-group with a background- and shelter-planting of *Quercus borealis*, the maple-group with *Acer rubrum* or *A. saccharum*, the alder-group with *Alnus incana*, the birch-group with *Betula papyrifera*, the spruce-group with *Picea glauca*, the pine-group with *Pinus resinosa*, etc.

In groups of large genera like, for instance, those named above, a subdivision will increase the clearness of the arrangement, and I have always found a separation of the species according to origin into American, Asiatic, and European much more instructive and practical than a grouping according to relationship. There are a few genera, however, like *Cotoneaster* and *Berberis*, in which the species of Asiatic origin are vastly in the majority. In these exceptional cases a grouping according to origin is not feasible and other principles of arrangement, perhaps based on relationship, have to be followed.

Outside of the genus groups which I consider to be necessary, I can see no reason for arranging trees and shrubs in an arboretum according to a taxonomic system. It is of much greater importance that each genus be planted in a place where most of its species will find suitable conditions. If planted in taxonomic sequence, just the opposite will usually be the case. If landscape beauty is considered in the arboretum, as I think it should, a taxonomic arrangement will be found also from that standpoint to be very undesirable.

A number of small genera, of which only one or two species can be grown outdoors, may be brought together in one special group, since, if scattered through the arboretum, they will always be difficult to locate.

Another special group should be made of the trees and shrubs of doubtful hardiness. If these are kept together, they can easily receive any extra care and protection which they may need, and, in case that they should get injured in an abnormally hard winter, they will not disfigure the whole arboretum.

The fruticetum: To gather all the shrubs together in a so-called fruticetum and to reserve the arboretum strictly for trees is rarely possible

and still more rarely desirable. Groups of shrubs form a pleasing and welcome interruption in an arboretum which without them might become monotonous. Besides, as pointed out for the roses, many shrubs require considerable space for proper development. Many of the numerous species of *Crataegus*, for instance, are actually shrubs in spite of their respectable size, and the lilacs, of which a botanical garden surely ought to have a good collection, also need a good deal of room. However, there are a number of shrubs, such as the brooms and most other members of the family Leguminosae; also *Cotoneaster*, *Chaenomeles*, the shrubby species of *Prunus*, certain dwarf forms of *Betula* and *Salix*, the shrubby members of the *Chenopodiaceae* and *Rutaceae*, most species of *Hypericum*, *Tamarix*, *Daphne*, members of the *Elaeagnaceae*, the shrubby *Compositae*, and many others which are very partial to perfect drainage. Where such drainage, which is essential for the well-being of these plants, is not naturally available, it will usually be found expedient to gather them together in a fruticetum on specially prepared, deeply drained beds.

This was done, for instance at the Montreal Botanical Garden where the fruticetum beds were arranged in a series of terraces against an artificial mound of earth, raised originally as a screen against the street. For appearance sake most of the paths were laid out as lawn paths; and, to interrupt the monotonous line of long straight beds, the formal rock garden, mentioned above, was located in the center of the whole arrangement. The rock garden in this position forms a welcome and most attractive point of interest and serves to draw to the fruticetum visitors who might not otherwise venture there.

There are five more garden-like arrangements of plants which have to be considered by a botanical garden and which from an esthetic standpoint present very interesting and difficult problems. They are gardens mainly in so far as the plants they display have to be grown in well-defined beds. In general, I believe that in all five of these gardens one has to put beauty considerations in the background and consider clearness of arrangement above everything else.

The medicinal garden: To show in this garden only those plants which are still in official use will hardly suffice to make such a collection interesting enough to the general public; especially, since it will not be found advisable in a public garden to give explicit directions on the labels as to how and for which ailments these plants are used. To give such explanations might entice people to attempt cures without medical advice which is a dangerous practice and must not be encouraged.

The Montreal Botanical Garden has evolved a scheme for the medicinal garden which is sure to render this section not only most instructive but also highly attractive. This garden here is divided into four parts, the

largest of which, arranged as background for the whole group, contains the plants which the American Indians used for medicinal purposes before they came into contact with the white man. Since the Indians used the bark and leaves of various trees, these trees have been disposed in a sort of grove surrounding an open glade. A small pond and brook have also been constructed. The various herbs and shrubs which the Indians employed are planted as far as possible in their natural habitats, interspersed with other plants from the same habitats which were not used but which help to make the arrangement look more natural. Only the plants which were used medicinally are labeled. A log cabin and totem pole lend local color to the scene. In sharp contrast to this group is the second which represents a medieval cloister garden and which contains in particular all the herbs which according to a decree of the Emperor Charlemagne were to be grown in every garden of his time. The background for this garden is formed by a stone arcade, representing a part of the old cloister. The two side boundaries consist of stone walls with tile roof; the front side has an iron grill fence. The centerpiece of the garden is a stone well. The plants are disposed on formal beds as was the fashion of the times. Parts three and four, surrounded by hedges, contain respectively the medicinal plants which are still in official use and those which are employed as home remedies. These are grouped according to the part of the plant which is used (root, leaf, flower, seeds), but besides this and the name no further information is supplied.

A special group of native and foreign plants which are poisonous and against which the public should be warned may also be included in the medicinal garden, but here again great caution must be advised. Poisonous plants have a horrid appeal to certain people and especially if too complete information is given on the labels the danger of abuse is ever present. Certainly, it would be extremely bad advertising if, during a murder trial, it should be brought out that it was at the municipal botanical garden where the murderer first conceived the idea as to how he might best rid himself of some unwelcome member of his family. Perhaps one might exclude from a collection of poisonous plants all those which can cause death, but even such plants as poison ivy and poison sumac will have to be surrounded by a fence with special warning signs not to touch them.

