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BULBS FROM SEED

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INTRODUCTION

Many plants that are purchased as bulbs, corms, or tubers are produced from seed, and a number of bulbous plants are always reproduced by seed and cannot be multiplied satisfactorily in any other way. An example is *Chionodoxa luciliae*, which does not divide at the bulb and so is always seminally propagated. Many such plants are developed from seed in 1 to 3 years into bulbs from which the purchaser may enjoy blossoms a few months after they are planted. Certain other species reproduce vegetatively but are much more satisfactorily handled in the nursery from seed. Some of these, although requiring 4 or more years to grow to maturity from seed and only about 2 years to flower from splits, are still more advantageously multiplied as seedlings.

In some cases seed is used in the multiplication of hybrids, thereby propagating mixed stocks, because no satisfactory method of vegetative reproduction has been evolved. An example of this type is the *vittatum* hybrid of the genus *Hippeastrum*, commonly known as amaryllis. It is quite possible that the *crocus* may be advantageously handled similarly, at least in part.

¹The common name or names of the plants are given in parentheses following the scientific name in the list of contents and in the headings in the text.

Some prominent groups of bulbous plants are so highly bred that they are characteristically vegetatively reproduced but still include desirable units that can be more advantageously reproduced from seed. The best example of this may be the tulip, of which many desirable species breed true seminally.

In both daffodils and tulips only the natural species can be advantageously multiplied from seed. The demands that the consumer makes on daffodils and tulips require an exactitude of performance inherent only in a clon. Present standards require that a bed of daffodils or tulips should be all of one color and the plants all alike, with not a single individual of color nor varying even a few days in the time of blossoming. Such certainty of performance can be attained only with plants that have all been produced vegetatively from one seedling.

In other groups handled in a different manner and serving a different purpose, the demands are such as to tolerate the variations that are likely to occur in seedling progenies.

Generally speaking, any natural species of bulb, unmodified by hybridity or selection, will reproduce the parent from seed.

Many of the species enumerated or described in this circular are not produced in the United States, at least not in sufficient quantity to supply even the meager demand of the amateur gardeners who are just beginning to use them. The job of producing many of these bulbs from seed demands mostly handwork, a small acreage, and it usually must be done on a very intensive basis. There is need and an opportunity for a number of growers to produce these crops, and the work should appeal to special growers who can become proficient in the production, establish a reputation, and become headquarters for these delightful, early, spring-flowering bulbous plants. In the last few years growers in this country have become proficient in the production of daffodils, tulips, and lilies. Proficiency in the production of glory-of-the-snow, striped squill, and winter-aconite is no more difficult.

In popular parlance a number of plant basal structures pass as bulbs, and bulb catalogs and books include under the term not only what is technically a bulb (onion), but a corm (gladiolus), a rootstock (canna), a tuber (Jerusalem-artichoke), a fleshy root (dahlia), and even sisyrinchium, which is difficult to fit into any of these categories. In this circular this broad use of the term is accepted, but in discussing the different root structures they are referred to by the proper terms that designate the group to which they belong.

PROPAGATION FROM SEED COMPARED WITH VEGETATIVE PROPAGATION

Possibly the majority of bulbous stocks are reproduced vegetatively, but in most of the great groups the seed method is used to some extent. In the majority of the genera there are certain species that are better adapted to the seed method than to any other; in other groups reproduction by vegetative means is so slow or so difficult that it is not resorted to at all.

It is in maintaining horticultural varieties, of course, that stocks must be increased by vegetative means, because of the need of varieties true to type which cannot be produced from seed. This vegetative multiplication is often referred to as the development of a clon.

Whenever the development of bulb stocks by seed is practicable, it is the most advantageous and economical method known, because it maintains vigor more certainly and avoids pests that are sometimes perpetuated through vegetative reproduction. Even when it takes 3 or 4 years to bring a seedling to marketable size, it is commonly a much cheaper method than the vegetative one by which the merchantable offset can be produced in half the time. This can be shown best by an illustration: *Narcissus triandrus albus* does fairly well when grown vegetatively in the ordinary way, like the common garden varieties; it also makes seed abundantly and reproduces true from the seed. This is most advantageously planted about six seeds to the inch in 3-foot rows 4 inches apart and left for 2 years without disturbance. A 3-foot bed 50 feet long will contain not far from 25,000 plants. At the end of the second growing season they should be dug and spread out into 3 or 4 times the space, and most of them will be merchantable 2 years later without being moved again. The vegetative reproduction of this species is slow, with not over 100 percent increase in 2 years. If 2,100 bulbs were planted in the 50-foot bed and left undug for 2 years like the seedlings, they would double in number every 2 years, giving a yield of only about 8,400 bulbs in 4 years on the same amount of land that would have produced 25,000 seedlings in the same time.

SEED-BED PREPARATION

The Pacific Northwest, in general, has an advantage over the rest of the country in the germination of seed. Most soils from the Willamette Valley northward have moisture at the surface continuously from September to June. The rains are gentle, causing little or no disturbance of soil particles and generally no erosion except on steep, clayey slopes. These conditions make for ease and security of handling seeds in the open. The main deterring influence is the heaving action of winter freezes. This, at least in the case of seed beds, is rather easily counteracted by the application of an inch or two of mulch, which is ample to hold the soils from either heaving or shifting.

At the United States Bellingham Bulb Station, Bellingham, Wash., although frames have been provided for growing seedlings in the usual way, they are used only to protect certain tender plants from frost and inclement winter weather. The experience with most plants at the station has been that results are no better in frames than in the open ground; in fact, most bulbous plants listed in this circular may be grown in the open more cheaply and easily than in frames.

Taut lines are run from the corner pegs on opposite sides of the plot to serve as guides for the operation of the roller marker, which accurately spaces the rows 3, 4, 6, or 9 inches apart across the 3-foot bed.

PLANTING THE SEED

A homemade tool is employed in preparing the depression to receive the seed. It is essentially a die, fashioned from two boards fastened together in the form of a T with the drop 1 inch and its lower face one half inch wide. This die is pressed to its full depth into the soil over each row mark made by the roller, thus forming a good depression of a uniform and exact depth.

The seed is distributed from small cornucopias fashioned from smooth, stiff paper. It is found that the crease into which the seed is distributed lends itself very well to a good and even placement, as it is tapered on each side toward the base, which is one half inch wide and flat-bottomed (fig. 1).



FIGURE 1.—Planting seed of bulbous plants. The two boys are using the die marker after the roller marker has been run over the bed to establish the position of the rows. Cornucopias from which the seed is distributed are shown.

Good germination can be obtained in this manner on quite refractory soils if the initial preparation is good. The method has decided advantages in situations where the soils are variable.

Before this method of planting was worked out, it was found that when field soil was used to cover the seed, unfavorable spots often packed so as to interfere with the seed coming through upon germination. This induced the use of a different covering. Lately the 1-inch deep depressions have been filled with composted soil containing sufficient organic matter to prevent baking and packing. The compost must not be too light, or it will blow off or dry out too rapidly. The material preferred is rotted sod on a fine sandy loam into which 1 or 2 heavy crops of rye have been plowed. Woods soil composted for a year has been found too light for best results. Imported peat is too light and also too acid for covering even lily seed. This prepared soil not only fills the row depressions but covers the whole

surface of the bed to a depth of about one fourth of an inch. Any coarse debris in the compost is raked off into the paths and left there.

Such preparation and care in planting pay in the better results obtained in germination. Often 200 seeds are planted to the row, the labor is less than it would be in frames, and a bed 50 feet long contains not fewer than 20,000 seedlings, therefore the cost is nominal. A seedling bed of *Lilium martagon album* 20 feet long at the Bellingham Bulb Station, when dug, yielded over 13,000 bulbs.

BULBS GROWN FROM SEED

ALSTROEMERIA (Alstroemeria, Peruvian Lily)

The Peruvian lilies, which are really amaryllids, are not grown in this country nearly as much as they deserve. They are seldom in evidence except on the San Francisco flower markets. Their reputed tenderness doubtless deters many persons from attempting their culture, but this impression is not wholly accurate. The species *Alstroemeria aurantiaca*, *A. brasiliensis*, *A. pelagrina*, *A. pulchella* (*psittacina*), *A. chilensis*, and *A. tricolor* have grown very satisfactorily for 7 years in a heavy clay soil in the writer's garden in the District of Columbia. The tops have been left undisturbed in the fall to catch and hold the leaves that fall close to them. In this way the plants are lightly mulched. Under these conditions there is no indication of tenderness, as all have persisted for 10 years since being planted.

