

LILY BULLETIN

~ 1941 ~



THE AMERICAN HORTICULTURAL SOCIETY
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Prepared for the Society by The Lily Committee under the direction of the Chairman.

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Lily Culture

Three years ago the Lily Committee of the American Horticultural Society was organized for the purpose of promoting the culture of lilies in the gardens of North America. The general plan was to set up an organization after the pattern of the Lily Committee of the Royal Horticultural Society which would not be too formal in its organization and would stimulate interest through publication of its yearbooks and holding of annual field days. To date, two yearbooks have been published and two field days held. The purpose of the present BULLETIN is to make available to amateur gardeners the latest and most essential information regarding lily culture in the garden in the hope that with a better understanding of this group of plants and their requirements greater success can be attained. There are, of course, a number of good books on lily culture and the Lily Yearbooks of the Royal Horticultural Society and the American Horticultural Society. There is also much information of technical nature that is available in scattered publications. The value of this BULLETIN, therefore, is that it makes more readily available the essential facts of lily culture in as simple a way as possible and still be useful and practical.

WHAT ARE LILIES?

This BULLETIN is concerned only with the true lilies belonging to the genus *Lilium*. The word "lily" as commonly used includes a great variety of plants in no way related to each other. Among these may be mentioned the day lilies (*Hemerocallis*), the water lilies (*Nymphaea*), a number of genera in the Amaryllis family, and nearly 50 other less commonly known kinds of plants.

The best distinguishing characteristic of the true lilies as a group is the nature of the bulbs. These are of various shapes and sizes, but in all kinds are made up of fleshy scales which over-lap each other like shingles. They are thus quite different from the tunicated bulbs of the tulip and narcissus, and from practically all other sorts of bulbs. In a few of the North American lilies the scales are not much flattened and terminate a short rhizome or underground stalk. These bulbs do, however, fall into the general description of scaly bulbs. *Lilium pardalinum* and some other west coast lilies have bulbs of this kind. Another characteristic of the true lilies is the position of the six floral parts (sepals and petals) which are inserted below the pistil which develops into the seed pod. The ovary is thus superior as contrasted with the plants of the Amaryllis family in which the floral parts are attached at the top of the ovary.

The genus *Lilium* is very large and diverse, consisting of nearly 100 species and several times that number of botanical varieties and clones. Their natural range covers almost the entire northern hemisphere from close to the Arctic circle down to the tropics. They are found in all manner of habitats from dry, hot plains and rocky slopes to swamps and in many types of soil.

It is little wonder then that when the gardener tries to bring together lilies from this wide range of climate and habitat that conditions are not always suitable for all.

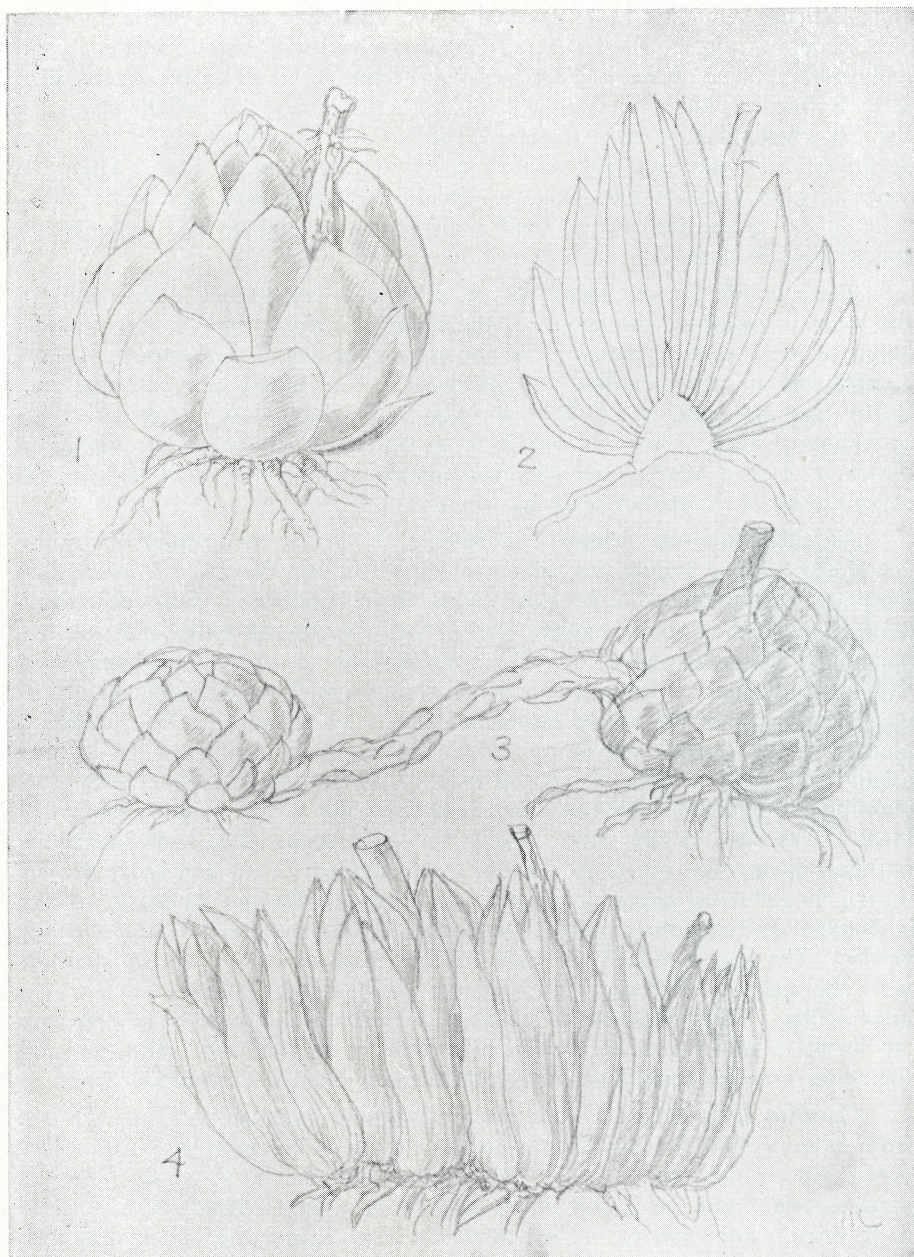
Most species of lilies do not have common names that are distinctive. A few kinds like the Madonna Lily (*L. candidum*) and the Tiger Lily (*L. tigrinum*) are well known. Adequate designation of most of the others, however, requires the use of the Latin names and anyone really interested in lilies should accept the slight task of becoming familiar with these.

The many species and varieties of lilies fall into several natural groups according to the nature of the flowers and their growth habit. Within the genus *Lilium* two sub-genera are recognized. One includes the cordate leaved lilies (*Cardiocrinum*) with only two species, neither of which are grown to advantage in American gardens. The most striking is *L. giganteum*, the giant lily of Himalaya. The other sub-genus includes the true lilies (*Eulirion*). This sub-genus is further divided into 4 main groups—(1) the trumpet lilies (*Leucolirion*), including the familiar *L. regale* and the Madonna Lilies. (2) the bowl-shaped lilies (*Archelirion*) including only the Gold-banded Lily of Japan—*L. auratum*. (3) The up-right flowered lilies (*Pseudolirium*) including the candlestick lilies and many of the common garden hybrid types of the Umbellatum-elegans group. (4) The Turkscap lilies (*Martagon*). In this group are most of the North American sorts such as *L. superbum* and other common garden plants such as the Tiger lilies and *L. Martagon*. Of course, it is impossible to consider this great genus in any detail in this BULLETIN and attention will be given only to the more readily available and easily grown sorts.