The economic garden (containing economically useful plants): In this garden also the most satisfactory and most instructive grouping seems to be one based on the part of the plant which is used: The plants which have edible fruits (tomato, pepper, eggplant, cucumber, melon, etc.); the plants of which the roots, root-stocks or tubers are eaten (radish, beet, carrot, potato, Jerusalem artichoke, etc.); the plants of which the leaves are eaten (spinach and salad plants, cabbages and condiments); the plants of which

the sprouts or leafstalks are eaten (asparagus, udo, celery, rhubarb, chard, etc.); the beans and peas; and the grain crops form natural sections. The wild species from which the horticultural varieties have been derived, such as the wild cabbage, the wild beet, the wild carrot, the wild lettuce, etc., must not be forgotten since they permit of interesting comparisons.

This is the scheme adopted at the Montreal Botanical Garden where also fiber plants, oil plants, tinctorial plants, fodder plants, tobaccos, aromatic plants, and native plants used as vegetables by the American Indians have been included. Each group is contained in a separate little garden surrounded by a hedge, yet a round trip, indicated by arrows, takes the visitor through the whole exhibit without forcing him to return on his steps. This garden contains 490 varieties of economically useful plants on individual beds and is extremely popular. All through the growing season it is always crowded with visitors.

Fruit trees and small fruits may be planted around the economic garden as a frame or, as was done at the Montreal Botanical Garden, they may be gathered together in a separate "fruit garden." It is usually not possible, nor is it necessary or indeed desirable in the average botanical garden, to display large collections of varieties of apples, pears, etc.; but all the various types including plum, cherry, apricot, peach, mountain ash, juneberry, medlar, quince, chestnut and other nut trees, hazelnut, raspberry, blackberry, currant, gooseberry, blueberry, etc., must be represented. Of the apples and plums one might show at least half a dozen or as many as a dozen varieties as a recommended selection of the best for the region in which the garden is located. Grapes may be grown on a pergola which offers a welcome ornamental feature for this garden.

As a feature of great attraction and immense educational value in connection with this group might be suggested a vegetable and berry garden on a plot of 50 x 75 feet which would supply a household of four or five people. In such a garden should be displayed only the most recommendable varieties of each vegetable and fruit in well-balanced quantities and in such a manner that full use is made of the garden all through the growing season. A rotation of crops on the various beds from year to year should also be demonstrated.

The morphological or biological garden: This presents a more difficult problem than the two last-named gardens. The object of its displays, which is to demonstrate the life functions of plants, is of the greatest popular interest, and most botanical gardens which have attempted such displays have done so with the intention of interesting the public. However, in all instances that I have had occasion to observe they have failed utterly in this quest. The public simply will not read a technical guide book, and the displays themselves, as carefully and thoroughly as they were

compiled, were too complicated, too detailed, and too intricate to convey any meaning without a thorough study of the guide book.

The only feature that I ever observed as being of general interest was a flower clock which demonstrated the possibility of telling the hour of the day by the opening or closing time of various flowers. The rest of the garden was passed over without even the faintest ray of understanding.

It seems to me that here also the saying can be applied: "A little less would have been more," and that in this garden perhaps even more than in any of the others which I have enumerated, careful selection of what is most essential has to be practised.

It is not at all easy to limit oneself to the most important features in the face of the very wide extent of the field here under consideration and I admit that as yet I have no suggestion for a good solution of this problem. Perhaps the public itself would be the best teacher. It might be possible to develop this garden gradually by starting with only one or two particularly eye-catching features and by adding by and by others which would explain certain problems most frequently puzzling to the public mind. Which these are, might be learned from public inquiries which are sure to come in.

At any rate, and especially if a more complete representation of the subject is desired, it seems to me that this garden should show very clear sectional divisions, each section clearly labeled according to its content, as for instance: Assimilation, Fertilization, Seed Distribution, etc.

The genetics garden is really a subdivision of the biological garden but may be kept by itself. It should demonstrate on living examples the laws of heredity and the principles on which the plant breeder has to base his work. There might also be a display of certain well-known horticultural hybrids together with their parents, or in the case of a multiple hybrid also with their grand- and great-grandparents. For samples of selective breeding the wild species together with the various mutants derived from it under cultivation and without crossing with other species should be shown. The *Crataego-mespilus* will make an interesting feature in this group if the sexual hybrid (*C. grandiflora*) is planted side by side with the graft-hybrid (*C. Dardari*) and if their strange relationship is clearly explained.

The taxonomic garden, the last I mention, is very similar to the biological garden in the problems and difficulties which it offers. If plants which are adapted to very different conditions are to be grown side by side to demonstrate their relationship, they must of necessity have individually prepared beds or even basins. Every bed must be clearly separated, family from family, and genus from genus, which necessitates a multitude of paths. Even if most of the paths are laid out as lawn paths, they will be prominent;

and, since the upkeep of so many lawn paths is very expensive, they are usually covered with gravel; consequently they dominate the whole garden.

Since the size of the families as well as that of the genera varies considerably, and since they have to be grouped together according to their relationship, a formal arrangement which seems to offer the only fairly pleasing solution is very difficult. However, if a compromise on the number of species which are to be displayed can be effected, a formal layout—perhaps with low hedges between the families—should be considered.