Mixed seed from this District of Columbia planting has been grown at the Bellingham Bulb Station with very satisfactory results. It was planted in late fall, germinated in March, and the second July following it blossomed profusely in the seed bed. Seed sown in August at Bellingham will usually give some flowers in 1 year.

The alstroemerias are difficult to handle because of the character of their underground parts. An alstroemeria root closely resembles a miniature dahlia root with the tubers connected to the crown by a threadlike attachment. This brittle structure makes it very difficult to pack and ship the roots. Furthermore, the old plants work down to extraordinary depths if the soil is at all penetrable.

Experience at Bellingham indicates that 1- and 2-year-old seedlings, the underground parts of which are only 6 to 8 inches long, can be handled much more successfully than older plants. Such plants will have blossomed in the nursery and, in the writer's estimation, are the most satisfactory to the customer when grown in mixed colors.

The patch of alstroemeria growing at Bellingham in partial shade under the Douglas firs suffered its only winter injury in the extraordinary season of 1929-30, when many of the plants were killed.

Alstroemeria chilensis (fig. 2), although rather troublesome to handle, is adapted to greenhouse culture. When potted in late autumn and kept cool during the winter it will blossom after the last of the tulips, is attractive and different, and lasts well when cut.

AMARYLLIS VITTATA

(See *Hippeastrum vittatum*)

ANEMONE

(See *Ranunculus asiaticus* and *Anemone coronaria*)

BEGONIA (Tuberous Begonia)

The discussion of *Sinningia speciosa* (gloxinia, p. 27) applies equally well to the tuberous begonia; indeed, the plants are generally considered together, and the same grower usually produces both.

In the culture in California the only real distinction made between them is during the development of the plants beyond the seedling stage. After one transplanting from the seed flats, the begonia is placed in the open under lath, whereas the gloxinia is grown on in the greenhouse.



FIGURE 2.—Root system of *Aletroemeris chilensis*, 2 years from seed.

bulbs. In date of blossoming they follow the early crocus, and they may be made to furnish clumps or sheets of color between the times at which the vernal form of the crocus and the early daffodils appear.

The chionodoxas should be grown in clumps, borders, edgings, dotted about in the grass, at the base of shrubbery, along the edge of woodland, on rockeries or walls. They are persistent plants when once well established, remaining indefinitely in meadows or pastures. At the Bellingham Bulb Station, areas where they had been grown 8 or more years previously were a riot of color each spring, although the land had been plowed twice and had been in timothy and clover meadow most of the time.

The same bulbs have persisted at Bellingham from 1916 to 1932, although dug and replanted every 2 or 3 years. They deteriorate with age, but persist and function for a long time. The 15-year-old

CALLA ELLIOTTIANA

(See *Zantedeschia elliotiana*)

CAMASSIA

(See *Quamoclit*)

CHIONODOXA (Glory-of-the-Snow)

The chionodoxas are among the most attractive and satisfactory of the early spring-flowering

bulbs became ill-shaped and had large, thin bases, flaccid snouts, and "steppy" coats, owing to partial disintegration. The meadow area where planting was done in 1922 was examined 10 years later, and it was found that seedlings several years old were plainly distinguishable. Under such competition, however, a year or two longer is required for the bulbs to reach maturity.

Seed sown 1 to 1¼ inches deep at Bellingham in September germinates in early spring. An occasional blossom may be seen the second year, but 3 years of culture under good conditions are necessary for the production of merchantable bulbs, which should measure not less than 4 centimeters in circumference (fig. 3).

The stocks are adapted to a culture that leaves a planting, once established, undisturbed for a long time. The planting will increase



FIGURE 3.—*Chionodoxa luciliae* in the foreground and *Puschkinia scilloides* in the three beds farther back. All are about 4 years from seed. In commercial practice the bulbs could have been sold 1 and 2 years previously.

in beauty from year to year if the bulbs are not too old when planted, because under good conditions the number of florets to a spike increases from 1 or 2 to 10 to 12.

The three species common in commerce all come true from seed. *Chionodoxa luciliae* has a blue, white-centered flower; *C. sardensis* is blue throughout; and *C. gigantea* is similar to *C. luciliae* but has a much larger flower. There is a desirable white form of *C. luciliae*.

Imported stocks are often far from perfect. Commonly many of the bulbs fail from rots and molds, but they are good seeders, and a crop of seed is usually produced the first year. This seed, grown under good conditions, produces stocks much more likely to persist than imported bulbs. *Chionodoxa gigantea* has proved to be much more difficult to establish than the others, but after the home-grown

seedling stock has once become established it has presented no more difficulties than the other species.

The present demand for chionodoxa is not great. In recent years only about 750,000 of the bulbs have been imported, all of which could be profitably utilized on 1 or 2 large estates. To be effective these stocks must be employed in very large numbers. Until advantage is taken of their production from seed and there is an adequate domestic supply available they may not be utilized in the most effective manner.

The chionodoxas make delightful pot plants. They cannot be forced, but they can be flowered by the end of January if carried cool and in very good light after being brought out of the heeling ground.

CROCUS (Crocus)

Corms of the common garden crocus reproduce wonderfully well vegetatively, but certain difficulties in their production apparently have not yet been mastered. The corm of the crocus may not soften and rot, but it hardens, mummifies, and dies. Experience at the Bellingham Bulb Station shows that the responsible malady is one to which all the common vernal garden forms are subject, but that the Mammoth Yellow variety is the most susceptible.

In the common garden varieties a reproduction of fourfold by weight, of which 25 percent mummify in storage, thus netting a threefold crop, is common. Such results are not at all satisfactory. A threefold yield that could all be saved would be preferable.

Commercial custom at present favors uniform colors in the crocus as in most other bulbous plants, but, while purchased in straight varieties, these varieties are commonly used in mixtures. Mixtures can be grown cheaply for general use, and straight varieties for the special clientele that calls for them. At present the mixture is likely to contain culls from all stocks. However, a mixture grown from seed can contain the most virile and satisfactory crocus corms that can be had. Of course the Mammoth Yellow does not seed, and consequently will not be represented in a seedling progeny.

Crocus can be produced from seed very easily. At Bellingham the seed is collected in June and planted in August. Germination takes place in early March. The seed is put in 1 inch deep, covered the first winter with an extra inch or less of soil, and left in the bed 2 years. By the end of the second year's growth the corms should be large enough to handle (fig. 4); if not, another year in the seed bed is advisable. Usually, however, 2 years in the seed bed and 2 more in the next position will produce good merchantable corms. Still better results will be secured if the corms are lifted annually after being removed from the seed bed. Sparse blossoming may take place the fourth year, which means that most of the progeny will blossom well the fifth and so can be merchandised at the end of the fourth year.

Collection of the seed, while not at all difficult, must be done very promptly. The seed vessel of the crocus is below the surface of the soil at flowering time and remains so until the seed is ripe, when the style lengthens very rapidly to about 2 inches. Soon after this the ovary ruptures and the seed is scattered.

Experience at Bellingham indicates that seed of either the purple, white, or striped varieties will produce all three colors. The predom-

inant color, however, is likely to be that of the stock from which the seed is derived; that is, seed of purple varieties will produce a predominance of purple flowers, and that of white varieties will produce flowers predominantly white, but with an abundant admixture of the purple and striped forms. All the flowers will be as good as any of the purple, white, or striped forms now on the market.

The difficulties in the culture of crocus apparently are no greater in this country than in Europe, where, it is said, more or less uncertainty always exists. European stocks often go bad, and the grower obtains better stock and starts anew. One way to avoid this difficulty is to grow seedlings, if not each year, frequently enough to maintain the health of the stocks.

There are indications that the crocus succeeds better on clay than on light sandy loams and that like many other bulb stocks it will not tolerate the use of animal manures.

CYCLAMEN (Cyclamen)

The common cyclamen is almost always sold as a potted plant in full flower. It is one of the most popular, dependable, brilliant, lasting, and generally satisfactory of plants sold in pots. For the most part it is utilized for the Christmas trade, but it may usually be obtained up to Easter.

