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THE PROPAGATION OF ROCK PLANTS

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C. R. Worth, Editor

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THE PROPAGATION OF ROCK PLANTS

FOREWORD

ONE OF THE GREATEST JOYS of gardening is that of increasing the supply of plants already in the garden, or of starting new and unfamiliar ones. The gardener who acquires all his plants tailormade from a nursery misses the superlative thrill of seeing a plant develop from a minute bit of green into a miracle of flowering beauty. Nurseries are indispensable to all of us, but there is none in this country capable of supplying every variety that the enthusiast may desire. Nor is the gardener's pocketbook usually equal to paying for all the plants of a kind that could be used. And, although many rock gardeners do not seem to realize it until a beloved treasure has vanished, even under the best conditions few alpines are Methuselahs, or even centenarians. A spare plant or two held in reserve would have replaced the loss, but perhaps now neither seed nor plants can be procured anywhere, and a gem is gone forever from the garden.

The rock gardener, if at all worthy of the name, must and will propagate plants. There are many books on the subject, even one devoted to alpines, but not all the information contained in them is trustworthy, and new methods are continually being devised. In this *Bulletin* an attempt has been made to bring together the experiences of various growers, covering all the methods, both old and new, on which information could be obtained. All is first-hand, none hearsay. Yet in these few pages it has been impossible to consider every minute detail of a vast subject, and many of the more elementary points have been left untouched. The beginner who needs more basic information (and the experienced propagator as well) can clear up many questions by consulting the *Handbook of Propagation* just issued by the Brooklyn Botanic Garden.

And so, for better or worse, this *Bulletin* is devoted to the most fascinating of gardening problems.

* * * *

Only the fool or the tiro dogmatises; the further one progresses in knowledge, the more certain one grow's of one's ignorance. The small, faint, illuminated patch of our experience only shows up the vast darkness by which our little islet of light is surrounded, and makes it seem yet smaller by comparison.

—FARRER.

RAISING SEEDLINGS IN A FRAME

DORETTA KLABER, *Quakertown, Pa.*

YOUR EDITOR HAS ASKED ME to tell how I raise plants from seed. I have done this before, but most of you have probably forgotten; besides, I change my methods a bit each year.

More and more I am convinced that starting early enough is the vital point. By early, I mean the first thaw in January. The coldframes are readied in the fall: all seedlings are cleared out, the ground raked, a fresh layer of soil mixture put in, a half inch of sifted soil over that, then just enough vermiculite to hide the soil. Celloglass covers, held down by stones, are placed over the frames. The soil mixture is loose and gritty with some nourishment in it. The proportions may vary, but roughly, I use

1 part loam
1 part compost
1 part sand or grit
1 part stone chips, ¼″ to ½″, any kind
½ part peat moss (damp)
½ cup general poison (I still have Pestox but doubt that it is procurable as Pennsylvania law holds the manufacturer responsible for any harm done to animals, etc.)

When I can get it I add one-half pail spent mushroom soil. Dried manure would do. Chips and all go right into the seed bed, with only the top half inch screened so that coarse material is removed.

The frames when first roughly built had the usual drainage layer at the bottom, before they were filled with soil. This soil is never removed, as seed a year or two old may decide it is time to sprout. Many an iris or other unpredictable seedling has come up long after the label has been lost! The rough building of the frame eliminates "tend to the airing".

Seeds, when received, are put in glass preserve jars, ring in place, and set in the refrigerator, but not in the freezing unit. Comes the January thaw, they are taken out to the coldframes, planted in rows, labeled; sprinkled with just enough sand to hide the seed, watered, covered with two layers of newspaper, then with the celloglass. Whenever there is snow the frames are filled with it. Otherwise the frames receive no attention till spring thaws start. Then Slugshot is dusted around, and traps placed about. The frames are opened at least every other day to see if anything is germinating, any bugs or worms around, any sign of mice, any moss forming. At the first sign of any of these things the paper is removed. The seeds are kept moist, at first using warm water from a fine rosed watering can, but later, when the weather warms up a bit, the hose is used. If there is any wilt, a tablespoon of vinegar to a gallon of water seems to stop it. As soon as it seems too warm to use celloglass, shade cloths are substituted. I find these a great improvement over slat covers, for they are lighter in weight, and let rain and sun through evenly. The material I use is called "Lumite", and is procured from M. J. Green, Lumite Division, Chicopee Mfg. Corp., Cornelia, Ga.

In the bitter days of winter there is some heaving of the ground. One is always sure that all the fine seeds, such as gentians, must be carried down too deeply, but it does not seem to work that way. The seeds seem to be raised with the heave and dropped with the thaw. Almost all come up in force eventually, and as they emerge another anchoring coat of sand is sprinkled on.

The soil is on the limy side so that real acid lovers do not do well here, but most at least show up before they die, and I always try again. This year some

difficult babies like helleborus, soldanella, *Silene hookeri* (true?), pyrola, *Senecio abrotanifolius, Lithospermum atro-coerulea* (? *L. purpuro-coeruleum*. Ed.), *Iris gracilipes alba, Dianthus callizonus, Aquilegia jonesii,* did not show up, although some have in previous years. Of thirty-nine packets of primulas only two did not germinate, *P. rosea* and *P. marginata.* Later I planted fresh seed of *P. rosea* from my own plants and they germinated to a man. Of twenty packets of gentians, twenty germinated, most in force. These included Himalayans, forms of *G. scabra* and *G. verna, G. crinita,* and *G. acaulis.*

Of course, not all the seedlings survive—one always loses some from assorted causes, some from no apparent cause. It is lucky that I lose some or I'd never get through transplanting 250 packets first to the nursery beds, then to the garden!

The seedlings are petted, of course, through their various stages—kept weeded, watered, cultivated. The majority prosper with these simple methods—no jars, no coffee tins, no flats, no sterilizing of soil, no dusting of seeds.

SEED-SOWING IN POTS

PETER P. KRIEGER, *Princeton, Iowa*

IT SEEMS THAT THE AGE-OLD RIDDLE of starting new life will never be completely solved. The annual preparation of the seed beds, and seed sowing, is of never-ending fascination to us. If we could examine the seeds of some of our alpines and wildflowers, often no larger than a speck of dust, we would discover that inside the hard outer shell is an embryo plant complete with seed leaves, stem and radicle, surrounded by stores of food sufficient for the interlude from the vivification of the embryo through the cracking of the outer shell, to the time when the tiny root can gather nourishment from the soil.