PROPAGATION

Few plants are capable of being propagated more easily and by more methods than are lilies. If bulbs are favorably located in the garden they increase naturally by division of the main bulb. This is particularly true of such sorts as the Madonna lilies, *L. Hansonii* and especially *L. pardalinum*. Some kinds, notably *L. Willmottiae*, *L. Davidii* and *L. Wallacei* send out underground stolons which form bulblets at some distance from the mother bulb. On the other hand, some other kinds may multiply very slowly as for example, *L. Brownii*. As a matter of fact, with most species a good indication of whether or not lilies are in a favorable position in the garden with congenial soil and drainage is their capacity to increase from bulb division. Under unfavorable conditions even if disease is not a factor bulbs become gradually smaller and the plant disappears.

Another important source of bulb increase in the garden are the bulblets which form at the base of the stem just under the surface of the ground, on nearly all species, particularly those which are planted deep. These small bulbs can be dug out in the fall and replanted, and with many kinds will produce flowering bulbs within two years. This natural tendency to form bulblets at the base of the stem may be taken advantage of with practically all species of lilies by jerking out the stems shortly after blooming and heeling them in for the rest of the season. The stems with the leaves upon them are jerked from the bulbs with a twisting motion and the lower third buried in well drained



Types of Bulbs.

1. Ordinary bulb showing remains of last year's flower stalk.
2. Section of same showing diagrammatic structure.
3. Stoloniferous bulb showing lateral stolon and new bulb.
4. Rhizomatous bulb showing four years' growth, the youngest portion at the left, the oldest on the right.

soil. If many stems are to be handled in this way they can be put in a trench at a 45 degree angle. One layer of stems is covered with several inches of soil and another layer of stems placed on top of these and in turn covered with soil. Bulblets in large numbers will form on the buried part of the stem. In the fall when the tops have withered, the base of the stems can be dug out, separated from the tops and planted in nursery rows or in beds. The stem bases with the small bulblets attached should be buried about two inches deep. After growing one season, the small bulblets can be dug up and replanted in spaced rows or beds.

Small bulbils are produced on the stems of a few species in the axils of the leaves throughout the length of the stalk. *L. tigrinum* is a common example of such bulbil production. In the same class are *L. bulbiferum*, *L. Sargentiae* and *L. myriophyllum* (sulphureum). The bulbils are collected just before they are ready to fall from the plant and planted out in nursery rows or frames at once. They will usually send up leaves and grow into blooming plants in 2 or 3 years. The gardener should realize that such bulbils will carry mosaic if the parent plant has mosaic.

Another important means of increasing lily stocks very rapidly is by the use of scales. For scaling the bulbs are dug as the last flowers are fading and the outer scales removed by breaking them off the basal plate. The mother bulb may be reduced to about one-half the original number of scales and then replanted in the garden where it will recover and bloom again. The scales may then be planted out in some friable sandy soil in a well drained position. Placing them in a somewhat raised Dutch bed may be an advantage. The scales are planted in rows buried base down concave side up about an inch to an inch and a half deep. The beds should not be watered during the first few weeks after planting and excessive moisture may cause the scales to rot. Small bulblets will form at the base of the scale, usually two to a scale. The beds should be mulched during the winter to prevent frost damage. They can be grown on during the following season at which time the small bulbs may be nearly an inch in diameter and can either be left there for an additional season or planted in the garden. The time required for scale bulblets to reach flowering size depends upon the species. With many sorts blooms can be expected in the third season after scaling. Bulbs may also be scaled in the fall and the scales held over winter buried in sand that is barely moist in a storage or root cellar. In the spring the scales with the small bulbs attached can be planted in the outdoor beds.

Growing lilies from seed has many advantages because seedlings are free from mosaic. The time required to produce bulbs of blooming size from seeds varies greatly with the species. Some kinds such as the Formosa Lily (*L. formosanum*), and the Easter Lilies may be brought to flower from seed 15 to 18 months after sowing. A few require a much longer time, so long in fact, that it is usually not practical to attempt growing them. *L. giganteum*, *L. Martagon* and *L. monadelphum* are of this class. Although this advice is sound, it may be ignored by all good gardeners. For the most part raising lilies from seed is not difficult if a few essential practices are observed. These are (1) a suitable soil mixture, (2) adequate and continuous moisture supply at least until the plants are well started, (3) partial shade to protect the young plants

from the direct rays of the sun, (4) spraying to prevent damping-off and *Botrytis*, (5) adequate weeding or summer mulch, (6) adequate mulching over the winter in the north. Many lilies have seeds that germinate readily, sending up a green grass-like leaf a few weeks after planting. Among these are *L. formosanum*, *pumilum*, *regale*, *amabile* and about 20 others. In another group, however, the seed germinates below ground and forms a small bulblet the first season which must be chilled, usually over winter before the sprouts will appear above ground.

The soil for growing seedling lilies should be friable and fairly rich. Good success is obtained by using composted loam soil containing considerable well rotted cow manure. This may be difficult to obtain and a satisfactory mixture can be made of one part sand, one part loam and one part granulated peat or muck. Such a soil should be mixed well with a commercial fertilizer such as 5-10-5 at the rate of about 1 measuring cupful to the bushel. Of course, leaf mold or well rotted manure may be used if they are available. Soil sterilization is a decided advantage but can usually not be done by the amateur.

Seedlings may be grown either in flats in the greenhouse or cold frame or in the open field. Seeds of species that send up shoots the first season can be planted in early spring in flats or cold frames in the well prepared soil described above. The seeds may be planted in rows or broadcast over the surface. Scarce or valuable seed may be carefully spaced in the flat with a spotting board.* Seeds should be covered $\frac{1}{4}$ to $\frac{1}{2}$ inch deep with finely sifted mixture of $\frac{1}{2}$ sand and $\frac{1}{2}$ muck or granulated peat.

After germination the lily seeds must not be allowed to dry out at any time. In hot, dry weather it is therefore essential that the plants be watered daily and that at all times the young seedlings should be protected from the hot sun. A lath shade over a cold frame or a covering of light cheese cloth is satisfactory. On dark days and the times of excessive moisture the shade may be removed to allow for better aeration as under excessively moist conditions the shade favors the development of *botrytis* and damping-off. In the young stages of growth before the first true leaf is formed the seedlings are particularly susceptible to damage from disease.

Damping-off is controlled by dusting the soil thinly with copper carbonate. This should be done just as the seedlings appear above the surface of the soil. Applying copper carbonate with a salt shaker is a satisfactory method. When the seedlings have their first leaves and before signs of *Botrytis* appear the beds should be sprayed with Bordeaux mixture prepared after the manner described later in the BULLETIN.