The production of the cyclamen of the greenhouse, *Cyclamen indicum (persicum)*, in the United States is almost entirely from seed, and the plants offered for sale are but 15 to 16 months old. The seed is sown during August and September in good compost in flats or pans. A pane of glass is usually put over the pans until the seed comes up, which takes about 7 weeks at a temperature of 70° F. After the first leaf is spread the young seedlings are pricked off, usually into flats, about 2 inches apart each way, and left at a tem-

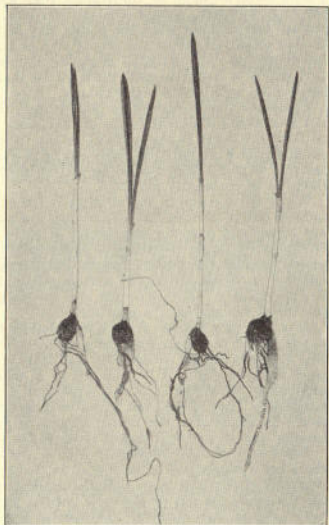


FIGURE 4.—Seedlings of crocus Kathleen Parlow the second year.

perature of about 60° until the second leaf is well formed. After this they may be shifted into 3-inch pots, then into 4-, 5-, and 6-inch pots, or the 4- and 5-inch sizes may be omitted; if the plants are well grown they should be in 6-inch pots by Christmas, when they are usually sold.

After the danger of frost is past in the spring, the young potted plants may be kept in coldframes that are partly shaded. The shading, however, should not be overdone, as is likely to occur toward late summer when the plants may become crowded. In September or early October the plants may be transferred to the greenhouse benches in good light. Some flowers usually appear in November, but it is better to pull them off so that the main crop which comes later will have a better chance.

Cyclamen should always be potted high, that is, the corm should not be covered with soil. Possibly the most frequent error made is to bury the corm as the daffodil or the tulip is buried. The ideal condition is with half the corm out of the soil; but it is better off entirely exposed than buried in soil or debris where the crown is likely to be constantly moist.

While the demand in this country is for cyclamen plants about 15 months old, in Europe much older ones are largely used. There they are often held over for the second or third year, when the plants become very large, requiring 8- or 10-inch pots. These 2-year-old plants produce many more flowers, but they are usually of mediocre quality. It is not considered economical to handle such large plants in this country. Both the cost and the danger of deterioration of the corms are against the practice.

It is perfectly feasible for the householder to carry his plants over to the second year and enjoy them the second winter. In order to do this the pots should be watered carefully until danger of frost is past, then they should be plunged in a moist, shady place, or the plants may be knocked out of the pots and planted in a moist, shady situation. They should not be allowed to dry out during the summer. In September the corms should be potted or repotted and brought inside, and will flower again at the usual season.

Besides *Cyclamen indicum*, which is strictly a hothouse plant, there are a number of other species in the genus, some of which are perfectly hardy and make delightful additions to the wild garden, the perennial border, or the rock garden, although they are almost never seen in this country. The writer has had *C. europeum* persisting in a wild-flower nook in his garden in the District of Columbia for 10 years. It blossoms regularly in late September and October and goes through the winter in vegetative condition, the beautifully marbled leaves adding a decidedly attractive touch to the border along with the Helleborus.

The cyclamen corms become very large, but do not divide much; consequently it is necessary to produce them from seed. Late fall planting has proved most successful on Puget Sound. The seed germinates in the spring, and the corms have taken 3 years to reach flowering size.

In the District of Columbia corms of *Cyclamen europeum* are planted 3 inches deep and receive a covering of leaves in the fall.

ERANTHIS (Winter-aconite)

The buttercuplike winter-aconite is one of the most infrequently seen of the well-known early-flowering tuberous plants. The reason is that when out of the ground the tubers deteriorate rapidly on account of desiccation. If freshly dug in Europe and promptly sent by mail to this country they may be established without difficulty, but such prompt handling is not easy to arrange. The tubers often lie in warehouses until other stocks are ready for shipment, are shipped on slow boats, or lie on wharves until they are dead. Frequently when they do grow they are so badly infested with a smut that they have to be discarded later. They must be planted as promptly as possible.

The writer had the good fortune to get a consignment of 100 tubers that came through promptly in an importation about 1920. They were planted in front of a bulb border 100 feet long. The stand was perfect. Subsequent trials have been far from successful, but the original importation spread in 12 years until the single line of tubers 1 foot apart is now a solid mat, 2 feet wide in some places. Where conditions were most favorable it pushed its way vigorously into the lawn, but where a clay fill had hardened and even grass had a hard time to grow, the aconite failed.

Erantnis can be reproduced vegetatively, but this method is not at all satisfactory, because the tubers grow large and have several growing points which must be cut off and reestablished. By far the best plan is to grow from seed. This is produced abundantly, but must be watched closely at maturity lest it be lost through shattering.

On Puget Sound it is advisable to plant the seed as soon as it is cleaned, about 2 weeks after being gathered, often as early as mid-May. It vegetates the following March. If the seed is held over even until late August it dries out and shrivels badly and is very likely not to come up until the second year. It is the practice at the Bellingham Bulb Station to plant the seed as soon as it can be cleaned, which is never later than June 1.

Young tubers are rather difficult to handle because of their small size and their dark color, similar to that of the soil itself. It is therefore almost imperative that the soil be put through a sieve to remove the tubers. It is also necessary to plant rather more thinly than in the case of most bulbous plants, and to leave the seed beds undisturbed for at least 3 years. The seed can be planted an inch or more deep in rows 6 inches apart, but there should be not more than 50 to the row. After the second year the blade of the leaf becomes comparatively large, unlike the majority of the monocotyledonous narrow-leaved bulbous plants, and consequently must not be crowded too much.

It is considered that only a fine sandy loam is suitable for the production of these tubers and it is almost imperative that it be capable of being put through a $\frac{1}{4}$ -inch mesh. Three years of good culture in the seed bed is necessary to grow stocks above this size. Even then a $\frac{1}{8}$ -inch mesh may be advisable for sieving. It has been found impossible to dig 2-year-old seedlings satisfactorily, for experienced diggers are not able to find half of the tubers.

There seems to be little difficulty with the plants after they are once established either in the East or in the West. Sometimes a consignment is infested with a smut that makes leaf pustules which rupture, exposing the black spore masses at or just after the ripening of the seed. If this smut appears, the best plan is to produce the seed crop and then dig and burn the tubers and tops. Just how serious this smut is cannot be said definitely, but there is danger that it may attack any of the so-called buttercups, trollius, and possibly anemones and ranunculus.

There are two main species, *Eranthis hyemalis* (fig. 5) and *E. ciliica*; both are desirable, but the former is the better known. A

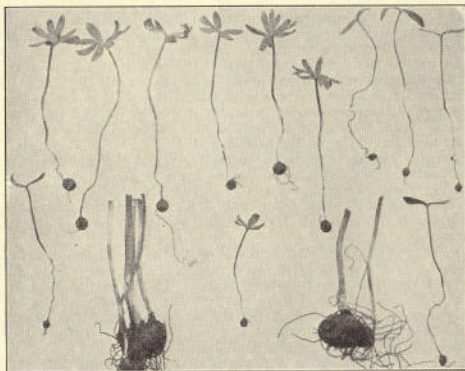


FIGURE 5.—*Eranthis hyemalis*, showing plants 1, 2, 3, and about 6 years of age. All are self-sown from imported stocks. The tubers are globular and the second year are about the size of a sweet-pea seed.

hybrid between these two is offered at times as *E. tubergeni*. It is said to be infertile and high-priced and is likely to remain expensive because of the necessity of resorting to the slow vegetative method of reproduction.

EREMURUS (Desertcandle, Fossil-Lily)

The Asiatic genus *Eremurus* is seldom seen in the American garden, for the reason that the plants are not only expensive but difficult to procure at any price. Stocks in this country have always been negligible, and foreign stocks have cost at wholesale about 50 cents apiece plus transportation, duty, and other expenses. Added to this high price have been the uncertainties of success, for failures with the plants have been more common than successes. Besides all these obstacles, vegetative reproduction is altogether too slow to be practicable for the nurseryman's purposes.

There are a number of desirable hybrids, such as *Eremurus himrob*, *E. tubergeni*, and *E. isbellinus*, but the *eremuri* mostly grown are native species which come true or nearly so from seed. With a little patience these can be produced in ample supply in the Pacific Northwest. It takes 6 or 7 years to bring the plants to blossoming size, but seed is produced each year, and the area occupied is small for the first 3 or 4 years. Seed sown in the fall germinates in the spring when handled as advised on page 4. To insure the plants coming true, it is of course necessary that species be grown separately, otherwise insects will cross-pollinate them and produce mixtures (fig. 6).

ERYTHRONIUM (Troustily, Dogtooth Violet, Lambstongue, Adderstongue)

The species of *Erythronium* are characteristically North American plants. They are very numerous and very beautiful but comparatively little grown and rather difficult to obtain in large quantity, although abundant in the wild state. Several cultivated forms of *E. dens-canis* are offered for sale in Europe, but most of the species sold in the United States are stocks collected from the wild. Their abundance in nature doubtless accounts, in a large measure at least, for the meager attention given them in nurseries. The time may come when bulb growers will take up the culture and furnish a more standardized and better product than can be supplied in the limited quantities that are now collected from wild stock.