In nature seed is sown as soon as it is ripe. From the millions of seeds sown by nature's method only a very small percentage grows into mature plants.

Most of our European fellow-gardeners can buy prepared and sterilized seed soil in their garden supply stores. We usually mix and sterilize our own soils. After years of experimenting with different soil mixtures, we have found that in our region, where the soil is rich in calcium carbonate ($CaCO_3$), which is raw limestone, we can grow successfully only calcicole plants—that is, those loving or tolerating lime.

To start our seeds we use only pans or pots, as they are easy to sterilize. Wooden flats encourage the growth of harmful fungi. We fill our pots about one third with drainage material (broken pots, stone chips, gravel) and cover this with a thin layer of sphagnum moss to prevent the mixture of seed soil from seeping into the drainage material.

The sterilized soil mixture for most of our alpine and wildflower seeds is one part of sand, one part of peat moss, and two parts of good garden soil. A little superphosphate is added to give the seedlings a better start. After the pans and pots are filled with this soil mixture—not quite to the top—we place them in the soaking tray until the surface becomes moist. Now we space the seeds carefully, about a quarter-inch apart, on the damp surface. The very small seeds of some of the rarer plants are mixed with brick dust and sown on the surface to prevent overcrowding and later damping off of the tiny seedlings. All seeds except the very small ones are covered about twice their thickness with a layer of powdered charcoal or coaldust and sand. After all seed containers are well saturated with water we plunge them in wet peat moss or coarse vermiculite in

the cold frame and cover them with a sheet of asbestos, to keep the seeds in darkness until they start sprouting. We like to have most of our seed pans in the coldframe by mid-January.

It is essential for many of our seeds to be frozen for a certain time to assure successful germination. We take the covers off the coldframes whenever there is a heavy snowfall so that the frozen pots will be completely covered with snow. Often we shovel the snow off the walks and throw it into the coldframe until filled to the top. Then we place the covers on the frames again. Now we can forget the frames until the snow is melted and the first tiny green sprouts appear in March.

Three factors are essential in the vivification of the embryo: correct germination temperature, oxygen, and water. The last softens the seed coat and permits the oxygen and moisture to enter and to start the embryo swelling and growing. To hold the necessary amount of air, from which the oxygen is drawn, the seed soil must be loose and porous. In the process of sterilization, much of the organic nitrogen is lost from the soil. Therefore we give the seed pans an occasional watering with a solution of a fertilizer containing 14% organic, 4% ammonic, and 5% nitric nitrogen; this is done after the cotyledons appear on the surface and the radicles thrust themselves into the soil to form a root system. (Warning: the author does not mention the dilution, which should be very weak, and even so may burn tiny seedlings, especially if they are not watered from overhead).

After the first true leaves have formed and the young seedlings are large enough to be handled, we transplant them into three inch pots and keep them growing in the coldframe until they are ready to be set in their permanent positions in the wildflower or rock garden.

SEEDS FOR BEGINNERS

THERE ARE NOT MANY ROCK PLANTS whose seeds can be sown in the open ground with any real hope of success, and even the beginner who is really interested might as well start using a frame, pots, or fruit jars for raising seedlings. Actually, with moderate care, by following the instructions elsewhere in this *Bulletin,* and with a little patience, a great many of the choicer alpines can be raised from seed without great difficulty.

A few kinds will germinate quickly, usually in little more than a week, if sown when the weather becomes mild in spring in an open-ground bed of well-prepared soil. It will be discreet to shade the bed lightly until the seedlings have made a little size, and to see that it does not become dry. Perhaps other, more interesting names can be added to the following list, but among the most nearly fool-proof are: aethionemas, *Alyssum saxatile* and its varieties, *Arabis albida, Arenaria montana, Aster alpinus, Campanula carpatica* and *C. rotundifolia,* dianthus (but not the tiny, rare kinds), *Erigeron compositus* and *E. trifidus, Erinus alpinus,* erodiums (sow where they are to remain, in sunny well-drained places), erysimums, *Geranium sanguineum* and *G. lancastriense, Gypsophila repens, Myosotis alpestris, Papaver alpinum* (sow where you want it), *Polemonium coeruleum* and *pauciflorum* (both rather tall), *P. humile* and *P. pulcherrimum* (dwarfs), *Silene schafta, Viola saxatilis aetolica* and the bedding violas—not pansies.

* * *

I have known of whole-hearted enthusiasts who sowed their seed at the bottom of two feet of soil, and then sat waiting piously for years in the hope of seeing it come up.—FARRER.

THE FRUIT JAR METHOD FOR SEEDS

CRW

A new method of germinating seeds, proposed by Dr. Lewis Knudsen, was reported by Russell C. Mott of the Department of Floriculture of Cornell University in the *Bulletin* for October, 1954. Although it violated all the principles usually observed in raising alpines from seed, the first trial, using rock plant seeds that were at hand, gave surprisingly good results.

The following April, working with Mr. Mott, and with the cooperation of the staffs of the Department of Floriculture and the Bailey Hortorium, I continued the trials, sowing several hundred jars with a wide variety of alpines and border perennials. The jars were set in the 32° refrigerator, but the thermograph there indicated that the temperature was normally about 34°, so that the jars did not experience freezing conditions. After three to four weeks the jars were brought into a cool greenhouse (55° night temperature) where they were shaded by papers until germination took place. Seedlings began to appear in three or four days, and germination in most cases was profuse. Jars which showed no activity after three weeks were returned to the refrigerator, where some germination took place, and the remaining jars were brought out the following spring and gave a good crop of babies. The sowings had been made too late, however, as none were brought out before May, and the greenhouse soon became too warm and humid, in spite of ventilation, for alpine seedlings; consequently this and the still unsolved problem of proper watering resulted in many losses.

In 1956 Gordon De Wolf sowed a vast number of seed lots, exhausting the supply of jars. The surplus seeds were sown in pots in the usual manner, and these were then plunged in sand in a bench covered with polyethylene which was sealed tightly to the sides of the bench. So far as I am aware, no cold treatment was given before placing the pots in the bench, but many of the species involved were those which do not require it. Germination by this method was poor, although as most of the seeds had been received from botanic gardens, it is highly probably that a considerable percentage of them was old and lifeless.

That year, and again this spring, I continued the trials at home, modifying the treatment somewhat because of lack of some of the facilities at Cornell. The results were so incredibly good that in the future most sowings will be made by this method; a few exceptions will be noted later.