Whether one should attempt to display a whole taxonomic system with the majority of its families and genera and a great many species, or whether one might be able to convey a sufficiently clear conception of the principles of plant taxonomy by showing only a few particularly interesting related families, I do not care to propound. Usually the choice of either one method or the other will depend upon the available funds, since the maintenance of such a garden, with its many individual beds, is very expensive.

The general public, I believe, should not be admitted to the taxonomic garden, mainly because the majority of people will not be interested in it, and their admittance would only cause a noticeable rise in the cost of upkeep. The taxonomic garden should be separated from the rest of the garden by a fence, and special permission to visit it might be given for certain hours to anybody who goes to the trouble to apply for it. Otherwise this garden should be reserved for student classes.

A lecture pavilion, possibly located in the center of this garden, should be provided, if courses on taxonomic botany are to be given right in the taxonomic garden.

This list of suggestions for the grouping of plants for the sake of order in large collections as well as for the purpose of increasing the public appeal of a botanical garden by means of attractive garden-like arrangements, long as it is, makes no claim to be complete. There is any number of others which might be considered in regions having a suitable climate, such as, for instance:

A desert garden, to accommodate those plants which live under arid conditions and demand a maximum of sunlight as well as perfect drainage.

An evergreen garden, to contain a collection of the broadleaved evergreens which demand partial shade and wind-protection.

A heather garden which, at least in the United States, finds most suitable conditions on a sunny slope which is watered from above by a

spring or creek. The heathers should be planted in large drifts of each variety interspersed with groups of junipers and various brooms. Large granite boulders skilfully placed will help to make the scene still more interesting and natural.

A rhododendron and azalea garden, for which the most ideal location is a sheltered valley receiving indirect shade from tall trees on the upper parts of the slopes, and with a deep natural accumulation of old leafmould. Where such conditions are not naturally available, artificial shelter may be provided through a screen planting of evergreens, but one must bear in mind that for complete success the following four requirements must be met: Indirect shade, especially towards noon (not direct shade under trees), a slightly acid humus soil, ample moisture and perfect drainage (not forgetting air drainage).

A hedge garden. This would have to be strictly formal, and would contain only clipped shrubs and trees, to demonstrate which are the most desirable plants for hedges of all types and heights. Since not all of the shrubs displayed here need be grown in hedgerows, but since their suitability might be sufficiently demonstrated by clipping them into cubes, pyramids, or square columns, and since there are also some handsome flowering perennials and even some annuals (like *Kochia*) which may be used for summer hedges, such a hedge display garden with its varying shades of green foliage may be rendered very attractive.

There may also be a *Japanese garden*, but it seems to me decidedly not worth while to make this only a weak imitation which is all the average occidental gardener can possibly produce. To lay out such a garden properly one must secure the aid of a skilled Japanese gardener who has been trained in Japan and who understands thoroughly the relationship between the various symbols which have to be employed. If this is done, one will obtain a most interesting sample of the age-old landscape art of the Orient which follows very different principles from ours, and this will then be a distinctly instructive feature in any botanical garden. The most appropriate place for such a garden would probably be in the Asiatic section of the geographical groups where it would serve to add local color. As a counterpart to this one might place in the European section a sample of a typical English sunken garden perhaps along the lines of the famous sunken garden at Hampton Court Park. At the Montreal Botanical Garden we intend to construct in the Canadian section of the geographical groups a fully equipped sugar maple camp as an added feature of interest and instruction.

Other plant arrangements sometimes suggest themselves through particular interests prevailing in certain localities. Of these may be mentioned the following:

Plants mentioned frequently in literature but of which people often have only a very vague notion could be gathered in a very interesting garden. The Shakespeare garden is a specialized edition of this. The same might be done for the plants mentioned in the Bible.

Plants which through the ornamental or symmetric shape of their leaves or flowers have frequently inspired artists and decorators, and especially those which unwittingly we see so often in stylized adaptations in wrought iron or stone ornaments, could form another group.

Plants which figure prominently in certain famous coats of arms or which for other reasons are associated with important events in history may also be brought together.

State flowers or the favorite flowers of the various nations may intrigue others. And so on and so forth ad infinitum.

TECHNICAL EQUIPMENT AND ADMINISTRATION

The above outline may assist in formulating the general principles upon which the functioning of a new garden is to be founded. After these general principles have been agreed upon, the next necessary step will be to work out a detailed program. Such a program must include, of course, all the technical facilities that have to be provided and must co-ordinate these in such a manner that smooth co-operation between the various departments of the garden will be made as easy as possible and that all duplication in the administration can be avoided.

For the planning of a botanical garden and the organization of its administration we shall have to consider in particular the following features and equipment:

1. The necessary buildings, especially the administration building, the power station, and the greenhouses.
2. The nursery with all its working accommodations.
3. The road system within the garden, and its probable traffic.
4. The control of the visiting public by fences and gates as well as by certain necessary rules.
5. The locations of necessary shelter and comfort stations.
6. The public restaurant or tea house.
7. Picnic areas and playgrounds.
8. Children's gardens: for the education of children under the supervision of teachers and of members of the garden staff.
9. The locations of necessary fields for plant breeding and testing.
10. The water system.

11. The sewer system.
12. The tile drainage where needed.
13. Light and telephone.
14. The recording and labeling systems of the garden.
15. The library and herbarium, as far as they have to serve the garden.
16. The seed exchange.