The plants, of course, should be kept reasonably free from weeds and during the first winter flats or the seed beds should be covered with a mulch of clean marsh hay, straw or shredded peat. The beds should be examined during winter to detect the presence of mice, as these rodents may become very troublesome under a mulch and may destroy large quantities of bulbs. The mice may either be trapped or poisoned.

When the bulbs have attained a size of $\frac{1}{4}$ " to $\frac{1}{2}$ ", which will occur at the

*See American Horticultural Society Yearbook, 1940, for details.

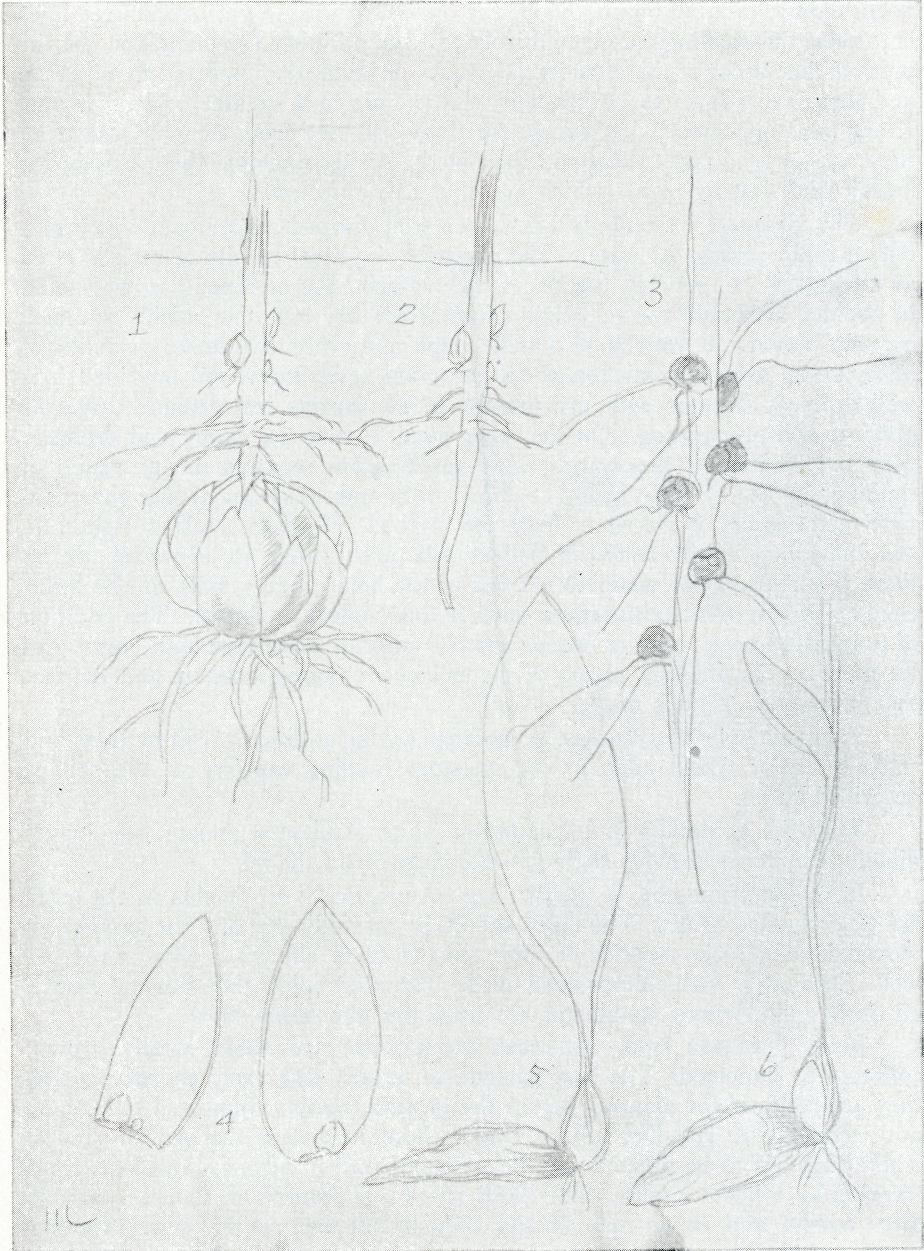
end of the first or second growing season depending on the species, the bulblets should be moved from the flats or seed bed and planted either in nursery rows or Dutch beds in well prepared soil. In the beds the bulbs may be planted about 2 inches deep spaced 4-6 inches apart in the rows with rows 8 to 10 inches apart. Transplanting from the seed bed may be done either in the fall or in the very early spring. It is possible to handle the plants when they are not dormant if care is used not to bruise the roots and leaves. After growing in the nursery beds for one or two seasons the bulbs are large enough to transplant to their permanent positions in the garden. In any case the nursery beds should be mulched during the winter to prevent damage to the bulbs from cold and particularly from heaving out of the soil by freezing and thawing.

With the species of lilies which do not send up a green leaf the first year Mr. G. L. Slate has devised a method which saves time and trouble. The seeds are planted in the spring in flats and these are stacked up in the cellar until late October. Flats would then be moved out doors in frames or in some protected place where they are mulched and left for the winter. In the spring leaves will appear above ground. From this stage on the growing of seedlings is the same as described for other species which send up leaves the first season. With *L. candidum* and other species which mature seed early (late August), a year's time may be gained by sowing the seeds as soon as they are ripe and stacking the flats in the cellar until late October. Some of the kinds of lilies which do not send up a leaf the first year of planting are *L. auratum*, *L. speciosum*, *L. Martagon*, *L. canadense*, *L. superbum* and, in fact, most of the American lilies.

CULTURE

Probably the culture of few plants is surrounded with so much misinformation as the growing of lilies. This is in part due to the fact that some kinds of lilies are difficult to grow and have special requirements. Most of the difficulties encountered, however, in the growing of lilies are related to disease, particularly mosaic and botrytis, and to heavy soils and poor drainage. Throughout lily literature there are many statements as to the necessity of ground covers and especially prepared soils and other details of management which are claimed to be essential. As a matter of fact, the majority of lilies are fairly easy to grow if 3 essential factors are provided. One of these is mosaic-free bulbs, another good under-drainage down to a depth of 18 inches or more, and third, a friable soil which permits the quick passage of water and good aeration.

In obtaining mosaic-free bulbs the grower is confronted with a very real problem. Bulbs collected from the wild of both American and Asiatic lilies are free from mosaic. These are only a small fraction of the bulbs sold. Although there are some nurseries which give attention to growing mosaic-free stock and can assure the purchaser of healthy bulbs, at the present time, most nurserymen are not well informed on mosaic and its causes and do not use practices which are conducive to producing disease-free stock. The would-be purchaser of bulbs certainly should give preference to nurserymen who indicate that they are informed regarding mosaic and who, either by isolation of their plantings or the production of seedlings may give some assurance of cutting



Propagation.