There are a large number of desirable species, ranging in color from pure white through yellow and orange to deep pink, that may be secured from collectors. Some of the species reproduce abundantly by offsets; others give but few offsets. Even some of those that propagate vegetatively can be more profitably reproduced from seed. This is particularly true of *Erythronium hartwegi*.

Experience with seedling culture at the Bellingham Bulb Station has been mostly with *Erythronium grandiflorum* and *E. hartwegi*, grown both from seed collected in the wild and from the cultivated plants. About 4 years of field culture are required to insure good flowering, although a few flowers are often seen the fourth season.

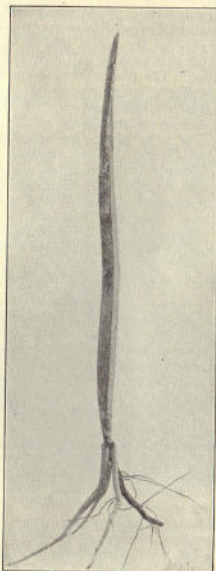


FIGURE 6.—*Eremurus robustus*, the second year from seed.

Stocks produced on Puget Sound have thrived in the vicinity of the District of Columbia.

In the culture of the erythroniums at Bellingham few difficulties have been experienced. The oldest corms are of *E. hartwegi*. They are 5 years old, from collected bulbs, have been dug and reset twice, and show no signs of deterioration. The only caution that seems desirable now is not to plant so thick as to prevent good aeration. The western United States species seem to be susceptible to the same sort of fire as the tulip, and it is believed that if large plantings are made this trouble will have to be reckoned with, as it is in tulips and lilies. The plants seem to require the most careful sanitary methods of culture.

The conventional method of seeding is followed. Rows 4 inches apart across the 3-foot bed, with seed 1 to 1¼ inches deep and 100 to the row, give good satisfaction. The plants are not disturbed until after the second or third year.

The complaint is often made that the lambstongues fail to flower regularly, but at Bellingham the western species do not justify this criticism when field-grown with a fertility usually accorded other bulbs. No complaint can be made of *Erythronium hartwegi*, *E. revolutum*, *E. hendersoni*, and *E. grandiflorum* when given field culture in open ground and moved every second or third year.

FRITILLARIA (Fritillary, Snakehead)

Fritillaria is a genus of interesting rather than showy plants, so closely related to the lilies that many of the numerous species have been included in the genus *Lilium* at one time or another. Although generally not showy, some of the species are very attractive and are admirably adapted to rockwork and edgings, while others make bold clumps which endure indefinitely in the border or even in neglected nooks in the uncultivated garden.

Fritillaria imperialis is the best known species and one of the most dependable but is not very popular. It is not at all typical of the genus. *F. meleagris* is much more typical, and many varieties of it are offered. These of course must be reproduced vegetatively, but as the varieties are mostly grown in mixtures they are adapted to be produced from seed, since they are good seeders and reproduce rather slowly by the bulb. Seed of the horticultural varieties of *F. meleagris*, however, come true in a large measure, and the stocks can be made true to type by roguing.

The seed is handled precisely like that of the lily. At the Bellingham Bulb Station it is sown in late August for March germination, but any time during September and October will do as well, and even spring planting is satisfactory. The seedlings are left in the seed bed for 2 years, then dug and spaced. At the end of the second growing season the bulbs may attain a maximum circumference of 4 centimeters. A few blossoms are usually produced from the largest bulbs the third year, but no merchantable bulbs should be expected until after the third growing season, and unless conditions are good a fourth season may be required to bring them to a merchantable size of 6 centimeters (fig. 7).

Most of the interesting native American species, so much neglected, reproduce either by seed or by scales, the latter often being no larger than grains of rice and abundantly produced on the thick, fleshy basal plate.

GALTONIA CANDICANS (Summer-hyacinth)

Syn. *Hyacinthus candicans*

Galtonia candicans or summer-hyacinth is a tall, stately plant, related to the garden hyacinth but very different in its general aspect. It is much neglected in this country, but has many admirable qualities.

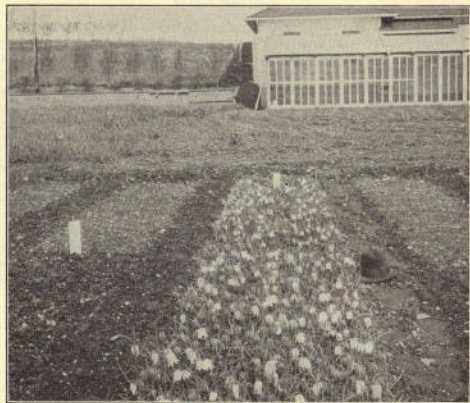


FIGURE 7.—*Fritillaria meleagris*, the fourth year from seed.

A clump in the border is very showy in August, when the long spikes of pendent white bells show off to good advantage interspersed among shrubs, delphiniums, and other plants of similar stature. When once established they remain indefinitely. At the Bellingham Bulb Station they do not appear aboveground before May.

An important characteristic of this species is its good merchandising quality. The bulbs may be kept out of the soil all winter in suitable storage and planted in the spring, although they are perfectly hardy and may be left in the ground undisturbed for years.

There is a small reproduction by bulb cleavage, as in the daffodil, but by far the best method of propagation is to plant seed and keep new generations of young seedlings coming on all the time. At Bellingham the seed is planted the latter part of August for April or early May germination. It is handled as advised on page 4. There

seem to be no difficulties involved in the culture except that it may be necessary to cover the seedlings with an extra inch of soil after the first growing season.

Although it takes 4 years to bring the seedlings to the blossoming stage, it is much cheaper to work up stock in this way than to depend on the natural increase of the bulbs.

GLOXINIA SPECIOSA

(See *Sinningia speciosa*)

HIPPEASTRUM VITTATUM (Amaryllis)

Syn. *Amaryllis vittata*

The gorgeous *Hippeastrum vittatum* hybrids of the conservatory and greenhouse, commonly known as amaryllis, are constantly increasing in popularity as the householder gets better acquainted with them. At one time the only ones on the market were produced in greenhouses. Florida and California growers are now producing them by the acre.

The bulbs throw a few offsets, especially during the first 3 or 4 years, but reproduction by this method is never rapid enough to serve the commercial grower.

J. Wise Byrnes, assistant in charge of the Division of Gardens and Grounds, Bureau of Plant Industry, has worked out a method of vegetative reproduction in *Hippeastrum vittatum* analogous to the scooping of the hyacinth. In the process, however, he reams out the base inside the root ring and then pots the bulb and keeps it growing without cessation for 2 years, when the bulbets are potted off separately. Even this is a slow method, but it accomplishes a moderate propagation when it is desirable to perpetuate certain individuals.

The difficulty of vegetative propagation has compelled the use of mixed seedlings in commerce. No good grower, however, plants all the seed he can produce; on the contrary, he saves for planting only seed from plants that produce flowers of the better colors. In *Hippeastrum vittatum*, as in the *freesia*, *ranunculus*, and many other groups, there is a tendency for seed stocks to deteriorate through the ascendancy of the more vigorous plants of the less desirable colors; consequently, it is necessary to give constant attention to the selection of seed in order to maintain the best colors.

The seed matures in the greenhouse in May and may be planted soon thereafter. Germination takes place promptly and the seedlings grow vigorously, making bulbs 4 centimeters in circumference in 1 year. They should be pricked off into 2-inch pots before the end of the first growing season and must be shifted to larger pots as they require more room. It is best to keep the seedlings growing in the greenhouse without cessation until they flower, which, under good conditions, will be in 2 years. Under out-of-door culture the plants become dormant at the approach of winter, and therefore require a longer time to produce the flowering bulbs.

Two errors are commonly made in handling *hippeastrum*. One is to neglect the plants during their growing season, and the other is to

provide improper winter storage conditions. From blossoming time until fall is the time that the plant builds up reserve strength for the next season's performance. During the winter the plants should be kept relatively dry and at a temperature of 45° to 50° F.; a higher temperature causes desiccation, and a lower one prevents proper development of the flower spike, which takes place during this season. The seedlings, on the other hand, need to be kept growing vigorously, if at all possible, from germination to flowering, after which a period of dormancy from frost in the fall to the starting of growth in the spring is necessary.