All the pint fruit jars I could find, whether glass or metal top, were used, and eleven dozen half-pint ones were purchased, while salad dressing, peanut butter, birdseed jars, anything of moderate depth with a tight-fitting top, were pressed into service. The half-pint jars proved to be exactly the right size for the amount of seed in most packets of alpines, while wide-mouthed pint jars were used for more generous quantities.

After being washed thoroughly, the jars were filled to within an inch of the top with a mixture of 75% peat, 25% sand by bulk, packed down as firmly as possible by use of one's thumbs. Unfortunately I took the sand directly from a propagating frame, and had a little trouble with weeds; it would have been better to have baked or steamed the sand for half an hour before using it. The peat, fresh from a moisture-proof bag, was fairly moist; dry peat should be soaked in water for a couple of days and then drained before use. It was found quite unnessary to sift a layer of very fine material on top of the jars, for even the finest seeds.

Then the jars were filled to their brims with a solution of two teaspoons of Vancide 51 to a gallon of water, and as fast as the liquid was absorbed, more was added, until a little remained above the surface of the soil; a jar absorbs very nearly its own volume of the solution, even when moist peat is used, although this seems physically impossible! Next the covers were screwed or clamped on—jar rubbers are never used—and the jars allowed to stand for two days, after which the covers were removed and the jars were set upside down on inverted flowerpots of suitable size, to allow excess moisture to drain off. They were then ready for sowing.

Unfortunately, while Vancide 51, an invention of Dr. Knudsen, is on the market, it seems to be available at present only in gallon lots, while a half-pint is sufficient for treating several hundred jars. Its sole purpose is to prevent damping off, which it does very effectively without harming the most tender seedlings—they may even be watered with the solution without injury—and it does not control molds. It seems probable that if this chemical is unobtainable, one of the other preparations designed to prevent damping off might be used effectively, but I have had no experience with any of them. In this case I should advise that the jars be filled with water after the soil mixture is in them, and drained after an hour or more, for the essential feature of this method is the maintenance of constant high humidity.

The seeds were sown by scattering them over the surface of the mixture, and fine ones were either left uncovered or were sprinkled with builder's sand. Larger seeds were covered to a depth of, usually, a quarter-inch with treated peat and sand. The names and sources of the seed were written in pencil on small strips of plastic which were pressed down into the peat at one side of the jar; the writing still is clearly legible after nineteen months. Then the jars were again covered tightly and set in an unheated and poorly lighted north room. As the sowings had not been made till April, the seeds were never frozen, but were kept where the temperature ranged from the thirties to the lower forties.

Within a week some of the seedlings were up, and a high percentage had germinated within three weeks. As the Cornell experiments had indicated that baby alpines may be allergic to artificial heat, as soon as growth began to show, the jars were moved to either the alpine house or an unheated sun porch, where they were shaded from direct sunlight. Metal covers were replaced with glass lids, fitted tightly at first, but gradually raised on one side to admit a little air; many species grew so rapidly that the covers had to be removed entirely in a few days, but a few of slow growth, among them ramondas, were left covered until next spring, and prospered. *Calceolaria darwinii* refused to survive when exposed to air, but grows, though precariously, in its miniature greenhouse.

How long the seedlings can be left in this undrained mixture without harm seems rather uncertain, for in most cases root growth is so rapid that they should be pricked off as soon as they can be handled. It is common to find plants with only one or two small leaves, and roots at least three inches long. The pricking off, and subsequent treatment, led to some difficulties at first, but these seem to have been overcome satisfactorily. A pot label, or dull table knife, is first inserted deeply on one side of the jar, then on the other side of a group of seedlings, and the colony is gently lifted out; if any resistance is encountered, the knife is inserted in other places, until the mass comes out easily, without breaking any of the delicate roots. The plants are then shaken free of each other, and potted up in whatever soil mixture is appropriate for the species; most do very well in equal parts of soil, peat and gritty sand. At first the

seedlings were set individually in very small pots, where, unless given constant attention, they dried out too rapidly, with heavy loss. Nothing smaller than a three inch pot is now used, and four or five seedlings (depending on the rapidity of growth of the species being potted) are set around the edges. Five inch azalea or bulb pots (regular fives contain too great a depth of soil for seedlings at this stage) hold up to two dozen babies. The pots are left in the alpine house (a frame with sash and shade would do as well) until they resume growth, and then are plunged in lath-shaded sand beds—cinders would perhaps be better, but they are unavailable. By late August most of the young plants are ready to go into their permanent homes. One blunder was made this year: shortly after the seedlings were plunged in the open beds, a series of heavy rains beat them into the soil and caused some losses. Now before being taken into the open frames, the pots are surfaced with small chips, which protect the tiny plants from overwatering and beating rains, and keep the soil moisture more uniform. Ruth B. Manton, in the October *Bulletin,* suggests surfacing the pots with hen grit, obtainable at any feed store. I have found this too coarse, and prefer the smaller medium or baby chick sizes. Road chips, one-half inch and smaller, or fine gravel may be used.

The jars that had shown no germination, partly because of the late sowing, were set in a cold cellar, where they froze during the winter, although no jars were broken, and taken to the alpine house in early April; seedlings popped up almost overnight. Because of inertia, some jars from which the 1956 crop had been removed were left sitting on a bench in the alpine house, uncovered and usually unwatered; by the first of April there was a profuse second crop in nearly every jar. This experience makes it seem advisable, if one has not the desired number of seedlings of a species, to remove them with as little soil disturbance as possible, press the remaining soil down firmly, and let the jar remain, preferably covered, until the second spring. Campanulas, in particular, almost invariably germinate over two seasons.

Most jars show some germination within four weeks, in April and May, but during the summer there is little activity. A day or two after sowing, it is advisable to remove the covers for a few minutes to permit the escape of fumes from the Vancide. In three or four days germination may start, and from then on the jars should be examined daily for two or three weeks. By this time there will be relatively few new seedlings appearing, and once or twice a week, in June, once in two weeks during July and August, is often enough to look at the jars. So far there has been no fall germination.

It may be found, when the jars are first examined for germination, that a few are not really moist; two or three teaspoonfuls of water will make up the deficiency, after which the jar will probably need no further watering until germination takes place, even though this may be delayed for a year. The watering of the young seedlings caused considerable difficulty at Cornell, where various devices, even atomizers, were used, all unsatisfactorily. Here whenever a pot is dry, a little water is carefully poured along one side, from a small watering can without a rose, such as is used for watering African violets; no seedlings are beaten down or washed out by this method. If a jar seems too wet, it may be tipped on its side, the bottom a bit higher than the top, until the excess moisture has drained off; soil and seedlings will not fall out when the peat-sand mixture is used.