1. Bulb in position below soil, showing basal roots from bottom of bulb, stem roots from base of flower stalk, bulblets forming on base of flower stalk. 3. Bulbils in axils of leaves. 4. Bulbs forming at base of bulb scales that have been propagated. 5. The same later, when the bulb scale has been used up by the developing new bulb.

down mosaic to a minimum. About the only sure way to get mosaic-free lilies is to raise the seedlings in ground isolated from all other lily plantings. At the present time most of the commercial stocks of bulbs are imported from Japan and these are known to be infected with mosaic to a greater or less degree. If one buys imported bulbs, except for those collected from the wild, about all they can do is to plant them and then in the spring examine them closely for mosaic and destroy plants which are obviously infected.

The ideal soil for a lily bed is a deep well drained sandy loam which permits a rapid passage of water. The presence of gravel or bits of rock is often an advantage. In general, the heavy clays which bake or remain soggy should be avoided as should the very light sands which dry out very quickly and lack organic matter. It can be said with some assurance that most varieties of lilies can be grown to advantage on any good agricultural soil provided it is well drained. If such soils are present in the garden less attention may be given to soil preparation. On the other hand, if soils are heavy and drainage poor modification is necessary. Such modification requires the provision of drainage by tile or rock drains, to 2 feet deep and so arranged that they provide ready access of the water from the lily bed. Digging a hole in tight sub-soil and filling it with rocks or cinders will rarely prove an advantage unless there is some way for water to get out of the hole. Heavy soils can be lightened by mixing them with coarse sand or fine cinders or gravel. The addition of granulated peat, muck or woods earth is also an advantage both because of its effect on the physical nature of the soil in promoting aeration and the fact that it supplies organic matter as well.

Excessively light soils may be modified by the addition of silt or loam and organic matter which adds to the moisture holding capacity of the soil as described above.

With the exception of *L. candidum* which is planted in late July immediately after flowering, lily bulbs are normally set in the fall.

In moving bulbs in the garden a good practice is to do this in the early fall after the first frosts. The bulbs should be carefully dug and the basal roots moved intact. Many species of lilies tend to form clumps if they are doing well. Ordinarily such clumps need not be disturbed unless they become crowded to the point where the blooms are small and the stems short.

Bulbs purchased from American nurserymen are either locally grown, collected or imported. The first named are usually dug early enough so that they are received for planting before the ground freezes. Imported bulbs may not arrive before late December. Under these conditions the plot of ground where they are to be planted may be well prepared in advance and kept from freezing by a heavy mulch. The bulbs should be planted as soon as possible after receipt and in no case should they be allowed to dry out. Another method of handling bulbs received late is to plant them in deep pots and store the pots in a cool place. Giving them the same treatment as in forcing tulips or narcissus bulbs is good practice. The spring planting of stored lily bulbs sometimes gives good results but may result in weak growth which is disappointing, or in failure of the bulb to come up at all till the second season.

The depth of planting lily bulbs is important. The kinds of lilies fall into

two groups, one of which forms roots only at the basal part of the bulb known as basal roots. The other group forms these basal roots also, but in addition many roots are formed on the stem between the bulb and the surface of the ground. Lilies which form basal roots only need not be planted very deep. Madonna lilies, in fact, should only be planted with the top of the bulb 2 to 3 inches below the surface of the soil. Other species of the basal rooting type which includes *L. Hansonii*, *Martagon*, *canadense*, *superbum* and most of the other American native lilies should be planted about 6 to 8 inches deep.

Lilies of the stem rooting group, particularly the vigorous kinds such as *L. Henryii*, *auratum*, *speciosum* and *tigrinum* may be planted 8 inches to 1 foot deep depending on the size of the bulb and the nature of the soil. The larger bulbs and the lighter soils permit deeper planting than heavier soils and smaller bulbs. Lilies with small bulbs such as *L. tenuifolium* and *L. amabile* need not be planted more than 6 to 8 inches deep. *L. rubellum* is a small plant and a depth of 5-6 inches is sufficient.

For plantings on many soils it is advantageous to mix peat, leaf mold, muck or other organic matter with the soil below the bulb. With the stem rooting sorts these materials may also be placed above the bulb where the stem roots will develop. The material should be spaded in to mix it thoroughly with the soil.

A satisfactory practice is to dig a hole deeper than you wish to plant the bulb, mix in top soil and peat or other organic matter to the depth decided for the base of the bulb, place the bulbs on this prepared soil, fill in the hole part way with top soil, add several liberal handfuls of peat or other organic matter and fill the hole with topsoil. It is a good plan to firm the soil well about the bulbs at the time of planting and the soil should be mounded up slightly so as not to leave a depression when the soil settles that will catch water during the winter.

The fact that some species of lilies grow in soils that are poor in nutrients has given rise to the idea that fertilization of all species is harmful. Experience shows this not to be true as practically all species will respond favorably to the application of well rotted manure applied to the surface of the soil, or medium to liberal applications of a good commercial fertilizer such as a 5-10-5 about the base of the plants. Fertilizing can be overdone as evidenced by the fasciation of the stalks.

With most kinds of lilies shading the soil or protecting it from the direct rays of the sun either by some ground cover or by a summer mulch of some loose material such as shredded peat or buckwheat straw is an advantage. For this reason lilies often do well when planted among low growing perennials or annuals or among shrubs. Some of the more vigorous sorts such as *L. tigrinum*, *auratum*, *canadense* are often at their best when the lower parts of the plants are shaded with other vegetation. This is, in fact, the way that they grow in nature. On the other hand, tight vegetation such as myrtle, pachysandra or pulmonaria are harmful probably because they compete directly with the lilies for water and nutrients and further keep water from rain from reaching the lily roots at all. Plantings arranged so that the leaves of perennial or annual vegetation shade the ground but the roots do not occupy the same area are usually satisfactory.

A mulch or ground cover which shades the soil prevents the surface layers from becoming excessively hot and in the case of the mulch, moisture is conserved. This is particularly important with lilies which form stem roots close to the surface of the ground. These stem rooting lilies may be particularly benefited by fertilizing the surface of the ground or by working in well rotted manure or peat. In any case the lily bed should be amply supplied with water for best results.

WINTER CARE

Although many species of lilies are very hardy and are not likely to suffer damage from low winter temperatures, most species will benefit from a protective mulch during the winter. Any coarse material will serve provided it does not pack too solidly over the beds. Evergreen boughs that will hold the snow are very good. Straw, shredded peat, or shredded corn stalks will all serve the purpose. Covering the ground to a depth of two to four inches is usually satisfactory. In the spring the mulch should be loosened up early and removed before any considerable amount of growth has taken place. Lilies that come up under a mulch are distorted in growth and yellow due to the lack of light. These rarely recover perfectly.

Mulch should be removed early from *L. Hansonii* and its hybrids because this lily comes up very early in the spring, and if the mulch is not removed the plants are distorted and otherwise damaged. Some kinds of lilies are tender to frost, particularly *L. regale* and its hybrids and the mulch should be left on relatively longer. Other tender lilies that suffer seriously from frost damage are *L. Henryi* and *Sargentiae*. *Elegans*, *canadense* and most of the American lilies, *L. martagon* and its hybrids will stand severe frost with temperatures down to 27° F. but will be injured by freezes when the temperature reaches 24-25°. In the early spring those tender lilies which have come above the surface of the ground should be protected from the occasional late frosts otherwise the season's bloom may be lost and the plants seriously stunted. Large flower pots or fruit baskets inverted over the plants will prevent rapid radiation and frost damage.