HYACINTHUS AZUREUS (Grape-hyacinth)

Syn. *Muscari azureum*

One of the most highly prized of the grape-hyacinths is *Hyacinthus azureus* (*Muscari azureum*), appreciated largely on account of its peculiar porcelain-blue color, so rare in plants. All the other popular species of the genus have a very profuse vegetative reproduction which is ample, but *H. azureus* seldom increases at the bulb and consequently must be grown from seed.

Seed planted at the rate of 150 to a 3-foot row, the rows 4 inches apart, will have room enough for 2 years, when the seedlings may be lifted and reset for 1 to 2 years longer with about three times the space. If cultural conditions are good, some blossoming may occur the second year and plenty the third.

The bulbs reaching this country are usually 5 to 6 centimeters in circumference. They start to blossom with a small spike of flowers at about 3 centimeters and continue to increase in size and perfection of blossom up to a maximum of about 8 centimeters.

For further information on this and other species of the genus the reader is referred to another publication.²

INCARVILLEA (Incarvillea)

There are two main species of *Incarvillea* of ornamental value, that have tuberous, thickened roots. They are natives of China and are perfectly hardy in the eastern United States as well as in the Pacific Northwest. Both *Incarvillea delavayi* and *I. grandiflora* will persist undisturbed in the herbaceous border for many years and without undue crowding. The plants are quite different from the ordinary bulbous stocks and belong to the *Bignoniaceae*, the ornamental species of which are largely shrubs. These small herbaceous plants with their large bignoniaceous trumpets are unusual, and the foliage is attractive.

The plants are particularly well adapted to regions like Puget Sound where late spring frosts are likely to occur, for they do not appear much before May 1, and their seed is ready to gather by the middle of August. Not only do they start late, but the early growth hurls the ground very closely for several weeks, making the plants still less subject to injury (fig. 8).

² GRIFFITHS, D. PRODUCTION OF GRAPE-HYACINTH BULBS. U. S. Dept. Agr. Bull. 1327. 15 p., illus. 1925.

Seed sown in late August soon after it ripens comes up in late April when handled as advised on page 4.

JUNO IRIS (Juno Iris)

The interesting bulbous species of Juno iris are most advantageously grown from seed in the Pacific Northwest. Planting in the fall brings certain germination in the spring.

Trouble with seed germination is often experienced in some groups of iris, but conditions on Puget Sound seem well adapted to this form of propagation in the Juno and some other difficult groups of the genus. The main advantageous condition is an assured moisture

supply close enough to the surface of the ground to obviate any danger of the seed drying out at any time from planting until the seedlings are up and well on their way. Even the *Regelio-cyclus* group seems to thrive under these conditions and comes up promptly in late spring from late summer planting.

The three species of Juno iris—*Iris orchitoides*, *I. sibirica*, and *I. bucharica*—have blos-



FIGURE 8.—*Incursilla grandiflora*, beginning of second year's growth from seed.

somed a little the third year at the Bellingham Bulb Station and quite fully the fourth growing season under entirely out-of-door and very ordinary conditions and with no special treatment. In 1929, which was a late season, *I. bucharica* was in full blossom on April 20.

It is best to leave the seedlings undisturbed in the seed bed for 2 years, because the bulbs are too small to handle the first year.

Juno irises are rather difficult to handle at any time. When properly handled they do not rot nor deteriorate more than many other bulb stocks, but the long, sprangly, brittle, fleshy roots are likely to be broken off or bruised. In either case molds are likely to find access to the watery tissues and cause damage. The bulbs should therefore be grown in a friable loam soil from which they can be dug with the least difficulty. Seedlings are easier to segregate and protect from bruising than are the vegetatively propagated stocks with intertwined fleshy roots (fig. 9).

The marketing of Juno iris is fraught with the same mechanical difficulties as the field handling. The bulbs must be handled individually in every pack. This adds to the cost and such stocks cannot be produced cheaply.

IXIOLIRION (*Ixiolirion*)

The word *ixiolirion*, meaning an ixialike lily, is one of the peculiar idiosyncrasies of plant names. An *ixialike* lily is not a lily at all, but an amaryllid, more closely related to the daffodil than to the lily, since the floral parts are superimposed upon the seed vessel rather than on top of the stem below it.

Ixiolirion is an early summer bulb rather than a spring bulb. It comes up early, but on Puget Sound does not blossom until late June. The seed matures rather promptly, being ready to gather by late July or early August. The bulbs are not very different from small tulip bulbs, and they merchandise about as well. The plant is not nearly so well known as it deserves to be.

Seed sown at the Bellingham Bulb Station in late July comes up the latter part of April. It is sown about 1 inch deep in rows 6 inches apart and is allowed to remain undisturbed for 2 years. If sown thinly, not over 75 plants to the 3-foot row, it may remain 3 years without being disturbed, when it should blossom profusely.

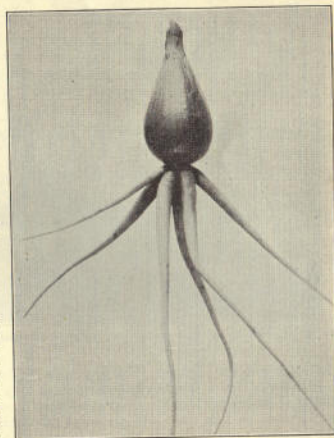


FIGURE 9.—A 4-year-old seedling bulb of *Iris sibirica*.

LACHENALIA (Cape-cowslip)

The Cape-cowslips have a beauty, ease of culture, persistence, and freedom from injurious plant and animal pests that should commend them to both producers and consumers in warm regions. There are a

large number of horticultural varieties that presumably can be reproduced only vegetatively. The native species from South Africa, however, grow wonderfully well from seed. Some of the varieties reproduce exceptionally well from offsets, while others produce few offsets or none at all.

About 4 years of work with these plants under greenhouse conditions seems to warrant the statement that they present no difficulties that need worry any grower who has had ordinary greenhouse experience.

Some years ago a quarter of an ounce of seed of each of 2 varieties was sown in 2 greenhouse flats, both netting about 5,000 bulbs at the end of the first year, although sown too thickly by far. No blossoms were produced the second year. The seed was sown in December, and the bulblets, after maturing in June, were left in the flats until September, when they were taken out and planted with more space in other flats.

At present 10 species are being grown from South African seed and about 3 dozen varieties from bulbs imported from Europe. All the seed imported has germinated readily, and under greenhouse conditions the bulbs are grown to flowering size in 2 years (fig. 10).

The particularly advantageous characteristic of these plants is their ready adaptability to continuous greenhouse culture. They



FIGURE 10.—A pure yellow South African species of *Lachenalia* (*L. aurea*), grown under glass from imported seed.

thrive through the season when grown in flats or pots. They may be left there to dry after they die down, and may be repotted again for the next season with continuous good condition of the bulb. Under greenhouse culture the bulbs are most advantageously stored during the summer undisturbed in the soil in which they were grown.

LILIUM (Lily)

The horticultural varieties of the genus *Lilium* can, of course, be reproduced true to type only by vegetative methods. However, the various species of the genus are, to a remarkable degree, unmodified by hybridization or selection. As a rule, these can be produced best from seed, and a number cannot be reproduced satisfactorily in any other way. Directions for handling these are fully set forth in another publication.²

² GRIFFITHS, D. THE PRODUCTION OF LILY BELLS. U. S. Dept. Agr. Circ. 102, 56 p., illus. 1920.

NARCISSUS (Narcissus, Daffodil, Jonquil)

The culture of daffodils from seed is difficult and requires much time. However, the necessity of growing stock from a single seedling to insure the identity of all the plants in a horticultural variety is more burdensome than is the period of years required to bring a plant from seed to maturity (blossoming). The development of a seedling bulb in flower into a commercial stock takes much longer and is much more tedious than growing a seed into a flowering bulb.

There is a great deal of interest of late in some of the small natural species of daffodils so admirably adapted to both rockeries and bedding plantings. These species are well suited to reproduction from seed. *Narcissus triandrus* *albus* is one of the best. It produces seed in great abundance, and reproduces true to type, like most natural species of plants (fig. 11). The crop of seed matures in late June and on Puget Sound may be planted in August to germinate the following March.

The regular method of handling seed at Bellingham, as detailed on page 4, has admirably sufficed to produce perfect stands of seedlings. Two hundred and fifty bulbs occupying a space 3 by 6 feet produced enough seed 1 year to net over 7,000 seedlings. Although it requires 4 years of culture and handling the plants every other year to bring them to maturity, seeding is a much more satisfactory method of reproduction of this and kindred species than waiting for the reproduction of the bulb, which at Bellingham seldom divides into more than 3 in 2 years. The advantage of increasing stocks from seed will be readily appreciated.