1. **The administration building.** In general it is advisable to curb one's impatience concerning the erection of the administration building and to be content with temporary quarters for several years or until the policies and the program of the garden are clearly established. Even if it is certain from the start that financial conditions will not permit the erection of a large building for some time to come, it is better to plan any administration building that may be erected right away in such a manner that it can be extended later without costly alterations. To permit such gradual extension it is absolutely necessary to plan right away the whole building as it will be eventually and to consider carefully the respective spaces needed, both in the near and the remote future for the following accommodations: Administration offices; library with librarian's office and reading rooms; herbarium with mounting room, sorting room, store-room and shipping room; lecture and conference rooms; information booth with telephone exchange; seed room; labeling room, where the various types of plant labels are made; store-rooms; lunch and rest room for the staff; janitor's quarters; photographic studio and dark rooms; laboratories; display rooms for dry-plant exhibits, etc. If regular courses are to be given at the garden to children and adults, or if professional training of gardeners is to be carried on at the garden, this also has to be decided before the administration building is designed, since quarters will have to be provided for these activities.

The power house. If possible, this should be hidden from sight, yet be near enough both to the administration building and the greenhouses to serve each and all without necessity of over-long conduits.

It must be borne in mind, however, that it is usually more economical to have two power stations than to have very long conduits; and, if for any reason it does not appear to be desirable or is not practical to locate the greenhouse units so close to the administration building that all can be served conveniently from one central power station, one should consider installing an automatic oil heating system in the administration building and to connect the power house only with the greenhouses.

The greenhouses present a very vital and a very complicated problem and must be planned with great care and thoroughness. It would go

beyond the scope of this article to give detailed instructions, or even to mention all of the various points which have to be considered; but it can not be stated too urgently that the building of a really good greenhouse is by no means a simple undertaking, and that one should never attempt the construction of a greenhouse complex without the assistance, or at least the advice, of an experienced greenhouse specialist. No expense should be spared to get the best, since here, probably even more than in most other cases, the best will in the long run be the cheapest. Mistakes which are made in the construction of the greenhouses or in the arrangement of the greenhouse complex can seldom be corrected later and will constitute certainly a permanent and increasingly serious handicap.

With the propagating and cultivating greenhouses, which will always have to be built first, may be connected one or two greenhouses specially equipped for the holding of horticultural courses for adults and children, as well as a greenhouse for experiments in plant physiology and one for plant breeding.

If not at once then certainly in the future every botanical garden will want to have also display greenhouses built specially to accommodate crowds of visitors and to provide instructive and attractive exhibits of plants. Since for practical reasons it will always be desirable to have the service greenhouses and the display greenhouses connected with each other, they should both be planned together, no matter how small the unit with which the first start is made. The design, like that for the administration building, can readily be of such a nature that it can be carried out gradually, yet will provide at every stage of its development a satisfactorily working unit.

Before one can design a greenhouse complex one has to know what kinds of plants are to be grown or displayed in these houses, which means that a scheme for the arrangement and grouping of the plants in the houses has to be worked out.

The most practical and most satisfactory grouping of plants in greenhouses will always be according to the optimum temperatures which they demand. Since several of the larger families of tropical and subtropical plants have one or two very distinct centers of distribution, like for instance the orchids, cacti, ferns, aroids, bromeliads, etc., these may be gathered together conveniently in one or two greenhouses. For instance, one warm and one cooler orchid house; one warm and one cooler cactus house; one aroid house; one bromeliad house, etc. Cacti and small succulents usually have to be protected by special screens, since many visitors cannot resist the temptation of touching or even of stealing them. Where this is to be feared, plate glass panels—in showcase fashion without wooden frame—will provide much more satisfactory guards than the customary ugly

wire mesh. Besides the above mentioned groupings various others are possible, as has been demonstrated admirably by many of the leading botanical gardens of the world. The Botanical Garden of Berlin, Germany, for instance, boasts of a very large tropical house in which, when last seen by the writer, beautiful landscape pictures had been arranged in three extensive groups—Tropical Asia, Tropical America and Tropical Africa. In a similar manner, not necessarily arranged in landscape pictures, may be gathered in separate houses the plants of Australia, the plants of the South of Africa, the plants of the southern United States, the plants of the Mediterranean region, etc. Small annex houses to some of the larger ones are convenient for certain special displays such as: a collection of those tropical plants which show conspicuous movements of any of their parts; the insect-catching plants; a collection of some particularly interesting desert plants, demonstrating their adaptations to the conditions under which they live; a display of those tropical plants such as crotons, caladiums, begonias, etc., which are distinguished by the exceptionally brilliant coloring of their leaves, and so on. Collections of those tropical and sub-tropical plants which are of economic importance or of medicinal value should also be brought together in special greenhouses.

A cool greenhouse set aside for a continuous display of flowering plants which figure in the florist trade: the chrysanthemums, camellias, primulas, cinerarias, etc., as well as a special house which contains a display of tropical water and bog plants, is found in almost every botanical garden.

An aquarium exhibit with aquaria built into the walls and displaying a good collection of submerged tropical water plants together with some easy-to-keep tropical fishes can often be accommodated in the basement of the *Victoria regia* house. Such exhibits are much too rare in botanical gardens, yet are not expensive to maintain and are distinctly worth while.

A special exhibit of the most satisfactory foliage plants for the living-room or sun-parlor, which are always of particular interest to the visiting public, should also be provided.

A small lecture room seating about one hundred people will be found very convenient to have in direct communication with the display greenhouses. When groups of people are to be taken through the greenhouses under guidance they can be assembled in this room for some preliminary explanations which will enable them to understand better what they are about to see. The basement of one of the greenhouses will often provide suitable space for such a lecture room.