Species tried by this method included almost all the choicer and more difficult alpines, as well as a few of the commoner ones. Many germinated profusely, which hitherto, treated conventionally, had come sparingly or not at all;

those usually easy to germinate appeared in about half the usual time. There have been some failures, of course, but it is difficult to tell whether the fault was in the method or the seed. The peat-sand medium may have caused trouble in a few instances, and further trials will be made using ordinary soil for penstemons and monocarpic campanulas, which gave the least satisfactory results. Perennial campanulas did very well, far better than controls sown in pots, and particularly good results were had from seeds of androsaces (some of the Aretias, which usually require at least a year, were up within a month), *Alyssum spinosum* (which had never germinated before in repeated sowings), drabas, gentians, cyananthus, Asiatic mertensias, ranunculus, anemone, trollius, meconopsis and primulas (the last two usually have germinated well here under ordinary treatment). Monocotyledons have so far been uneven and somewhat erratic in behavior: of calochortus, fritillaria and narcissus sown this spring, so far only a few feeble seedlings have appeared; erythroniums lay dormant for a year, then germinated profusely; iris—only two species were tried—did well; lilies, a few species sown in both jars and pots, did equally well under both treatments, but the quick lilies respond so well to ordinary pot culture that they have not been tried to any extent. In general seeds which germinate quickly, especially geraniums and erodiums, were sown in pots, though in a few cases where for a check sowing was made both ways, results were better from the planting in jars.

Compared with sowing in frames (see Doretta Klaber's article), more work is involved, but the results seem to justify the extra trouble. Anyway, in this climate, if there is a warm spell in January or February sufficient to thaw the soil in frames—and that does not always happen—the soil is too sticky, no matter how skilfully compounded, to make sowing satisfactory. The preparation of jars, and sowing of them, is far quicker and more simple than using pots—and I write from experience with thousands of the latter, and perhaps a thousand of the former. It is far less messy, and the sowing can be done in the kitchen on a raw day without upsetting the neatest housewife. The principal advantages come later: if a jar is tipped over, as often happens, the peat mixture will not spill out, or even be disturbed; sowbugs cannot carry off the seeds (until I used this method, and at about the same time caught the villains in the act of robbing pots, I had not realized that many cases of non-germination were failures simply because the seeds were no longer there); slugs rarely climb on the jars; watering is rarely necessary before germination, and only occasionally afterward. People spending the winter in the city may sow the seeds as they arrive, set the jars in a cool place, and carry them to their summer homes without danger of spilling or breakage if the jars are replaced in the original cartons.

I am often asked whether polyethylene is not as satisfactory a cover as jar lids; the indications are that it is not. During the sowings made at Cornell, a number of coverless jars were used and had a piece of polyethylene turned down over the sides, fastened quite securely with rubber bands. Condensation of moisture on the polyethylene did not vanish as the temperature rose—though it did with glass lids—so that the contents could not be seen without removing the plastic covering. This was a nuisance, but, far more important, there was virtually no germination in the polyethylene-covered jars, as against excellent in the glass, and from the number of sowings this could hardly be blamed on the seeds.

* * *

An application of camphor to the surface will often elicit life, even at the eleventh hour, from sluggish and recalcitrant seeds.—FARRER.

THE GERMINATION OF GREAT PLAINS SPECIES

CLAUDE A. BARR, *Smithwick, S.D.*

I MUST ALWAYS PROTEST that I am not an authority on the germination of Great Plains species or any others. At that I have very good company. Nature herself makes an awful fizzle of it on the plains, or perhaps more exactly, if not in germinating, in getting the little fellows grown to the autonomous stage, that is rooted deeply enough and well developed in the green parts so as to withstand the vagaries of the Plains summer climate and competition with established neighbors.

Does this suggest a simple solution, namely spacing, to reduce competion? It isn't as simple as that. One may come almost at once to a rude awakening when he gloats over a row of prized seedlings that under rare favorable auspices have sprouted almost to the seed, for at a later inspection he may find them vanishing or completely gone. What has happened? Damping off? No, it practically doesn't occur on the Plains—I'm speaking of course of outdoor culture. At the worst a body of dry, windy and withering air has moved in, accompanied by high temperatures, and the plantlets are done for.

It cannot be immodest to admit that in my need for plants I have tried about every means that occurred to me. First, because my basic soil is a difficult one, crusting and curling in rapid drying of the surface after any wetting, modification, by incorporation of varying amounts of fine or coarse sand, vermiculite, peat, leafmold, old manure or other humusy material, separately or in combination, the objective being to build a medium that would be acceptable to the plants, would retain moisture effectively, yet provide the requisite drainage and would not crust. Next, bed upon bed in which the gumbo was entirely replaced with soils brought in by the ton from here and there, as I found a soil that seemed promising, and these often modified with sand, humus or gravel. So far, so good. Yet failures or partial failures occur with appalling frequency as weather takes too strong a hand and means of supplying moisture are ineffective.

With the acquired stoicism of an Indian, causes have been sought, many failures meditated on. Depth of planting, soil texture, concentration of moisture due to slight depressions, shading if any, even the hour of the day at which the last remnant of a late snow left the beds and severity of freezing and honeycombing if very wet at nightfall.

In the wild, that is, just beyond the garden fence, where the uncultivated primeval prairie stretches for miles, numerous fascinatingly beautiful native species have maintained an ebb and flow of existence in the tough gumbo clay —a disintegrated mud shale, technically Pierre formation—for untold ages. Among them are *Mertensia lanceolata, Townsendia exscapa, Viola nuttalli, Oenothera caespitosa, Penstemon eriantherus, Asclepias pumila, Malvastrum coccineum, Petalostemons purpureus* and *oligophyllus, Dalea enneandra, Astragulus gilviflorus, Phlox andicola, Gutierrezia sarothrae* and others. In areas slightly changed by wind or water action or by residual material, many other attractive kinds come in: *Oxytropis lamberti, Lithospermum incisum, Astragulus missouriensis, Astragulus goniatus, Sideranthus spinulosus, Tradescantia bracteata, Phlox hoodii, Zygadenus gramineus, Calochortus nuttalli, Leucocrinum,* and so forth.