As indicated above many species of lilies thrive even though there are other plants near them which shade the soil. They do suffer, however, from competition from rank growing weeds which compete directly for moisture and nutrients. If the weeds are not kept down, therefore, with a mulch, it is necessary to stir the soil about the plants for weed removal. Cultivation should not be deep as stem roots forming early in the season may be damaged. There is often serious injury to lilies in the early spring just as they are coming through the soil by over-zealous cultivation and weeding. Some kinds, among them *L. amabile*, *superbum*, *concolor* and *Maxwill*, do not appear above ground until about the time the tulips bloom. There are few lily growers who have not experienced cutting off the shoots just as they appear at the surface of the ground and thus ruining the plants permanently. Unless you are certain where the lilies are, and this is almost an impossibility, the gardener should be content with pulling the weeds in the vicinity of the lilies until they are well above ground.

DIFFICULTIES

Lilies are subject to certain disease and insect troubles with which the average lily grower will sooner or later become acquainted. As a rule these troubles will yield to proper control measures and lily culture in general need not be more difficult than the culture of any other plant group. Some species in this genus are an exception to this and it is not unusual to find them thriving in a flower garden.

Without much question, the most serious disease with which the lily grower has to contend is mosaic. Lily mosaic has been recognized in this country for only a relatively short time, possibly a dozen years, but the disease has undoubtedly been present for a very long time and probably has been responsible for many of the little understood vagaries of lily culture that have been reported in the older literature.

Lily mosaic is caused by several viruses. A virus might be defined as a sub-microscopic disease-producing agent which multiplies inside the cells of the plant in association with the protoplasm. They are not strictly living organisms like the fungi or the bacteria, but they do produce characteristic and serious symptoms which often destroy the usefulness of the plants in the garden or kill them outright. Lily mosaic is present only in living plant tissues. It is not present in the soil nor does it persist in dead material. It is, however, present in all of the cells of any affected plant either large or small and a plant once infected can never be freed from it. Fortunately for the lily grower, it is not transmitted from one generation to another through the true seeds. The lily virus is carried from diseased to healthy plants by plant lice (aphids) and possibly some other insects during their natural feeding habits. The insect sucks up the juice of an infected plant and when it subsequently feeds upon a healthy plant the virus is transmitted to the healthy host. There are virus diseases affecting many plants other than lilies, but most of these do not affect lilies directly. An exception to this is the tulip mosaic which can be transmitted to lilies.

The symptoms of mosaic are difficult to describe with accuracy because of variation in the response of various species and the differences in viruses themselves. Such variation may depend upon the species of lily, age of the plant, type of virus or mixture of viruses present in the diseased plant, whether infection occurred during the current season or earlier and the environment under which the plants are growing. The most commonly recognized symptoms are an irregular light and dark green flecking and mottling of the foliage of the infected plant. Such mottling bears no relation to the regular veination of the leaf and is thus distinguished from the regular mottling which occurs in chlorosis or the yellowing which is due to a deficiency of iron or magnesium. Here the pattern is regular, the veins being a darker green. Along with mottling, mosaic diseased leaves may also be badly distorted and twisted. With some species such as *L. formosanum* the flowers themselves may be distorted. *L. tigrinum* and *L. Sargentiae* show a streaked color pattern in the flower buds when infected with tulip virus. With some species the effect of mosaic infection is very pronounced. This is particularly true in *L. auratum* which if it becomes infected in the early stages of seasonal development will

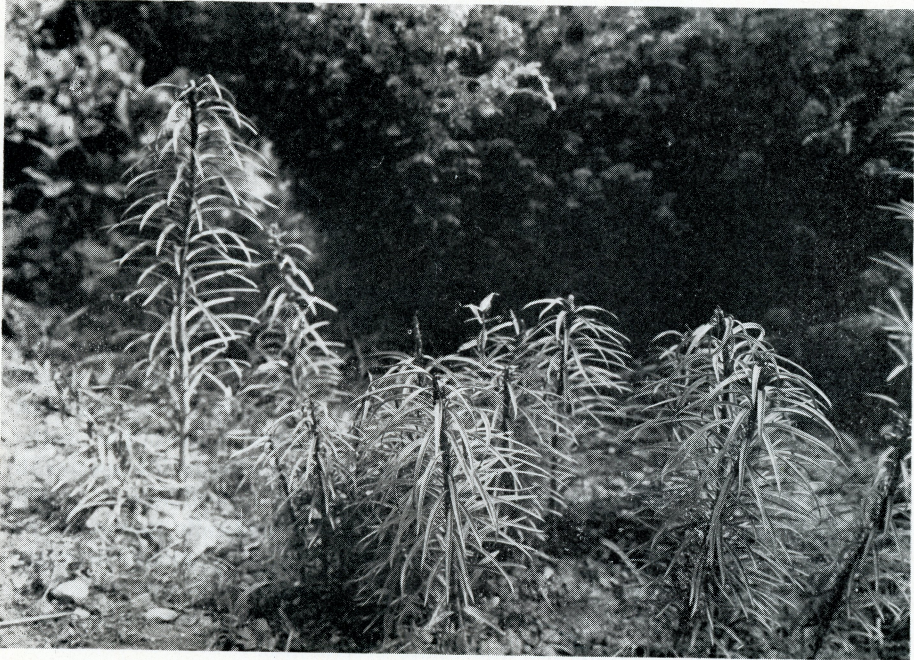
develop crook neck a few days after infection. In this species the growing point bends sharply downward within a few days after infection. The leaves become yellow and drop off and in the space of two weeks the plant will have died.

The difficult feature in the mosaic situation is that some species, particularly the *L. regale* hybrids, \times *L. testaceum* and the Dauricum-Elegans-Umbellatum groups mask the symptoms so that it is very difficult to determine whether or not they have mosaic. In general, mosaic symptoms are more easily detected during cool weather periods of the early growing season, particularly just as the plants have come through the ground and are beginning to elongate. At this time the lily grower who is trying to keep his plantings free from mosaic will examine the plants carefully for signs of mottling and breaking of the leaves and destroy the diseased plants.