For cultural success it is desirable to have for every type of display house also one or two corresponding cultivating houses where the plants can be prepared for the display and where they can be brought back after

the display. Thus they will receive the individual care which it is impossible to give them in the display house, and which they need particularly after having been repotted or while they are at rest. It should be the policy of every garden to exhibit in the display houses only good healthy specimens of each kind of plant. As soon as a plant shows signs of sickening, it should be taken back to the cultivating houses, where it may receive the care needed for its recovery, and where replacements must always be kept on hand.

Since there will, therefore, be frequent transportation of plants from the cultivating greenhouses to the display houses and back, the two groups should be connected with each other by a covered passage.

The propagating houses may well be connected with the cultivating houses and this whole complex should be adjoined immediately by the nursery, where hardy plants are grown in nursery rows or in beds. The more compactly all of the working accommodations can be arranged, the more smoothly will the various departments co-operate and the more easily can the whole organization be controlled.

2. The nursery, therefore, is the place also for the following units:

- a. A series of cold frames, substantially built of concrete, some of which may be equipped with electric cables for heating.
- b. A lath house for the raising of various plants which need shade.
- c. A root and plant storage cellar.
- d. A refrigerated room equipped with shelves for the after ripening of seeds (should be kept at a temperature of 32-34° F.).
- e. A storage place for soils, of which are needed peat, sharp sand, cow manure, horse manure, leafmould, sod-soil; and for rock garden purposes granite gravel and crushed limestone. Manure soil, sod-soil and leafmould need several years to ripen, therefore, several piles of them have to be provided for, and a new pile of each of them has to be started every year.
- f. A shelter building for various kinds of machinery, such as trucks, power-sprayer, tractor-and-plow, lawnmowers, motor cultivator, tree-mover, pruning apparatus, roto-tiller, etc. Here also should be kept a reserve supply of garden tools.
- g. A steam sterilizer to sterilize soils, pots and plant boxes.
- h. A work room or machine shop, which may immediately adjoin or be connected with the power house.
- i. A carpenter, painter, and glaziers' shop.
- k. A toilet and washroom for the workmen.
- l. An office for the greenhouse head gardener and for the outdoor head gardener.

- m. A rooming and boarding house for the permanent gardeners, if the location of the garden makes this desirable. Where this is not included in the scheme of the garden a locker room for the gardeners in which they can keep their clothing and personal tools and where they can eat their lunch, should be provided.
- n. If a university or schools have to be provided all through the growing season with living plant material for demonstration, it is desirable to include within the nursery a special planting of such trees and shrubs as are regularly wanted, so that the specimen plants in the collections of the garden need never be disfigured for this purpose. Such a planting may be arranged as a shelter belt around the nursery.

Ample space—5-10 acres or even more—should be allowed for the nursery so that crowding at any time will be avoided. The woody plants particularly should be planted in blocks, as they are in every commercial nursery, each block to be moved in its entirety every second year. During the first years, and as long as the nursery contains extensive collections, it will be found most convenient to arrange the plants in each block in alphabetical sequence, or, at least, to keep the species of each genus together. To do this appears at first to be a very difficult job, but the time and trouble which such an arrangement will save later on repays many times for the initial effort.

For the small quantities of each kind of plant which a botanical garden usually will want to raise, it has been found to be most satisfactory to pot the young plants as soon as they are ready to leave the seedpans. They will then spend their first winter in the cold frames, and in the spring these potted plants can wait until all other transplanting in the nursery is finished, since from the pots they can be transplanted safely at any time. When finally these young plants are lined out in the nursery, their being in pots will render an alphabetical arrangement very simple.

The thorough preparation of the soil in the nursery, the starting of a soil supply, and the building of a series of cold frames will always have to be among the first things to be considered when a new botanical garden is being started.

3. The road system. including the footpaths, of a botanical garden should always be as well defined and as simple as possible, so that everybody can find his way with few directions. Roads as well as paths always should lead somewhere, and there should not be more roads or more paths than are absolutely necessary to make all points readily accessible. The best road system will probably always be the one which employs several distinct types of roads, certain types forming their own system. For instance, there might be one wide avenue, providing a round trip or a trip through

the length of the garden. That would be the backbone of the road system. Then a system of secondary roads, some of which might also be built as wide paths to be used as roads only in one direction and only by the light trucks or other vehicles of the garden. Then two or three types of paths, each type marked by a special style of gutter or distinguished in some other manner. Road maps, displayed on well selected spots, and marking the spot on which one stands, will further facilitate orientation in large gardens.

Where several main avenues have to be provided, each of them might be planted with a different kind of tree which will assist visitors in orienting themselves. One might also consider arranging along the main roads a special display of all the kinds of trees which are suitable for street or avenue planting. In that case the most pleasing results will probably be achieved if one keeps the genera such as the oaks, the ashes, the lindens, etc., together and if they are not planted in avenue rows but rather in groups of 3-5 plants of each kind.

Automobile traffic, especially through traffic, which enters at one end and leaves at the other, is extremely undesirable in a botanical garden, since it renders the control of the visiting public very difficult, if not impossible. In gardens of less than 300 or even 400 acres extent, public automobile traffic should therefore be excluded, though ample parking space will have to be provided in the immediate vicinity of the main gates. Special permission to drive through the garden may be granted in exceptional cases or to privileged patrons or members of the garden. In larger gardens, too extensive to be covered afoot, cars might be allowed only on the main road system, where they may travel only in one direction around the garden. All cars should then be required to check in when they enter and check out when they leave. Several parking places within the garden and near the most frequently visited features will have to be provided, while all parking along the roads should be prohibited.