ORNITHOGALUM

(*Ornithogalum umbellatum*)

The common star-of-Bethlehem is the most familiar representative of the large genus *Ornithogalum*. Growing it from seed is entirely unnecessary; indeed, no effort is required to make it grow after a



FIGURE 11.—*Narcissus triandrus albus*, a species that is most advantageously grown from seed.

single scrap has been covered with earth in almost any position. However, it reproduces and volunteers readily from self-sown seed.

On the other hand, *Ornithogalum nutans* is not so prolific and is most advantageously produced from seed. *O. thyrsoides* from South Africa produces plenty of bulletlets from both bulbs and leaves. *O. lacteum* (the Darling chincherichee) is less lavish with its vegetative propagation if the bulbs are favorably situated (fig. 12). However, it comes so readily from seed that seeding is the logical way in which to handle it. *O. pyramidale* and *O. arabicum* also seem to multiply best by seed.

The most hardy and persistent of these species is the star-of-Bethlehem. *Ornithogalum thyrsoides*, *O. lacteum*, and *O. arabicum* are tender except in California and the immediate Gulf coast. They are all easily grown from seed under greenhouse conditions or in coldframes, blossoming profusely the second year. At Bellingham seed of *O. lacteum* was sown in the fall in the open, 1 inch deep, and germinated in April. Very careful mulching carried the seedlings through the first winter, and they blossomed well the next year, but all were killed the second winter.

PUSCHKINIA SCILLOIDES (Striped Squill)

Syn. *Puschkinia libanotica*

Of all the early spring-flowering bulbous plants the striped squill is the most dependable. It is seldom known to fail. Adapted to the same uses as the chionodoxas and following them at a little later date, it is suited to positions ranging from the rockery to naturalization in grasslands. It is different from any of the other spring flowers, and is vastly more showy and robust than the chionodoxas or early squills. The flower spike is massive for so small a plant, often containing 15 or more florets. The lamina of the petals is very light blue or nearly white with a bright blue stripe on the midrib, giving the mass a pleasing effect.

Puschkinia scilloides, so similar to the chionodoxas, does not have a satisfactory vegetative method of reproduction by the splitting of the bulb. Like the common hyacinth it requires about 6 years to reproduce, and even then the volume of reproduction is very moderate. The vegetative method, by the natural splitting of the bulb, as in the hyacinth, might seem the logical way to propagate it; but this method has its disadvantages: It takes too long; it is more expensive than reproduction by seed; and, when grown too long, the bulbs are subject to the same sort of deterioration as are those of the hyacinth. In view of these facts, reproduction by seed is to be preferred until horticultural varieties appear, when a vegetative method will have to be employed.

Planting is usually done in late August or early September, but any time in the fall will do, as germination takes place in March. A seeding made one spring did not come up until a year later. Seed may be planted 150 to the 3-foot row, 1 to 1½ inches deep, in rows 4 inches apart. Experience indicates that the seedlings can profitably remain in the seed bed not less than 2 and possibly 3 years, when 25 to 50 percent of the bulbs will be large enough to sell as the smallest and most advantageous size for the consumer. It is always

best for the gardener to get bulbs that have just reached merchantable size.

The striped squill begins to blossom with 1 or 2 florets when the bulbs are about 4 centimeters in circumference. The bulbs grow to



FIGURE 12.—*Ornithogalum lacteum*, grown from imported seed.

be 7 to 8 but rarely 10 centimeters. Imported bulbs measure about 5 centimeters, rarely 6, and it is thought represent 3 years' growth from seed. The results obtained at Bellingham have been strictly under field conditions on soil that is not overrich and with no extra feeding or attention. They therefore represent what any

grower who exercises ordinary care in culture may expect. With careful selection of soil and a little extra fertility, 1 year in 4 may be gained (fig. 3).

QUAMASIA (Camas, Quamash)

Syn. *Camassia*

Quamasia (Camassia) is strictly an American genus of plants, most prominent in the West, but having one representative in the East. The name is Indian, and the bulbs were an important article of aboriginal diet. The larger-bulbed species are not edible, on account of a bitter substance that they contain; the smaller ones, such as *Quamasia quamash (Camassia esculenta)* and *Q. hyacinthina (C. Fraseri)*, are extensively used.

Present demands from trade sources in this country are supplied from the wild, but the species are grown by bulb nurserymen in Europe and are regularly offered for sale to growers. Since the wild sources of supply are still plentiful in the United States and the collected bulbs are satisfactory, it may be some time before it is necessary to propagate them.

Some of the species divide freely at the bulb when they grow old, but the larger-bulbed varieties, such as *Quamasia leichtlini* and *Q. cusicki*, are slow to divide. Even those in which a good division occurs after a number of years are much more satisfactory when developed from seed.

On Puget Sound seed is best sown in the fall and comes up in early spring. In the case of *Quamasia leichtlini* and *Q. cusicki* it seems best to sow the seed thinly enough in the row so that the beds need not be disturbed for 2, 3, or even 4 years. The seedlings of these species have a peculiar habit of dropping to a lower level the second year, making them difficult to dig satisfactorily. It is not uncommon to find the small bulbs fully 4 inches long with their greater part no larger in diameter than a knitting needle (fig. 13). The next year the bulbs round up at the lower level and assume their normal form.

A collection of camas grown for propagation on Puget Sound must be rather carefully looked after when the flowers have faded. The readiness with which the seed grows when allowed to shatter is likely to cause mixtures in any collection of varieties that is neglected. With sufficient moisture and fertility the bulbs may persist for several years in cultivated fields. Since the leaves are mostly radical and therefore not seriously injured by mowing, the plants persist indefinitely in meadows. At Bellingham 4 species persisted in a timothy and clover meadow for 6 years.

RANUNCULUS ASIATICUS (Persian Buttercup) AND ANEMONE CORONARIA (Poppy Anemone)

In each of the genera *Ranunculus* and *Anemone* there exists a species, *R. asiaticus* and *A. coronaria*, which has given rise to a vast

amount of decorative material. The derivatives of these two species have so overshadowed their respective genera that it may be forgotten that each genus is large and includes a very extensive assortment of garden and greenhouse material. Since the average grower thinks of *R. asiaticus* and *A. coronaria* only as ranunculus and anemone, they will be discussed together in this circular, not because they are alike, but because the production of stocks by the grower involves the same treatments.

The conditions of southern California seem best suited to the commercial production of these two groups of ornamentals (fig. 14). Like so many bulbous- and tuberous-rooted plants, they seem to need to mature into a drought. This is exactly the condition they meet in California, and the climate there is so mild that there is no interference with their vegetative development.



FIGURE 14.—A field of French ranunculus in California.

Their culture is very simple. Seed is planted in September in drills 12 to 15 inches apart, or in beds about 3 feet wide, under open-field conditions, and in soil that is fertile but without raw manures. The seed is sown about three fourths of an inch deep, and the soil is thoroughly firmed over it as soon as it is planted. Germination takes place rather promptly and growth continues through the winter and the next summer, when the plants become dormant and the tubers are ready to dig.

The greater part of these crops is ready for the market at the first digging, or 1 year after the seeding. A considerable percentage of the roots will not have reached marketable size, and these, together with the propagation from the larger tubers of ranunculus, are left to continue growth another year. The best growers believe that 2 years is the limit for commercial culture of any progeny of seedlings because of the difficulty of maintaining the health of the stock longer. In fact, some growers experience difficulty with corn roots even in the second year. As in freesia culture, one of the difficulties results from the too-frequent use of the land for these crops. Some



FIGURE 13.—A seedling of *Quamasia leichtlini* at 2 years of age. Six inches of the plant above the roots is shown; 5 inches of this is bulb. The seed was planted 1 inch deep and left in the seed bed 2 years.

growers have rotated ranunculus with anemones, which is no rotation at all, as these crops may be considered the same so far as effect on the soil is concerned.

In the ranunculus a natural division of the roots takes place during the period of growth even in 1-year seedlings, but in the anemone the division is mostly effected by cutting the roots. When the production is on a seed basis with little carrying over of the roots from year to year, vegetative propagation is of little moment.

Thus far dependence has been placed mainly on imported seed from European specialists. No one has as yet undertaken to supply growers with home-grown seed, as is done abroad. Producing good seed of these items is fully as technical as producing that of the pansy, petunia, or many other plants. Growers of either ranunculus or anemone seldom attempt to save their own seed. As good seed of ranunculus and anemone can be grown in this country as in any other. There is no reason why there should not be American strains of these groups as well as those of French, Italian, and Irish derivation. A domestic seed supply is needed, and the industry will not be fully rounded out until such supply is available.