How do they do it? It is to be observed that in these potash-rich soils large crops of plump, viable seeds are produced, for the most part annually. All kinds are capable of lying over to a second season or for much longer periods. However, it is especially notable that none of these perennial species displays a weediness in the sense of carpeting the ground through free germination of seeds. I

haven't in any instance observed such a condition, and by midsummer or such time as the surviving seedlings have grown to show specific character they are very much scattered, often so rare as to appear nonexistent. Only a few kinds such as *Allium textile, Penstemon eriantherus,* and *Oenothera caespitosa* are to be found in small or larger spaces of bare soil. All others survive, as it appears, through the advantage of the modicum of shelter afforded by sparse dead or living grass blades and other vegetation or an occasional bit of duff.

On the evidence nature doesn't do a very good job with seedlings, never overplays her hand, yet by precarious means the species are perpetuated. In a series of favorable years, often favorable to but one or a few species, populations may build up until a showy flowered kind will color portions of the prairie, then from drought or other mishap it may become scattered or rare for many long years.

Attempts at copying natural methods in the garden have met with some success, perhaps very good success as compared with results from the lavish outlays of seed that nature employs, yet far from what one would wish. Lath screens with the laths spaced to give fifty percent or more of shade, supported at two inches to two feet above the beds have been of some merit. A scattering of pine needles to approximate the natural sparse prairie cover where the wild flowers thrive has met with good results when good moisture was present. Best results are had in the slat house, a "lath house" of one-by-fours spaced six inches apart, to give somewhat less than fifty percent shade. Ameliorating factors of slat house environment are lower and more uniform temperatures, increased humidity and greatly retarded evaporation and drying. It is obvious that some shading for germination and early growth are beneficial, but necessarily one must study his own conditions and results of experiments.

On the Plains moisture is most plentiful in early spring and as the early start gives seedlings the longer period for development ahead of summer's heat and drought almost all local species have adapted themselves to germinate in very low temperatures, some within a few hours after winter's frost goes out of the ground. This indicates winter or very early spring planting. As an instance, *Penstemon grandiflorus* has germinated well with winter planting, with April planting and average moisture not at all.

In line with the sometimes reported experience of seedlings coming freely in a hard gravel path while germination was especially poor in a carefully prepared and tended seed bed alongside, I know of an old gravel pit, worked some eighteen years ago, where it has been interesting to watch the advent of flowering plants. It is now a veritable garden, with *Oxytropis lamberti,* the "purple loco"—with some plants as fine in color as the American Beauty rose—the most numerous and conspicuous reclaimant.

The pit had topsoil and some subsoil stripped, then a few feet of gravel removed. There remains a considerable depth of gritty alluvial clay, marking an ancient stream course, with enough scattered gravel from coarse sand grains to the size of one's fist to mostly cover the clay. In places alluvium and gravel are mixed to a depth of several inches, and well compacted. All must have been completely sterile and only a trace of humus can have accumulated in the intervening years. Grasses have made scant headway while some twenty species of flowering plants and a few weeds have made of the half acre a happy picnic ground. There is now some crowding.

In this opportunist garden, far out in the "desert air", the gritty clay apparently takes water well, retains it well, drainage is adequate, and the gravel acting as a mulch as well provides effective shade for small seedlings. Just in the last year or so this marvel of natural planting has impressed me as perhaps

worthy of emulation. I shall try gravel mulching for seed beds, first preferably with sifted fine gravel that will not interfere subsequently with cultivation, then if necessary coarser grades that may have to be lifted and replaced with continued use. And it may be worthwhile to test the use of that sterile gritty clay.

SNOW AND GERMINATION

MANY BRITISH GARDENERS, perhaps because they are usually "have nots" in this respect, have expressed the opinion that snow coverings of their seed sowings would solve all germination problems. That ardent gardener Rae S. Berry used to tell of carrying pots containing some especially treasured seeds up on Mount Hood, to bury them in a snowbank; she was repulsed by the rangers, who feared that she would introduce new and deadly plant diseases! Doretta Klaber, in her article in this number, implies that snow is responsible for good germination.

Years ago, diligently following British suggestions (there was no one in the East to advise me), I would set all pots which had not yet germinated, including fall-sown ones, on the concrete floor of a shed, and bury them in snow whenever the opportunity offered. The only obvious results were that the pots did not dry out during the winter, and that a good many cracked under the treatment. Some seed lots were sown part in fall and part in early spring, and in every case the later sowing germinated better—often the fall-sown ones did not appear at all. Clearly this treatment was wasted energy.

Later, recalling some remark of Louise Beebe Wilder's on the effect of spring snow on her seed-bed, I carried the pots out to cold frames about the first of April, put sash over them, but opened them up whenever there was a snow shower. Sure enough, after each snow many seedlings would pop up, although whether the snow itself or the abrupt change in temperature was responsible I do not know. Unfortunately there are many Aprils when no snow falls here, and the pots cannot be set out earlier, as without artificial heat in March the seedlings would succumb during cold spells.

Next, I tried keeping the pots in the basement, at a temperature of around fifty degrees. Whenever there was sufficient snow (in February and early March), I would carry buckets of it inside and pile it several inches deep on top of the pots. As soon as it had melted, in a few hours, the treatment would be repeated. This was continued over an interval of several days, then interupted to give the seeds a chance to germinate. Auriculas were up within a week —normally they require three weeks or more, if sown in early spring. Polyanthus took their usual three weeks, a stray androsace or two appeared, but nothing else seemed to be affected. Obviously, except with the auriculas, I was not getting results.

These past few years, whenever there is room in the normally overcrowded alpine house, seedpots are set on the bench in late March, where they experience moderately warm daytime temperatures (usually not over sixty degrees), and relatively cool nights, but no freezing. Beginning about the first of April, seedlings appear in vast quantities, and grow madly so that one is soon engulfed in the endless chore of pricking them off. Fruit jars from which the first crop had been removed in 1956, and which had been left sitting on the bench, largely through inertia on my part, gave me last spring some of the finest seedlings I have ever had, which developed rapidly enough to resist the heat of June.

FERNS FROM SPORES

KATHERINE E. BOYDSTON, *Niles, Mich.*

I HAD ALWAYS THOUGHT that to raise ferns from spores would require laboratory equipment, great knowledge and large amounts of time, none of which were at my disposal. But in the past three years, I have found that it can be done in very small space, with a kitchen oven and pyrex dishes (instead of laboratory sterilizer and petri dishes) with only general amateur interest in ferns and very little time. To watch those first tiny pricks of green develop into the lovely ruffled prothallia and then into baby ferns is an exciting and rewarding experience indeed. Best of all, it makes it possible to have rare and impossible-to-obtain species for our rock gardens and this without expense or twinge of conscience about conservation!