4. The control of the visiting public. At once the main protection against vandalism and the best measure of control of the public in the interest of the visitors themselves is a strong encircling fence. The entrances to the garden should be very carefully planned, and the fewer entrances there are the easier will be their control. The gates should be constantly guarded during the day and should be closed by nightfall. Most European botanical gardens exact an entrance fee, at least on certain days of the week, and increase their guards on the free days. The writer feels that also here in America serious consideration should be given to the levying of a small admission fee. This charge may be so small that it could hardly be counted as an income for the garden, but it would tend to exclude that type of visitor who comes only to loiter and amuses himself by doing all kinds of

wilful damage. For the same reason a garden should establish an age minimum for unaccompanied visitors—say fourteen years, requiring younger children to be accompanied by adults responsible for their conduct.

5. Comfort stations. In a botanical garden of several hundred acres extent it will always have to be considered that eventually a number of shelter pavilions, perhaps in connection with or near comfort stations, will have to be erected. Though it may be impossible to build any of them in the beginning, they should be provided for in the general scheme, and their locations must be determined.

6. Public restaurant or tea house. Zoological gardens nearly always include a restaurant—or sometimes even several—in their general scheme, while in botanical gardens restaurants are unfortunately rare. This is probably a remnant from the old attitude which did not invite the general public; certainly the need for a restaurant is just as great in a modern botanical garden as in any other large public park. Such a restaurant, if located in a particularly pleasant spot, will form a welcome focal point to which visitors will gravitate for refreshments after having made the tour of the garden.

7. Picnic and playgrounds. Few botanical gardens include picnic and playgrounds in their layout but those who don't usually have to regret the omission later. Children will always feel tempted to play hide-and-go-seek in the alpinum or football in the arboretum. If they are chased away from one place they will continue their game in another and will do much damage to the plants wherever they go. This situation is always difficult to cope with unless there is a well equipped playground to which the children can be turned. The same principle applies to the picnic grounds. In a large botanical garden people want to spend most of the day. At noon they will sit down anywhere on the lawn, scattering their newspapers and other refuse about, as unfortunately city people usually do wherever they sit down. Again it will be a problem to suppress this practice unless a picnic ground has been provided, with tables and benches, shelters and comfort station, running water and perhaps fireplaces. There most people will then go by themselves because of the conveniences which are offered, and the others can be sent there.

8. Children's gardens. During the last twenty-five years or so an ever-expanding movement has developed to connect the nature study given in the public schools with instruction in gardening. Many of the larger cities in European countries have such so-called school-gardens, where a large field is provided on which either the children have their individual beds or communities of children, consisting usually of the pupils of one class, maintain small gardens. Such a European city school-garden usually provides, besides the land for the children's gardens, such instructive

displays as an ecological arrangement of the most common wild flowers of the vicinity, or a pretty flower garden. Here also the city school gardener raises a supply of such flowers and plants as the city schools require regularly for demonstration in their botany or art classes.

A city botanical garden should consider carefully whether it should not provide for such children's gardens. When it can readily spare the land, such an undertaking will always be found much worth while. That it can be done successfully in America has been demonstrated admirably, for instance, by the Brooklyn Botanic Garden, which offers courses of practical and theoretical instruction not only to the gardening children but also to teachers who wish to have training in the supervision of children's gardens.

Such children's gardens, if they are to be included, will probably best be located in some far-away corner of the garden so as not to interfere with other activities. They will then have to be provided with their own facilities, as a shelter building, etc., of which the Brooklyn Botanic Garden also offers excellent examples.

9. Plant breeding and testing fields. The unique opportunities for plant breeding which the plant collections of a botanical garden offer should be utilized to the full. There are a great number of special experiment stations for the breeding and improvement of plants of economic importance, such as vegetables, grains, fruits, and even forest trees, but only few devoted to the breeding of ornamental plants. Without realizing it, the American public has been quite content with mediocre varieties. Such widely known garden plants as phlox, michaelmas daisies, heliopsis, and others which are based on native North American species had to be developed in Europe and come back to us from there. Bred for European climatic conditions, these varieties do not succeed as well in America as they do in Europe. There are innumerable other native American plants, now being casually passed by on the roadside, which are only waiting for a plant breeder with vision to provide us with truly American garden flowers of surpassing beauty.

The plant breeding and testing fields have to be classed among those features which, in a garden developed gradually, are best planned for a later extension. They need not be connected with the nursery, but as they will have to use some of its facilities they should, if possible, be located not too far away.

10. The water system. If at all feasible, a botanical garden should have its own water system, supplied by its own wells. Large cities frequently treat their water chemically to purify it for drinking purposes, and certainly untreated water is preferable for plant growing. In regions where droughts or water shortages occur from time to time it is, of course, particularly important for a botanical garden to have its own safe supply.

All through the garden a carefully planned pipe system with hydrants and faucets must supply water wherever it is needed. The alpinum especially must not be forgotten and there, if possible, an overhead sprinkling system providing a fine mist-like spray should be installed. Also for certain sections of the nursery one should consider the provision of overhead sprinklers. Through labor-saving and efficiency they will quickly pay for the initial cost of installation. In regions which have so-called hard water, a rain water supply, particularly for the greenhouses, is also of the greatest importance. The rain water may either be led from the greenhouse gutters directly into basins under the benches of the houses, or it may be collected in large tanks and then be supplied to the greenhouses under pressure.