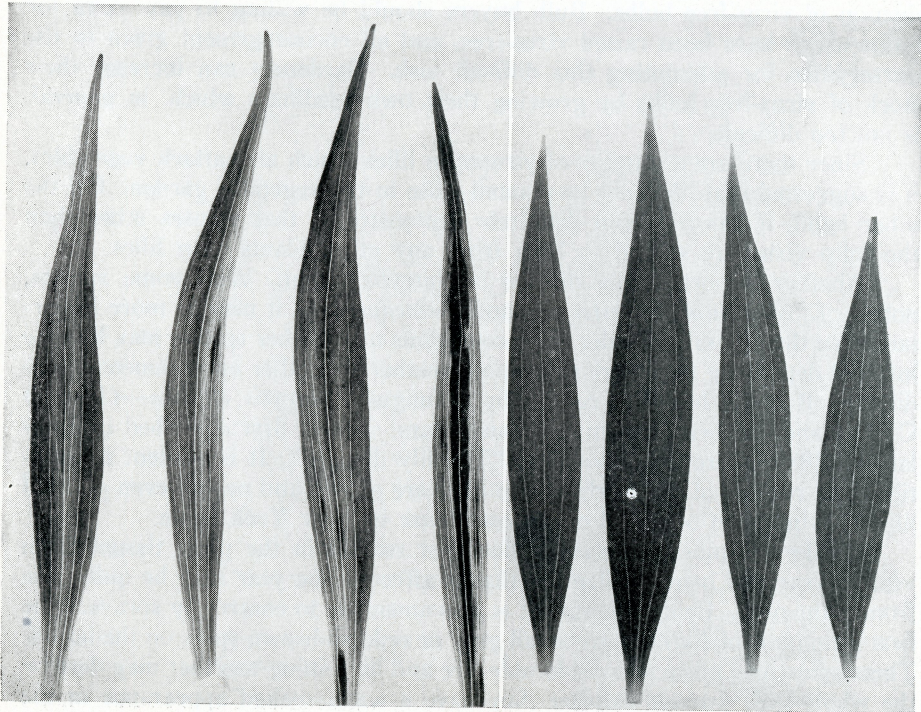
Control.—The difficulty of detecting mosaic in all of its forms makes it practically impossible to rogue a partially infected planting so that all diseased plants are moved. The observant gardener can take out the most obviously diseased plants and with some species such as *L. auratum*, *canadense*, *superbum* and some others, can probably detect all infected plants. In infected mixed plantings, however, there are likely to be some symptomless carriers, "typhoid Marys," if you please, which remain after the careful roguing job is completed. Nevertheless removal of obviously diseased plants is distinctly worth while in the garden if there remain a considerable proportion of plants that are apparently healthy. The spread of mosaic is usually between adjacent plants and removing a diseased plant from a group of healthy ones may at least delay the infection of the others. Control of the aphid carriers of the viruses under outdoor conditions is never more than partially successful since enough carriers always remain to spread the disease. In localities where aphid infection is serious, it is worth while to control this insect as much as possible, but such control cannot be relied on as a sure method to prevent mosaic spread.

As a practical garden problem, mosaic can be handled according to a number of different methods. In a fairly large garden it is often possible to handle different areas in different ways. Such areas should be isolated from each other as far as possible by hedges, walls or shrubbery. Under some conditions the aphids carrying the virus may travel for a considerable distance especially with the wind. Ordinarily, however, the spread is likely to be among plants which are closely associated. These separate garden plots can be developed according to any one of several different plans. One of these would be to avoid mosaic altogether and plant only those bulbs known to be free from virus. This is a difficult thing to do unless all bulbs come from seedlings which have been grown in isolation. Bringing in any bulb from the commercial sources is likely to introduce mosaic into an otherwise clean planting. This can be effectively prevented if only species are brought in which show symptoms that can be recognized, as for example *L. auratum*, *formosanum*, and *canadense*. Diseased plants can be removed as soon as they show above ground. In such isolation gardens the utmost care should be used not to bring in either diseased lilies or broken tulips.

Another plan which may be followed with some success is to compromise with mosaic and be prepared to accept the limitations and inconveniences which



Frost damage on Lilium regale.



Mosaic. Lilium superbum, infected (left), healthy (right).

the diseases will present. Do this by planting those species which are to be relatively tolerant of the virus or which escape infection. In the first group are the species *L. candidum*, \times *testaceum*, *tigrinum*, *Sargentiae* and its hybrids, *regale*, *myriophyllum* (sulphureum), the *Elegans* and *Umbellatum* groups, *speciosum*, and a number of other species. These lilies will apparently give fair results even though they are infected with virus. Another group of lilies have been observed under various garden conditions to be moderately free from mosaic even though exposed to it. Among these are *L. Brownii*, *Henryi*, *pumilum*, *amabile*, *Maxwill*, *Grace Marshall* and some of the others of Miss Preston's hybrids. A few species and varieties of lilies seldom, if ever, become infected with mosaic and can be grown in almost any planting. Among them are *L. Martagon* and *Hansonii* including the famous Backhouse hybrids and *L. pardalinum*. Under this plan of "living with mosaic" the gardener would expect to replace bulbs now and then because there is certain to be some spread of the virus and some of the virus combinations will destroy some of the plants. It should be possible, however, to keep a good representation of lily species in the garden from year to year, particularly if a supply of seedlings is grown along for replacement. In such a garden it would be practically impossible to grow the species which are very susceptible to mosaic, and among these are such fine plants as *L. auratum*, *canadense*, *formosanum*, *japonicum*, *rubellum*, *superbum* and a number of others. Of these, *L. auratum* and *formosanum* are particularly liable to infection and immediate destruction.

Under the program which aims to keep lily plantings entirely free from mosaic some progress has already been made in the way of commercial production of virus-free bulbs. Bulb buyers should be willing to pay extra for bulbs which have been raised virus-free, and all encouragement given to the nurserymen for attempting this difficult task. Gardeners can increase their stock of virus-free bulbs by growing their own seedlings which, in general, is not too difficult.

Since there are a number of viruses in lilies which also attack vegetables, it is suggested that lilies not be planted close to the vegetable garden. On the other hand, it has not been definitely demonstrated that viruses other than the tulip virus are spread to lilies from any other plants than lilies.

Another important lily disease is *Botrytis* blight. With some species, notably *L. candidum*, \times *testaceum* and *chalcedonicum*, it may be more important even than mosaic. Under some conditions many other species may become infected depending to a large part upon weather and other environmental conditions. *Botrytis* blight is caused by a fungus (*Botrytis elliptica*—(Burke) Cooke) and has been known for many years. It was first described in England in 1888 where it is known as "The lily disease." It is present in practically all regions of the world where lilies are grown and occurs even on wild lilies, having been observed on *L. canadense* in New York State.

Unlike the mosaic disease it does not remain in the plant tissues from year to year and hence a planting that is affected one year may be quite free from it the next. Being a fungus it is also amenable to control by sprays. The first symptoms of *Botrytis* are small gray or reddish-brown spots on the leaves. These spots may grow to considerable size and by joining together may destroy the whole leaf. In wet weather they have a water-soaked appearance in the

center and may develop a gray mold on the surface made up of the fruiting structures of the fungus. If infestation is severe the spots enlarge to include the whole leaf and under some conditions whole plants are practically destroyed. At its worst whole beds of *L. canadense* or \times *testaceum* may be reduced to brown shapeless stalks. Small spots on leaves do not disfigure the plant much, but on flowers and buds unsightly distortion results.

The *Botrytis* fungus over-winters on dead lily stalks and leaves and also on the rosette leaves of *L. candidum*. Spores are shed in the spring and are splashed by the rain or fly through the air to new plants. The seriousness of the infection is dependent upon weather conditions. Prolonged cold rainy periods, frequent showers, heavy fogs and dews all favor the development of the fungus in providing the water droplets on the leaves which are necessary for spore germination and the penetration of leaf tissues by the fungus. Lilies planted in low shady places which lack drainage or air movement are more apt to be affected by *Botrytis* than those planted in more open locations. The most susceptible species should never be planted in such locations and gardens with no better place should confine themselves to less susceptible kinds.