SCILLA (Squill)

There are two groups of squills that can be produced most practically from seed. The first is represented by *Scilla sibirica* and *S. bifolia*; the second is derived from *S. italica* and is seldom seen in this country, although a desirable ornamental.

The general discussion of chionodoxa applies to these plants, which fill a similar place, have the same uses, methods of culture, and blossoming season. On the whole, *S. bifolia* is the most delicate of the early spring bulbs considered here. It has a good truss of a dozen small flowers, but is likely to be mistaken for a small-flowered *Chionodoxa sardensis*. *S. sibirica* (*amoena*) is particularly attractive on account of its charming delphinium-blue color, so rare in plants. It also has a white variety, and both reproduce fairly true from seed. *S. bifolia* has, in addition to its white form, numerous other attractive varieties seldom offered for sale (fig. 15).

The second group of squills to be raised from seed is that derived from *Scilla italica* (Italian squill), which is entirely different from the other early forms, being more closely related to *S. hispanica* (*campanulata*) or the Spanish squill. These are large plants, a foot high, that do not blossom until May or early June. They make some division of the bulb when old, but not enough to be a practical method of propagation for commercial purposes. They possess on this account some advantages over *S. hispanica* and common blue squill, *S. nonscripta* (*natans*), for when placed in permanent positions they do not need to be divided so often.

The Italian squills are good seed producers and volunteer from self-sown seed in any border or similar planting unless the flower spikes are removed before the seed ripens. On Puget Sound the seed is best planted in late August or September, 1 to 1½ inches deep, in rows 4 inches apart, left for 2 years, then dug and spaced. A few blossoms may be seen the third year, but full blossoming occurs the fourth year. The production of bulbs is therefore a 3-year job. The seedlings thus handled need be dug only twice before being sold. The bulbs are large and consequently need vastly more space

than *S. sibirica*. At the end of the 2 years in the seed bed they should go into rows 6 inches apart.

The Italian squills are of no value for forcing, but *Scilla sibirica* and *S. bifolia* make very attractive pot plants. No attempt to bring them in early should be made, for any attempt at forcing will prove disastrous. If the plunged pots are brought into a carnation

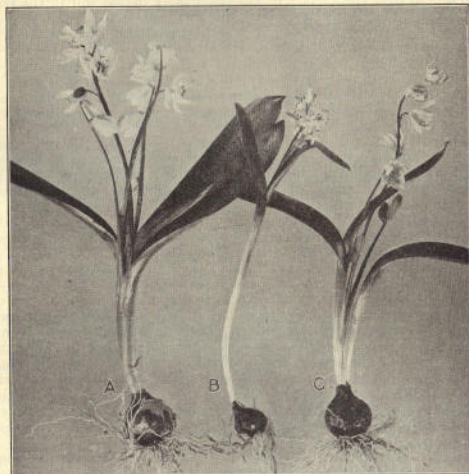


FIGURE 15.—A and C, *Scilla sibirica* (A, white; C, blue); B, *S. bifolia*.

temperature after January 1 and carried in good light, blossoms may be had by the middle of February, which is as early as it has been possible to get Puget Sound bulbs into good flower.

The Italian squills consist of a single species that, like the Spanish, is offered for sale in blue, white, and pink.

SINNINGIA SPECIOSA (Gloxinia)

Syn. *Gloxinia speciosa*

The production of gloxinia tubers for the market is a task for the specialist, although when the nature of the plants is known there is nothing really very difficult about the culture. The necessary equipment is neither elaborate nor expensive, but conditions of culture must be under absolute control. To succeed with these plants one must be able to maintain a temperature of 60° to 70° F., partial shade, and high humidity.

Soil for gloxinia culture should be high in organic debris that is not completely decomposed. Rotted fibrous turf, sand, leaf mold, and turf, or any similar compost that is light, airy, porous, and retentive of moisture is suitable. On the Pacific coast, native peats and woods soils seem well suited.

The seed of the gloxinia is so small that when planted it can only be dusted over the surface of the moderately firmed soil in the pots or pans. Frequently it receives no covering, but is only pressed lightly with the pot firmer; if it is covered at all, the soil must be very fine and not too much of it put on. The pots are then kept constantly moist, without sogginess, and held at a temperature of 65° to 70° F. It is usually advisable to cover them with a glass in order to maintain suitable moisture conditions until the plants are up, when more light and air are necessary. When the seedlings have become large enough to handle they are pricked off into flats or 3-inch pots and will require still another shift into 4- or 5-inch pots within 6 months. If well grown, they should begin to blossom in 7 months. During this entire period the atmosphere should be kept constantly moist, and fair lighting but no direct sunshine should be maintained.

If seed is sown in January, the plants should be in blossom in July or August. By making successive sowings, blossoming stocks from seed may be had nearly throughout the year.

In commercial production of the bulbs in this country dependence is placed almost entirely on production from seed. This is saved from the best plants, which give varicolored progenies, but all of them are attractive and desirable. A grower seldom saves his own seed. As with many other bulbous plants, it is much easier to produce new corms annually from seed than to attempt to carry the corms over to the second season, although this is commonly done with those that do not make marketable size. Usually, in commercial handling, no attempt is made to carry the stock over to the second year. A crop of seedlings sown early in the year is marketed in the fall and another new crop is grown from seed for the next year.

Should one desire to perpetuate certain colors, this can be done only by vegetative propagation, which is accomplished by means of leaf cuttings. Leaves are removed from the plants, preferably with a portion of the stem attached, are laid with the under surface in firm contact with moist sand, and kept moist at a temperature of about 65° F. To accomplish this it is customary to hold the leaves down with pebbles or by a half inch of sand covering only one half to two thirds of the blade. The midrib may be cut at several points. Bulblets form in about 3 months, and blossoming plants occur in about the same time as from seed.

The plants may also be propagated by dividing the corms. Just as growth starts in the spring the corms are divided with a sharp knife into as many pieces as there are shoots from the crown. The divisions are potted separately and handled like old corms.

Gloxinias are usually started in January or February. The type of soil heretofore described is suitable for potting the stocks purchased from dealers. It is a good plan to use a pot that will just hold the corm, and to shift the plants when they are about half

grown. The potting should be rather firm, but the crown of the plant should always be free of soil. A temperature of 65° to 70° F. at night is suitable for starting and growing the corms. The air should be kept moist by an overhead spray during early growth, but as the leaves expand, water should be kept off both leaves and flowers.

If it is desirable to keep the old corms for another year, the pots can be allowed to dry off gradually and then be turned on their sides under the benches or in the cellar where they will not dry out too much. When it is desirable to economize space, the corms may be stored in dry sand in flats or boxes. The storage temperature should not fall below 50° F.

TIGRIDIA (Tigerflower, Mexican Shellflower)

The Mexican shellflower or tigerflower is readily and easily reproduced by the natural division of the bulb. The reason for including it in a list of bulbous plants to be grown from seed is that the demand for it has been so great during the last few years that nearly all sales have been by retail. Few dealers, let alone jobbers, have been able to get stock to handle. Culture from seed is therefore necessary in order to develop adequate supplies.

Under most conditions the plants are heavy seed producers, at least during a portion of the long blossoming season. At the United States Plant Introduction Garden at Chico, Calif., it was found that seed production was ample after the middle of September. Before that time the weather is apparently too hot. In the vicinity of Washington, D.C., seed sets readily, but the verberna bud moth (*Olethreutes hebesana* Walk.) is so destructive that only a comparatively small supply is ever gathered. On the other hand, seedling is abundant on Puget Sound, and no pests have appeared thus far. Success is also reported from Michigan.

On Puget Sound seed may be planted 1 inch deep at any time between fall and early spring when the ground can be worked. Seed has been sown in flats in the greenhouse at the Arlington Experiment Farm, Rosslyn, Va., about January 1. When all danger of frost was past, the contents of the flat were transferred to the field without disturbance. A little blossoming occurred in late fall. Seed sown under sash protection in midwinter at Chico, Calif., has blossomed profusely by the middle of September and produced merchantable bulbs.

Care is necessary in winter handling of tigridia. The bulbs must on no account be allowed to freeze. When dug, the large fleshy roots must be carefully preserved without bruising, and thoroughly dried before being put away for the winter in boxes or bags. This takes a long time, but if the roots are not dried thoroughly the bulbs will not keep; neither do they keep well if the roots are broken off. First-year seedlings keep best when thoroughly dried and then stored over winter in dry earth.