11. The sewer system is quite as needful as the water system and must also be worked out in detail before the construction of the garden is commenced. For the proper drainage of roads, the drainage of water basins, the plumbing equipment of comfort stations and all other buildings, including of course the greenhouses, a thoroughly efficient sewer system is all-important. Also for public drinking fountains, so often omitted in botanical gardens and yet so important for a truly public park, a sewer connection must be provided in the very beginning of the construction. Later on their installation may necessitate the tearing up of roads and the destruction of established plantings which may render the expense prohibitive.

If the prevailing subsoil condition presents a problem, large display greenhouses sometimes require special sewer facilities which have to be considered before their location is permanently fixed on the general plan.

12. Tile drainage. If ill drained areas are included in the park they may often be rendered fit for cultivation through a carefully designed system of tile drains ending in a gully which is connected with the sewer. Any such places which are to be improved with artificial drainage must be spotted and marked on the map before the final plans are drawn up, since trees must not be planted closer than 40 feet to any of the tile drains. Their roots will otherwise quickly find and clog the drains, rendering them useless. Some of the feature gardens mentioned in the first part of this paper can readily be accommodated in such artificially drained areas.

13. Light and telephone. To illuminate the whole garden at night is quite impossible, not only because of the enormous expense and because of the hideousness of the forest of light poles, but also because one can never hope to light up sufficiently all the dark corners. A botanical garden must be closed at nightfall since to permit the people to enter at night would invite prowlers and could only result in much unpleasantness. Only the approach to the administration building should be lighted when evening lectures are given, and the comfort stations and other buildings should be equipped with electricity which may be needed on dark days. Telephone

connections to the various parts of the garden, for instance to the comfort stations and the gates, will always be a great asset—if they can be provided—since they will make possible quick reports to the administration building in case of an accident or other emergency. Since telephone and light lines are always very unsightly they should be put into underground conduits; and again it has to be emphasized that such a scheme must be thoroughly considered before the garden is constructed. Certainly it will cost many times more to build such conduits after the roads and the plantings have been finished.

14. Record and labeling system. The great importance of keeping complete records of the plants which are cultivated in a botanical garden cannot be over-emphasized. To maintain them a special department for labeling and recording has to be organized, of which one intelligent gardener should be in permanent charge. As need arises, he must receive help which, especially during the vacation months, can usually be obtained cheaply through the employment of some students of botany or horticulture.

The procedure of recording works about as follows: Each lot of seeds or of plants should, when received, be given a number, which should always be carried on the labels of these plants. The card in the index to which this number refers should give a complete story of all that is known about this particular lot of plants, and this information must be constantly kept up to date, as long as any of these plants live. For this end the gardeners who are in charge of the various sections of the garden must be required to turn in every year a report on the plants which have died in their sections, stating the cause of death as far as it can be ascertained. A complete record card should read about as follows:

Nursery-number 1586-33.

Hardiness-Zone V.

Garden-number 295.

Name: *Malus baccata mandshurica* Schneid. (came as: *Pyrus baccata mandshurica*).

sds. received from Experimental Farm, Kirin, Manchuria, Febr., 1933.
sown: April 20, 1933.

germinated: Febr., 1934.

14 plants in nursery, Block A, row 24, spring, 1936.

5 plants planted in *Malus* group, spring 1938.

3 plants planted in spring garden, spring 1938.

2 plants planted in nursery (border for cutting) 1938.

1 plant given in exchange to . . . 1939.

1 plant given in exchange to . . . 1939.

2 plants in *Malus* group chewed badly by rabbits, replaced from nursery spring 1939.

Of the arboretum, pinetum, and other tree plantings, large-scale maps must be drawn on which the location of each tree is plotted and the record number of each tree is given. Also of the plantings of herbaceous plants in beds, detailed maps which give the record number of each variety must be prepared as soon as the bed is planted and must be continually kept up to date. Of the nursery a typewritten inventory of the plants in each row must be prepared every year and kept on file. Only in this manner is it possible to prevent the loss of records from which most botanical gardens suffer. It need hardly be said that the recording and labeling department must receive the constant and careful supervision of the curator of the garden; and no label should ever be displayed in any part of the garden which has not been carefully checked for misspellings and other mistakes.

15. Library and herbarium. The library of a botanical garden, so far as the garden itself is concerned, need not be a collection of rare editions, but it must contain a good selection of the reference books which are needed for the work of the garden. Such a garden library would probably best be located in the administration building and be made accessible only to members of the staff and privileged students. These two groups should also have exclusive use of the herbarium, which above everything else should contain *complete* specimens—flowers, fruits, leaves, rhizomes and rootstocks—of all the plants which are cultivated in the garden. Care should be taken that every herbarium sheet bears the record number of the plant from which the specimen was taken, so that it may be traced to the card index for further information. Since it is of interest to know how soon after planting or at what age each variety produces its first flowers, it should be the aim from the beginning always to collect specimens from a plant when it flowers for the first time, and this information should be recorded on the herbarium label. A few specimens of seedlings which are raised in the garden should always be preserved in the herbarium in the stage when they show their first true leaves. Not only is it frequently important to make sure of the identity of a plant while it is still very young, but a herbarium of seedlings is also of great value for comparative study, and such specimens are far too rare in all herbaria.

An effort should also be made to obtain good wild-collected herbarium material of all plant species and geographical varieties which are cultivated in the garden. For these it is particularly important to have the collectors take careful notes as to association and climatic conditions under which the plants were observed to grow naturally.