Control.—Sanitation will decrease the number of fungus spores available for early infection. This consists of the destruction of dead lily debris in the fall which will reduce the number of overwintering fungus fruit bodies (sclerotia). The systematic removal of all diseased leaves during the growing season will improve the appearance of the plants and reduce the number of spores for late infection. All such debris should be burned. Many careful gardeners practice such control measures whether they have the disease or not, but sanitation alone is not sufficient if weather conditions favoring the disease prevail.

Fungicides offer the best means of controlling this disease. Bordeaux mixture spray 4-2-50 or copper lime dust both give good control without causing injury to the plants. The 4-2-50 formula is made up as follows: Dissolve 4 oz. of crushed or powdered copper sulfate in one gallon of water. Mix 2 oz. of hydrated lime in two gallons of water. Pour the lime water into the copper sulfate solution stirring vigorously and use it at once as it deteriorates on standing. Copper-lime dust must be applied when the foliage is wet. Either of these fungicides is a very good protectant but they should be applied before infection takes place and applied often enough to keep the new growth covered. In dry seasons two or three applications will suffice on even the most susceptible lilies. In wet rainy periods weekly or bi-weekly applications may be needed. Several light applications are better than one or two heavy doses. Spraying should be done before rainy periods rather than after.

A third important lily disease is known as basal rot. It is probably much more common than is ordinarily supposed and accounts in part for the disappearance of bulbs in the garden and for weak, unsatisfactory growth generally. It is particularly damaging to *L. candidum*, \times *testaceum*, *bulbiferum* and its variety *croceum*, *formosanum*, some of the Preston lilies and the Backhouse hybrids. The disease has probably been the limiting factor in the commercial production of the highly prized hybrid \times *testaceum*.

Foliage symptoms are not consistent with this disease but a yellowing or purpling of the leaves and a stunting of stem growth often follows basal rot infection. Plants which are doing poorly for no other apparent reason will

often be found to be affected with basal rot. Upon digging the diseased bulbs they usually fall apart because the connection between the bases of the scales and the basal plate has been destroyed. Mites and other soil inhabiting insects are almost always present in large numbers feeding on the decaying bulb tissue. Control measures should aim at keeping the fungus out of the garden if it is not already present. Examine bulbs carefully before planting and do not set any that show rot in the area where the scales join the basal plate. Newly purchased bulbs may be infected and show no symptoms in the early stages. As a precaution all newly purchased bulbs of the susceptible species mentioned above may be dipped in a 1-100 solution of commercial formalin (40 per cent formaldehyde) for one hour. Ordinarily, diseased bulbs are discarded as a total loss. If they are particularly valuable and if the infected area is not too large they can be trimmed free of all diseased and rotted tissue, dipped in 1-100 formalin for an hour and replanted in a new location. The scales which have been broken from the basal plate may have the diseased part cut off and then be used for scale propagation after disinfection.

Soil beds which are known to be infected with this fungus can be sterilized by drenching with a 1-50 commercial formalin solution at the rate of $\frac{1}{2}$ to 1 gallon per sq. ft. of bed space. Cover the bed with tar paper or burlap for 24 hours after drenching, then uncover and allow to aerate for 2 weeks before replanting. Such soil treatment is particularly important in growing seedlings. In scale propagation scales should be dipped in a 1-100 formalin for an hour before planting.

In addition to basal rot there are a number of other bulb rots which are troublesome during shipment and storage. The gardener's chief concern with these rots is to learn to recognize them and refuse to buy bulbs which are badly diseased. Some species such as *L. rubellum* and *japonicum* are particularly likely to damage from storage rot. There are a number of other minor diseases which affect lilies but which are ordinarily not an important factor in the garden.

The insects which are troublesome in the lily garden are relatively few and unimportant. Several types of borers occasionally damage lily stems. Ordinarily these are not a major problem in the lily garden. If the frass from the insect chewings is apparent at the base of a stalk the opening can be found and the larva killed with a wire or stiff straw. Such a stalk is likely to break with the wind and must be staked if it is to produce bloom. Several mites and thrips infest lily bulbs and foliage. Ordinarily, however, these are not a serious problem in the garden and there is little that can be done in their control. Aphids, commonly called plant lice, frequently become so numerous on lily foliage that they cause considerable flower bud and foliage injury. They can be held in check by spraying or dusting with any of the commercial nicotine insecticides.

Another trouble not related to insects or fungi is chlorosis characterized by a lack of green coloring matter in the leaves. It is usually troublesome only on alkaline soils with lilies such as *L. canadense*, *superbum* and sometimes *Hansonii* which are best adapted to acid soils. This condition is due to a deficiency or unavailability of iron or magnesium in the soil. The addition of peat or sulfur to the soil will increase the acidity and make iron more avail-



× *Lilium testaceum*.

able. Spraying the foliage with 5/10 per cent ferrous sulfate solution will often correct the situation. If the iron sulfate does not improve the plants 5/10 per cent magnesium sulfate may help.

Limberneck is the name applied to the condition where plants which otherwise are apparently growing thriftily suddenly collapse, wilt and turn brown at a point a few inches below the growing tip. The cause of the trouble is not well understood but it is probably related to poor root development at the base of the bulb. Frosts often cause severe damage to susceptible species such as *L. regale*, *Hansonii*, *Henryi* and some others. The symptoms are gnarled, thickened and distorted foliage and stems. Frost damage has different symptoms depending upon severity of the frost and species involved. Frosted plants are often difficult to distinguish from those affected with mosaic.

SELECTIONS

In a bulletin of this scope it is quite impossible to even mention all of the lilies that may be grown in a garden or to point out the various uses for which the different species could be used. Such information is available in the more comprehensive books on lily growing. It is, however, useful to point out some of the more important considerations in the use of lilies in the garden. This great group of plants ranges in color from white through delicate pinks, apricot, yellow, orange and red to nearly black in some of the varieties of *L. Martagon*. Comparatively few are pure white without spotting or other color. Of these *L. candidum* is outstanding. The Easter lily, *L. longiflorum*, is also white inside and out as are some of the forms of *L. japonicum*. Most other white lilies have either a yellow throat inside and the outside of the buds may be more or less tinged with green, brown or pink. *L. regale* combines the satiny whiteness of the outer parts of the petals inside with a yellow throat and a variable strongly tinted outside color of the flower parts. In some forms this may be an attractive shade of pink. *L. Brownii* is a very attractive combination of sheer whiteness within and a dark purplish brown cast outside. This is particularly prominent in the bud.

Pink lilies are relatively few. *L. rubellum*, one of the earliest of all lilies, is a very attractive deep pink. Some forms of *L. japonicum* are also pink. However, there is considerable variation and one buying bulbs expecting them to be pink may be disappointed in that the flowers will be white. The most vigorous and easily grown of the pink spotted lilies is *L. speciosum rubrum* which should be in every garden.

Most of the reds in lilies are somewhat tinted with orange. The coral lily, *L. pumilum*, is a good red, as is *L. chalcedonicum*. Some forms of *L. concolor* are red or scarlet, and at least the outer half of the petals in varieties of *L. canadense*, *pardalinum* and *Humboldtii* are red. These last named for the most part have yellow throats with black or purplish spots.