The bulbs must be protected from mice. Neglect for 2 or 3 days has cost some growers their stocks.

Variations of a pleasing and important nature are likely to occur in any batch of seedlings. Several of these variations have been segregated in Europe as the bases of horticultural varieties, and some such varieties have been started in this country.

TRILLIUM (Trillium)

Although some writers advise propagating trilliums by division of the corms in early spring, a limited experience with them indicates that they may be more advantageously increased by seed. Experience at the Bellingham Bulb Station seems to show that both *Trillium sessile californicum* and *T. grandiflorum* produce seed abundantly and that the seed germinates readily in the spring from late August seeding. Both varieties behave very much alike.

Trillium sessile californicum, collected in the Siskiyou, reproduces by corm multiplication rather slowly. There have never been more than four blossoming stems in 6 years from an individual corm.

The reproduction by seed is also slow, requiring 6 years to bring the corms to flowering size. However, considering the ease of culture, abundance of seed production, certainty of germination, and the very small space occupied for the first 4 years, the production is not tedious after the first period of maturity is past, if seed is sown each year.

At Bellingham the seed has been drilled in about six to the inch, in rows 6 inches apart across a 3-foot bed, and left 4 years without disturbance. The seedlings are then reset and spaced 1 inch apart in rows 6 inches apart. In this arrangement, 1,000 plants occupy but 3 or 4 feet of a 3-foot bed during the first 4 years. The next 2 years they need 20 to 25 feet. They have been grown in partial shade on a Lynden gravelly loam.

Trillium sessile californicum is a striking plant vegetatively, although its blossoms may not be so attractive as those of some of the other species. At Bellingham it is a robust, strong grower. The blossoming period is from mid-April to late May. It takes a long time for the flower to reach full size, and each one produces a well-filled fruit (fig. 16).

TULIPA (Tulip)

Growing from seed is recommended for the very interesting, often quaint, and more often decidedly decorative natural species of tulips, but not for the ordinary garden tulips. The native species are infrequently listed, and only the discriminating buy them. A few foreign growers list them at a rather high price. *Tulipa sylvestris* is probably the best known, for it more nearly approaches the stature of the highly bred garden tulip. There are, however, especially desirable native species that are just beginning to be appreciated in this country.

The rapidly developing popularity of rock gardening and the greater appreciation of the small and delicate flower in contradistinction to the demand for size are turning attention more and more to the natural species of tulips. No bulbous plants are better for the rock garden than such tulips as *T. dasystemon*, *T. turkestanica*, and *T. clusiana*, which are all but unknown in the United States.

Delicacy is not their only qualification. Some of them show great possibilities on account of their adaptability to warm climates. *Tulipa clusiana*, *T. sylvestris*, and others seem well adapted to culture in warm regions. *T. clusiana* seems well adapted to the conditions as far south as northern Florida, and *T. sylvestris* seems to do as well in North Carolina as on Puget Sound.

The most practical way to grow most of these species is from seed, which is produced abundantly. The seed resembles that of the lily, and seedlings are as easily grown. There is usually a small reproduction from the bulbs, but seed sown on Puget Sound in September will germinate in March, and a progeny should become fully mature and be ready for the market the fourth year, if handled every 2 years. The bulbs are not large enough to dig out of the seed bed until the close of the second growing season. They should then be dug and spaced. The fire blight, which so often prevents seed production on Puget Sound, is less likely to be a menace in a warm region.

ZANTEDESCHIA ELLIOTTIANA (Golden Calla, Yellow Calla)

Syn. *Calla elliotiana*

The common white calla is reproduced by offsets that are produced abundantly by the old tubers. The golden or yellow calla of commerce may be reproduced in the same way. However, certain difficulties connected with the vegetative reproduction of the yellow calla make it advisable to resort to seed propagation.

It is a peculiarity of this group that there is no distinct line of demarcation between the old and the new tuber; the only provision for getting rid of the old, useless portion that has flowered is for it to rot off. Often this is the undoing of the plant, for this rotting, especially in the presence of abundant moisture, is likely to continue into the new portion of the tuber instead of healing up as it should. For this reason the maintenance of health in vegetatively propagated commercial stock of the yellow calla has always been more or less difficult.

The commercial production of tubers from seed is the most satisfactory, the seed being planted annually and the crop turned off at about 3 years of age. The grower develops the stock to merchantable size and then disposes of it, depending upon the next batch of seedlings for the next annual sales.

In regions to which these tubers are adapted, like California, seed production is ample and the seed germinates readily under suitable temperature and moisture conditions. Under greenhouse handling,

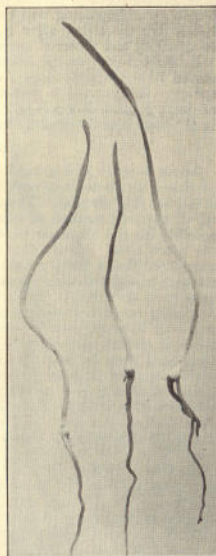


FIGURE 16.—*Trillium sessile californicum*, 2 years from seed.

as well as under good cultural conditions in the open, blossoming tubers may be produced with 2 seasons' growth, but usually 3 years are required for the best commercial sizes.

The yellow calla is employed for both out-of-door culture and green-house forcing. When potted up in good loam, one tuber to a 6-inch pot, blossoming will occur in February. Usually the forced tubers are discarded after flowering, but they may be grown on to maturity and flowered again.

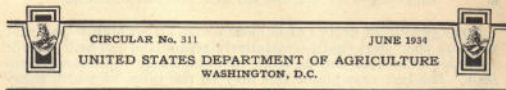
Under out-of-doors treatment the stocks should be dug each year, stored like gladiolus in a frostless situation, and planted in the spring. However, it is sometimes possible to grow the plants out of doors in quite cool regions. They have been grown without injury in the open near Portland, Oreg., for a number of years.

OTHER ITEMS

About a score and a half of genera of bulbous stocks that are produced in whole or in part from seed have been discussed in some detail in this circular. These are not the only bulbous plants to which the seed method of reproduction is applicable; this makes it possible for the consumer to secure the flowers without the waste of too much time. Many other genera might be so treated, but it is considered that a further discussion of the subject would be in large measure repetition, since enough of the methods of culture from seed have been described to suffice for other items than those listed.

Among other bulbous genera most advantageously grown from seed may be mentioned *Colchicum*, which, although requiring 6 to 7 years to mature, can often be produced faster and more profitably from seed than by waiting for the corns to divide. *Allium* constitutes another large genus containing a number of very ornamental species that are most advantageously grown from seed in a way similar to that used for their domesticated cousin, the common onion. Both *Calochortus* and *Brodiaea* have species that reproduce abundantly by offsets, while others of their species must be grown from seed. Two most interesting genera, *Cypella* and *Herbertia*, closely related to *Tigridia*, seem to be much more satisfactorily produced from seed than by the division of the bulb. In general, the *Liatris* (*Lacinaria*) or blazing stars come readily from seed, breed true, and are better grown in this way than in any other. *Zygadenus* is another genus of some ornamental value that should be handled as seedlings.

Asparagus, *Cooperia*, *Crinum*, *Dicentra* (*Dielytra*, *Bikukulla*), *Hosta* (*Frankia*, *Niobe*), *Galanthus Gloriosa*, *Mirabilis* (*Quamo-Adidon*), *Nothoscordum*, *Sisyrinchium*, and *Urginea* are other bulbous genera to which the seed method of reproduction is more or less applicable.



BULBS FROM SEED

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INTRODUCTION

Many plants that are purchased as bulbs, corms, or tubers are produced from seed, and a number of bulbous plants are always reproduced by seed and cannot be multiplied satisfactorily in any other way. An example is *Chionodoxa luciliae*, which does not divide at the bulb and so is always sexually propagated. Many such plants are developed from seed in 1 to 3 years into bulbs from which the purchaser may enjoy blossoms a few months after they are planted. Certain other species reproduce vegetatively but are much more satisfactorily handled in the nursery from seed. Some of these, although requiring 4 or more years to grow to maturity from seed and only about 2 years to flower from splits, are still more advantageously multiplied as seedlings.

In some cases seed is used in the multiplication of hybrids, thereby propagating mixed stocks, because no satisfactory method of vegetative reproduction has been evolved. An example of this type is the *vittatum* hybrid of the genus *Hippocrepis*, commonly known as amaryllis. It is quite possible that the crocus may be advantageously handled similarly, at least in part.

¹The common name or names of the plants are given in parentheses following the scientific name in the list of contents and in the headings in the text.