The first step—to obtain the spores. Though a few ferns ripen their spores in very early summer, the majority may be looked for in late summer or early fall. Some ferns have their spores on separate fronds completely different from the sterile (e.g. the cinnamon, ostrich and sensitive ferns) but most of them have fertile fronds quite similar to the sterile. With the aid of a hand lens or magnifying glass look at the underside of some fern fronds. There you may see "brown dots" or "dashes," often thought by the novice to indicate "something wrong with the fern." They are in truth the sori or groups of spore cases (sporangia). In each of these there are numberless spores.

The sori or "fruit-dots" may be round (as in the wood ferns) linear (as in aspleniums) curved, etc. Their shape and position or pattern on the frond constitute one means of identifying the species. Even without a view to collecting for planting, it is time well spent to study these many variations, one more of Nature's minute perfections.

In a few, they are naked, in some they are covered by a reflected margin of the frond (as in maidenhair), in most by a thin membrane called the indusium. As the spores ripen this opens and the sporangia discharge their spores. Sometimes fronds collected seem to be laden with "brown dots" but if the hand lens view shows this to be only the scaly remains of the spore cases with no tiny dark roundish bodies present, we are too late. It is best, then, to watch the fern and gather the frond or pieces thereof when at least the sporangia at the top are still light in color and indusium-covered. Some on the lower pinnules will probably be gone but others still present and ripe.

Each kind is put into a clean white envelope and left in it until dry. At this time the infinitesimal spores discharged in the envelope will look like black or brown dust. In general, fresh spores germinate faster than old ones, but most stay viable for months or even years. The osmundas are the exception, needing to be planted soon after gathering, tho recent experiments have shown that they, too, will last several months if kept under refrigeration.

And now to get ready to plant. Here I use small covered pyrex dishes because they can be sterilized without breakage, are inexpensive and have a neat appearance on the glass shelves. Others use glass-covered flower pots, freezer dishes, fruit jars, etc. At first I tried spores of two ferns in all the recommended ways of planting: (1) on sterilized soil; (2) on porous brick set in water; (3) on pieces of tufa rock in water; (4) on an inverted sphagnum-filled clay flower pot; (5) on pure peat; and (6) on finely-sieved sphagnum. Each was glass-covered. In both cases, the soil was so far ahead in amount as well as promptness of germination it has been used in all plantings since then. That used is the usual mixture of leaf mould, sand and loam, approximately one-third each. If leaf mould is not available, peat moss may be substituted to give the whole

Mrs. Boydston's fern room, which should be ideal for seedlings also.

mixture a "good feel." It is then put through the fine mesh of an ordinary window screen and then baked in the kitchen oven for about three hours at 350°. Water is added to create steam in the oven. When time allows, I feel it is better sterilized by repeating the baking a day or two after the first time as suggested by Dr. Wherry.

Meantime, the dishes and covers are sterilized by boiling in an ordinary hot-water-bath canner. When both the dishes and soil have cooled to room temperature the soil is spooned into the dishes and gently tapped down with a flat-bottomed glass to a smooth level surface. If too dry, some distilled water is added. Two mistakes of my first planting may here be mentioned, to be avoided by other beginning fern planters. I followed advice read somewhere to put the soil-filled dishes in the oven and sterilize all at one time. But with the evaporation of the water, the dirt hardened on to the sides of the dish leaving an unremovable and unsightly ring. Second, I filled the dishes to too near the top. Very little soil is needed for this first stage, so leave room between it and the glass cover for the first tiny fern growth—about three-fourths inch at least.

When all the dishes to be planted are thus prepared and covered, one at a time is taken to another room and one envelope of spores or fertile frond is opened at a time and some "spore dust" tapped onto a clean white paper. At this point, use the hand lens or magnifying glass to be sure there are some of the dark roundish minute spores present and not just bits of sporangia. The unaided eye cannot give you this information. If there seem to be too few spores which had been discharged in the envelopes the backs of the fronds may be gently scraped with a silver table knife. I usually pour such scrapings through a very fine strainer onto another clean paper, thus elimating all but the finest bits of brown scale. If this sifting is not done, every possible piece should be

picked off the paper or the soil with tweezers for they are the probable cause of later mould or fungus trouble.

The fine dust of spores is then scattered as evenly as possible and not too thickly over the soil surface by tapping the paper, the cover is replaced and the dish labeled. This is best done by printing the name on a very narrow strip of paper which can be covered on all sides by scotch tape to hold it securely on the dish and protect it from water.

The planted dishes are then put in the light of a window or fluorescent light, for unlike seeds they do not need the dark for good germination. If the window is in the sun the dishes must be shaded by cloth or paper. Though they should not be allowed to dry out, better results have been found here if they were not too wet. Dishes like mine need watering every ten to twenty days depending on weather and temperature. If completely sealed, they will need no attention for a much longer time. Distilled water is used for the first growth stages, boiled water later.

In general, the spores having eighteen hours a day under fluorescent light germinate in two to four weeks, while those having only window daylight take a month or so longer. The first tiny specks of green grow slowly into the heart-shaped or kidney-shaped ruffled prothallia, that mysterious in-between stage in the life-cycle of ferns. Tiny hair-like roots fasten this prothallium lightly to the soil and on its lower surface are borne the reproductive organs of the fern. When with the aid of a bit of water these have united, the first frond of the new fern plant eventually emerges from the prothallium by which it is nourished until the tiny plant has become large enough to strike roots of its own. Its mission accomplished, the prothallium now withers away. These first fronds are simple and shaped like tiny clover or violet leaves—the daintiest mites of perfection imaginable, and no matter how minute, the infinitesimal fronds unroll in the accepted fashion of all ferns!

When most of the prothallia are topped by these little ferns, it is time to give them more room. Small round patches of them are transplanted to another covered dish or pot. Here, because of limited space, these patches are moved into trim rows in a large terrarium-like case which can be glass-covered. The perfect tool for this I find to be an apple-corer—the sharp point able to cut out the small patches without injury to the rest of the dish, and the rounded back just right to press it into the soil of the new place. Although "man's best tool," fingers would be far too clumsy for this task.

It is amazing how fast these tiny plants grow, how soon they take on their true fern shape, now that they have more space and air. When they are large enough and strong enough the top glass is gradually removed. The rows become quite crowded before the young ferns can be separated to single plants, so an occasional lift with Rapid Gro or other safe foliar feeder is given in weak solution.