Seed collection. The herbarium of a botanical garden should also contain a seed collection for comparative study as well as for reference, and this should be as complete as it can be made. Particular attention should be paid to the seeds of the plants which are in cultivation in the

garden; and, wherever possible, a sample of the seeds which are sown in the garden should be preserved. The label should bear the record number which this lot of seeds—and later the plants which are raised from it—bears in the garden. As soon as the plants of this number reach flowering age and can be definitely determined, the seed sample in the collection must either be marked as true to name or its naming must be corrected. Such an authenticated seed collection is of immense practical usefulness.

16. Seed exchange. The botanical gardens of the world have been exchanging seeds among themselves for many, many years. Every year they publish a list of the seeds which they have for distribution, and of this list they generally send two copies to each of their correspondents. All that one needs to do then is to mark in one copy of the list the varieties of which one would like to have seeds, and to return it to the sender, keeping the second copy for reference. Usually the orders will be filled in the order of their arrival—first come, first served—so that late comers will find the supply of seeds, which is never large, partly exhausted. For this reason it is advisable always to return the seed lists without delay. No seeds ever are sold by these botanical gardens, but the seed exchange is free and open to anybody who in his turn is willing and ready to distribute seeds of interesting plants gratis. One of the first things a new botanical garden should do, therefore, is to get listed on this seed exchange, since here is its chance to obtain in a very short time an excellent collection of plants at very low cost. The only expense is that caused by the distribution of seeds, and that is almost negligible. There is usually hesitation on the part of a new botanical garden to enter this seed exchange; the argument against it being that it has as yet no plants of fruiting age from which seeds could be offered. However, there is such a constant demand by all botanical gardens for wild-collected seeds, especially of North American plants, that this argument need not be a deterrent. In fact, botanical gardens of Europe have frequently stated that they find it more difficult to obtain seeds of the less common North American plants than of plants from Mongolia or Siberia or other out-of-the-way places. Naturally, a new botanical garden will always want to make first of all a thorough survey of the flora of its immediate vicinity, and will want to collect seeds of the plants native to its region for its own use. To offer seeds of the more interesting of these plants for distribution is small additional trouble, yet this will not only serve to make many friends for the garden, but will constitute a real service to botanical science.

Such an exchange list need not be large but it must be interesting. Also, later on, it should be the policy of a botanical garden not to include in the exchange list seeds of common cosmopolitan weeds, but to offer only such varieties as might be of interest to others. Seeds of garden hybrids which do not come true should be strictly excluded from the

exchange list. Certain species of plants if grown in close proximity to near relatives are almost sure to cross-breed and to produce hybrid offspring. These must either be omitted from the seed exchange list or it must be stated whether or not precautions were taken to prevent hybridization. It must be borne in mind that a short but interesting seed list is not only much more valuable to others but also much more economical to the garden itself than a long but worthless list.

For the drying, cleaning and storage of the seeds collected in the garden or from the wild, either for the garden's own use or for distribution, a special seedroom should be provided in the administration building. This room must be equipped with shelves for drying, large tables for cleaning and sorting, and cases with small and large drawers for storage. The seed collection mentioned under "Herbarium" may also be kept in the seedroom; or one may make two separate collections—one of small samples between glass slides for herbarium work and another of larger samples kept in glass bottles in the seedroom.

When the program for the garden has been completed and from the above outline those features have been selected which are to be included in the final scheme, we are finally ready to turn to the designing of detailed maps.

For this it is necessary first of all to know the ultimate extent of the garden. If not all of the land is available at once—as is frequently the case—it must at least be definitely settled which of the surrounding or adjoining parcels of land will be added later, and arrangements must be completed for the reservation of this land.

Then a topographical survey as well as a soil survey to a depth of six feet must be made of the whole grounds and the local climatic conditions must be carefully studied from weather report files.

With all these data prepared one should design a general map for the whole garden as it will or might be eventually, even if this means looking far ahead into the future. It is not often possible to construct a botanical garden in its entirety in one continuous operation. Usually a start is made at first only on a few acres of land with one or two propagating greenhouses, a nursery, and the nucleus of an administration building; and the layout is gradually extended as more funds become available. However, no matter how small the beginning, it must fit into the general scheme and every part must be started in such a manner that without change of location it can be developed by stages into its final shape and size and yet function

satisfactorily at all times. Such planning will not only make future extension more economical but it will also assist in the obtaining of funds for further construction. Naturally, one will want to have within the first section that is to be developed some of the most attractive features in order to enlist the interest of the public. That necessity has to be considered in the design of the general plan. But, it means inviting mistakes and courting failure, if only that part is designed on which the development is to start, leaving the consideration of later extensions to the future. This appears so self-evident that some readers may wonder why so much emphasis is placed on this point; but, when viewing the existing botanical gardens critically, one frequently observes mistakes, and sometimes very serious mistakes in their general arrangement, which in most instances can be traced to the initial lack of systematic planning.

In summing up it may be stated that to reach perfection in as complicated an organization as a large botanical garden is probably beyond human power. However, it is possible to come near to perfection by careful advance planning and by smooth co-operation of all those who have to contribute their work to the ultimate success. The scientific director, the technical director and the architect are, of course, the key figures, but even none of them must try stubbornly to impose his own will. They must be able to discuss intelligently every problem as it comes up and must be ready to consider it from all sides. With them there will be any number of helpers in various capacities, every one of whom should be given a chance to voice his opinion and to make suggestions. The simple workman sometimes can make valuable suggestions concerning small details on which he is working, and it is distinctly worth while to listen to him. If everybody is given credit for the suggestions he makes, all will soon be eager to contribute their best efforts and will come to look proudly upon this garden as their own achievement. That is the spirit to create and to cultivate if one covets near-perfection.