Pure yellow lilies are relatively rare. Among them are *L. Parryii* and forms of *L. concolor*. Others such as *L. Szovitsianum*, *canadense* and *Hansonii* and forms of *elegans* are mostly spotted in the throat. Recently, a very good unspotted yellow form of *L. amabile* has been introduced.

The orange-red group is one of the largest. This one is typified by *L.*

tigrinum with its brilliant orange-red flowers with dark purple spots. × Maxwell, *Davidii*, *Maximowiczii* and a large number of others are more or less similar.

× *L. testaceum* is a peculiar apricot shade known as Nankeen Yellow. *L. Batemanniae* is a rich apricot. *L. cernuum* is an odd shade of lilac, somewhat lighter than the almost purple *L. Martagon*. Some of the varieties of *Martagon* such as *cattaniae* and *dalmaticum* are very dark wine-red.

Most lilies are pleasantly fragrant except that some such as *L. auratum* and *regale* are almost over-powering with their perfume. A few, however, have a disagreeable odor, among them *L. amabile* and *Martagon*.

The time of flowering of lily species and varieties ranges through practically the whole season beginning with *L. carniolicum* and *rubellum* shortly after the middle of May in central New York and ending with *L. speciosum* and *formosanum* late in the fall. In the latitude at Ithaca, New York, these late species are often frozen before they have flowered, and it is impossible to mature seed on them in the garden. The lily season reaches its height in late June and early July at which time perhaps 50 species may flower. In late July and early August *L. tigrinum*, *Henryii* and *auratum* are in bloom.

SPECIAL SOILS

Although a surprisingly large number of lilies are not at all fastidious as to the soil type and exposure in the garden there are others that are somewhat restricted as to the conditions under which they will succeed. This is to be expected when one considers the tremendous geographical and ecological range under which this great genus is spread. Many of the older books put considerable emphasis upon the acidity of the soil. This, however, does not seem to be important in most cases. In general, it is said that the European lilies, among them *L. candidum*, *chalcedonicum*, *Martagon* and some others, thrive best on alkaline soil and that the American lilies such as *L. canadense*, *superbum* and the Asiatic lilies need acid conditions. This certainly is not strictly true because the American and Asiatic lilies are found growing well in soils which are slightly alkaline or at least only about neutral. A few species, particularly *L. canadense* and *superbum*, show yellowing of the leaves called chlorosis in highly alkaline soils. This can usually be remedied either by mixing acid peat with the soil or by the application of iron sulfate or aluminum sulfate to the surface of the soil at the rate of about $\frac{1}{4}$ lb. to a sq. yd. This is spread on the soil surface and washed in by the rain.

SHADE

A number of lilies are benefited by shade. Among these are *L. Hansonii* and the Backhouse hybrids, also *Martagon* and its various forms. In fact, *L. Hansonii* and sometimes *Henryii* in the bright sun will bleach and burn, making the flowers very unattractive long before they would otherwise wilt. *L. Henryii* and *rubellum* are also shade tolerant, although the former may become somewhat spindling if the shade is too dense. *L. giganteum* is also a woods species. Among the American lilies *L. washingtonianum* naturally grows in thin woodland but *L. superbum* and *canadense* are usually in full sun.

In fact, the majority of lily species need full sun for their best development. *L. regale* particularly suffers in the shade, and if planted close to buildings is inclined to lean at a sharp angle toward the light.

HARDINESS TO COLD

Some of the lilies are very hardy. Stem bulblets of *L. Henryi* and *tigrinum* will often survive the northern winters even though they are exposed on the surface of the soil. On the other hand, some species are much more tender and have to be grown with considerable protection. *L. philippi nense* and *L. nepalense* are almost sub-tropical in their requirements. *L. longiflorum* and *L. myriophyllum* will survive under some circumstances in central New York, particularly if they are planted deep and mulched heavily or set against the foundation of a house, otherwise they rarely come through the winter. *L. ochraceum* has been kept outdoors through the winter in southern Pennsylvania, but rarely survives in central New York. These semi-hardy lilies will therefore need special consideration to winter protection.

Long years of experience with lilies in England and America by gardeners have led to the designation of some species as easy to grow, some as difficult and others as intermediate. The following lists are selected from those in "Lilies for American Gardens" by G. L. Slate. They apply particularly to the central New York area where soils are mostly alkaline. The reasons behind the failure of the difficult group are not always clear. In some cases it is certainly linked with disease such as mosaic with *L. auratum* and basal rot with \times *testaceum*. In my own experience I am confident that *L. auratum* would be easily grown if it were not for mosaic susceptibility. On the other hand failure of other sorts is doubtless linked with special cultural requirements of soil acidity, moisture supply, soil texture and drainage which if better understood could readily be controlled. The lists do not include kinds that are not readily available to gardeners.

EASY TO GROW

<i>L. amabile</i>	<i>L. Henryii</i>	<i>L. pumilum</i>
<i>L. canadense</i>	<i>L. formosanum</i>	<i>L. regale</i>
<i>L. candidum</i>	<i>L. Hansonii</i>	<i>L. speciosum</i>
<i>L. concolor</i>	\times <i>L. Maxwellii</i>	<i>L. superbum</i>
<i>L. croceum</i>	<i>L. pardalinum giganteum</i>	<i>L. tigrinum</i>
<i>L. Elegans</i> vars.		

MODERATELY EASY TO GROW

<i>L. auratum</i>	<i>L. Martagon</i>	<i>L. Sargentiae</i>
<i>L. Brownii</i>	<i>L. rubellum</i>	<i>L. Shuksan</i>

DIFFICULT TO GROW

<i>L. giganteum</i>	<i>L. Parryi</i>
<i>L. japonicum</i>	<i>L. philadelphicum</i>
<i>L. Kelloggii</i>	<i>L. rubescens</i>
<i>L. myriophyllum</i> var. <i>superbum</i>	<i>L. Wardii</i>
<i>L. ochraceum</i>	<i>L. Washingtonianum</i>

USES IN GARDENS

Lilies have many uses in the garden. A few are adapted to growing in the rockery, among them *L. rubellum*, some dwarf forms of *L. elegans*, *cernuum* and *pumilum*. Most species, however, are vigorous plants with considerable height and are adapted to the perennial border or the shrub border or to open spaces among trees. Lilies are at their best placed in groups among shrubs or other perennial plants, preferably with a background of shrubs or a hedge. Strong growing types can be placed towards the back of the border and weaker growing sorts such as *L. pumilum* and *L. amabile* and some forms of *L. elegans* can be placed in the foreground. Lilies are particularly effective in groups or clumps among the trees where there is only partial shade during a part of the day. Colors, of course, must be carefully chosen. A particularly pleasing combination is the white Madonna lilies planted with a background of blue delphiniums. There are many of the orange lilies, particularly *L. tigrinum*, the colors of which are so bold and striking that they may clash with other perennials which are off-shade. For this reason, this lily is particularly effective in clumps by itself among shrubbery where it competes only with the green foliage.

In conclusion it should be emphasized again that this bulletin is offered with a full realization of its limitations particularly as to completeness. It is hoped, however, that there is sufficient sound information contained to enable beginners to start along the road to successful lily culture. As interest increases and successes are attained it is always possible to increase knowledge by referring to the books and technical articles and by becoming allied with garden clubs and other organizations which are interested in lily culture.

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