When they are large enough to be moved out of doors, care must be used to select a time when weather and temperature will give the least shock. Mine are usually moved to rows in nursery beds or cold frames and carefully shaded and watered for some time. Here they spend their first winter, usually protected with glass or evergreen boughs and the following spring are ready for permanent homes in woods, rock garden or wall.

My small area for raising ferns as shown in the picture is only a six by eight foot porch off a small kitchen where U-shaped shelves have been built on the window sides. The lower is in the form of three terrarium-cases under three flourescent lights each double-tubed. The corresponding space above may be used as shown for potted plants or as is being done now since the picture was

taken, as three more beds of soil where the larger young ferns can be grown in rows. The six inch glass shelves under the lights have place for thirty-one dishes of planted spores, those above around the windows, for fifty-four more. But even this total of eighty-five is never enough for all the species wanted! Some contain the rarest of rock aspleniums, America's rarest fern, the harts-tongue, maidenhairs of New Zealand, English crested and curled forms of male fern, lady fern and polypody, European rock ferns, ferns from our west coast, our mountains and our deserts.

The American Fern Society maintains a spore exchange similar to the A.R.G.S. seed exchange. Members send spores from all parts of the United States and from trips abroad, and any members wishing to grow them may have those desired for the asking.

It has been a temptation to try all that come in—even those known to be not hardy here. Plantings this fall will be confined to those wanted for the woods and rocks here.

In our new rock garden stream-side area to be begun next year, it is my intention to plant only ferns raised from spores on this small fern porch. It will be interesting to see how many there may be growing there in five years time.

In spite of oven sterilization, there may be occasional trouble with moulds and algae, but in spite of these infrequent disappointments, for a new gardening experience of great satisfaction and absorbing interest, I heartily recommend trying a few spore plantings.

DIVISION OF PLANTS

THE PROPAGATION OF PLANTS by division is usually so simple a matter that there can be few gardeners who have not practiced it. Yet, for the benefit of the novice to whom such matters are still a dark mystery (if there is any among our readers), a few remarks may be in order.

What plants may be divided? Almost any which produces a number of crowns, each with a root system of its own. The more widely these are separated, or the more loosely held together, the easier is the task. Yet many plants forming a compact mass, such as peonies and astilbes, and some iris, may have to be cut into fragments, each of which will grow without fuss. It is best not to divide plants which are difficult to establish, and obviously species which are tap-rooted, or which produce a single rosette, are not suited to this method.

How is it done? The whole plant may be lifted, most of the soil shaken off, and, the plant broken or cut into pieces, each of which has a growing top or crown, and at least a few roots. Or if the plant forms a mat, only a part of this may be lifted and broken or cut from the rest, and then divided. If the plant is precious, and lifting it seems perilous, it is often possible to dig down beside the plant, remove the soil close to its roots (on one side only), and break off a piece without disturbing the rest of the plant.

How are the divisions cared for? Usually they can be planted at once in their permanent positions, watered well, and not allowed to dry out till they seem fully at home. Valuable species are often best grown in pots for a few weeks, or an entire season, before being set in the garden.

When is this done? Spring, shortly after the plants start active growth, is usually the best time, late fall the worst. With care it may be done throughout the growing season, except in extremely hot weather, unless one is prepared to give special attention to the divisions.

What are some of the rock plants that are easy to divide? Acaena, ajuga (too, too easy—keep it out of your garden!), *Androsace sarmentosa (A. sempervivoides* is a bit more difficult to reestablish), *Anemone nemorosa, A. ranuculoides, Aster alpinus,* astilbe, bergenia, *Campanula carpatica, C. cochlearifolia,* and several others, *Ceratostigma plumbaginoides (Plumbago larpentae), Dicentra eximea, D. formosa, Draba aizoides* and *D. olympica, Geranium pylzowianum,* geums, *Globularia cordifolia,* iris, some mat-forming penstemons, potentillas, primulas, encrusted saxifrages, sedums, sempervivums, synthyris, *Thalictrum kiusianum,* most veronicas, and of course all bulbs.

POLYETHYLENE

MR. EPSTEIN'S ARTICLE, and another in the Propagation Handbook issued by the Brooklyn Botanic Garden, suggest that the alpine gardener may find many profitable uses for this material.

A few of our members have already discovered that cuttings, and small plants free of soil, may be shipped in a polyethylene freezer bag, with no packing material at all, and that they will arrive at their destination in perfect condition. It is essential that the top of the bag be folded over, and fastened with a rubber band, so that moisture will be preserved.

Because I read too carelessly a comment in a Round Robin letter, last April I embarked on a new method of sowing seeds of lilies which form the bulb, and then require a period of dormancy at low temperature—not necessarily below freezing—before developing leaves. Taking a handful of moist peat and sand left over from the fruit-jar sowings, I dropped it into a polyethylene freezer bag, mixed the seed with it, rolled the bag up tightly, put a rubber band around the bag, with the seed packet slipped underneath as label, then dropped all the "sown" bags into a carton which was set on top of a kitchen cupboard, in the warmest place I could find. In six weeks *Lilium speciosum* had formed bulblets, while *L. auratum* was somewhat slower. When the bulblets were the size of a grain of wheat, and no longer seemed to be increasing in size, the bags were put in the bottom of the refrigerator for a month, after which peat, bulbs and ungerminated seeds were dumped on top of a pot of ordinary soil, and were covered lightly. In a short time, by mid-August, true leaves had appeared, and the young plants are still, in early November, in active growth. Seeds of several western species, given the same treatment, did nothing, until I learned from the current Yearbook of the Lily Society that they require cool treatment for bulb formation. Belatedly the sacks containing these seeds went into the refrigerator, and in a few weeks tiny bulbs were visible.

This method is far preferable to the familiar one of sowing seeds of lilies of this type in jars of sand, for it is far less messy, and very little space is required. It might well be tried on peonies, which behave similarly, and probably on other large seeds of slow germination, although they would require closer watch than lilies do—especially the peonies, which would have to be removed from the refrigerator at the first sign of top growth. It could likewise be used on alpines needing low temperatures for germination, although in such cases the amount of soil should be much smaller and might dry out more easily (the lilies have required no water added, although sown six months ago). After cold treatment, the soil and seed mixture could be scattered over the surface of a pot or fruit jar and would need no further cover; I must try it this winter.

ASEXUAL PROPAGATION OF ROCK PLANTS AT THE NEW YORK BOTANICAL GARDEN

(Notes taken by Mr. Ralph Bennett at a lecture given by Mr. Politi, head gardener of the New York Botanical Garden, during a symposium meeting of the American Rock Garden Society in New York City on December 8, 1956, reprinted from the Bulletin of the American Penstemon Society, 1956)

WHEN I FIRST STARTED PROPAGATING rock plants here at the Garden, I thought that every kind of plant needed a different treatment. I really went hog wild. I had thirty or forty kinds of media and many different methods for dealing with different kinds of plants. I found that that is neither necessary nor desirable. Practically all kinds of rock plant cuttings have rooted very well with our one basic method. When we used different methods, we had poor results. Now we have almost 100 percent success.

We use nothing but white silica sand as our basic rooting medium for most things. Sometimes we use ground cinders because of their moisture-holding ability, but they are not necessary. We don't add any peat or vermiculite. We found that they cause the sand to remain too moist for best rooting. It is important to use sharp sand. For most things we screen out the fine material through a window screen, leaving the pieces varying in size from a sixteenth to about an eighth of an inch.

Sand, as received from a dealer, is clean enough so that we never have to disinfect or sterilize it, but we do have to wash it. We just put it in pails and swish a hose around in it until all the dirt is washed out. The only time we ever disinfect it is after we have been using a batch of sand for two years. After that much use it is a good idea to sterilize it. We use formaldehyde. But we never do it to any newly received sand.

Even though sand is supposed to have good drainage, we also use a drainage layer in the bottom of the flat or bench. We use broken crocks. Then to prevent the sand from washing down into the drainage layer and clogging it, we put something over the layer of broken crocks, such as a piece of window screen or a thin layer of sphagnum.

Over this we put a 3-inch layer of sand. This is thick enough for all kinds of cuttings. It must be well compacted. We take a brick and pound the sand down as hard as we can.

This first part of the process is very important. You might say that the secret of success is to start with clean, sharp sand, well compacted. If you don't start right, nothing you do later will be of much help.

People have different ideas about inserting the cuttings. We have two methods. My favorite one is to use an ordinary pencil. With the rubber end, not the point, we make a hole in the sand. Then, holding the cutting with two fingers of one hand, we place it in the hole and with the other hand use the pencil to pack the sand around it. The rubber prevents injury to the cutting if you hit it accidentally. While we are packing the sand with the pencil, we at the same time exert a slight upward pull on the cutting with the fingers. Thus we are able to feel when the sand is packed around the cutting, by the resistance it offers to the upward pull.

Sometimes we insert cuttings in rows instead of individually. We make a cut in the sand with a knife along the edge of a stick and put in a whole row of cuttings at one time, firming the sand down against the whole row with a thin board. But I much prefer the pencil method. You can get to do it so quickly that

you don't lose much time as compared with the row method, and you can be sure that each cutting is firmly set. This is worth the extra trouble.

As to rooting hormones, we sometimes use them and have nothing against them, but with cuttings of rock plants we have found that it doesn't make much difference. It may speed up the rooting by as much as a week and may be useful with very difficult things. But with our basic method we have been getting a hundred percent results with almost everything; so I don't see how a hormone could make it any better. We found on a check test that the treated cuttings rooted one week sooner than the untreated ones, but the latter caught up in a short while; so that we didn't really gain very much in the end.

After the flat or bench is full of cuttings, we flood it with water. This serves two purposes. It waters the cuttings and it compacts the sand still more firmly.

It is important not to let the cuttings stay in the rooting medium too long. We try to get them out when the roots are only a quarter to half an inch long. We find that if taken out then, they will start growing immediately and vigorously when moved. They are full of vitality when the roots are short. If allowed to stay in the sand very long, since there is no nourishment in the sand, the roots become hard and lose some of their vigor. Then when the cuttings are taken out, they are likely just to sit and not start growing again for a long time. It usually takes about three weeks for cuttings of rock plants to start rooting; so we begin to look at them in about that time. Take one up and it will give you a clue to the rest of them. Don't be discouraged if some of them don't root in three weeks. I have known some kinds to take two to three years.

As soon as the roots are from a quarter to half an inch long, we put the cuttings in two and a half inch pots. In taking the cuttings out of the sand, don't just yank them out. Pry them loose from below. We use a very sandy mixture in the pots. If you transfer cuttings suddenly from pure sand to dense soil, it is an awful shock and they will not grow well. The first soil should be much like the rooting medium, that is, very sandy. A good mixture is one third each of sand, soil, and compost.

It is also important not to leaves the cuttings in the pots too long. We don't bother to plunge the pots in a coldframe. As soon as the cuttings are well established in the pots, and the weather is suitable (not too dry or hot), we put them out in nursery soil beds. The beds have good soil, that is, it has a good amount of humus in it. We put all the cuttings in the same kind of soil. It is the same as we use for our perennial borders, not the kind that you use in your rock gardens. Don't yield to the temptation to baby the cuttings. It is their nature to want to grow and they will if you just let them alone. In fact, in good soil they may grow too large for the rock garden, but we are talking now about growing plants for stock. If you don't want them to grow so large, you can plant them in the rock garden from the pots, or cut them back after they have stayed in the nursery bed long enough to become good and strong.

The time of year to take the cuttings is very important with rock plants, because they are inherently a hard group anyway. Many of them are not happy with us, wish they were somewhere else, and are just struggling for existence. So we take the cuttings at the time when they will have the greatest chance.

In the middle of the summer the weather in New York City is usually so hot and humid that the plants are having a hard time just to stay alive. They are not likely to be full of vigor, and cuttings should be taken when the plants are growing actively. We take ours in two periods—from about the middle of May to the end of June, then skipping to the middle of August, we continue taking them all through the winter.

It is essential to make the cuttings with a very sharp knife. We don't use a

pruning shears. Don't use a knife with poor steel, because it just can't be made sharp enough. A razor blade is also good, but use one with only one edge or you may find that you are making cuttings of fingers as well as plants. Cut straight across the stem, not at an angle. The clean cut is safer than pulling the cuttings from the main stem, as is sometimes done, because in the latter case there are apt to be shreds of plant tissue hanging loose. These are likely to start decaying, and that is very apt to cause the whole cutting to rot.

Take the cutting just below a node. Don't go far enough below to leave a stub, and don't cut through the node itself. About a sixteenth of an inch below the node is all right.

Short cuttings will grow better than long ones. A good rule is to take them as short as possible, rather than the other way around. The only time we take longer ones is when the wood is soft a long way from the ends of the twigs. It is especially true with rock plants that short cuttings are better than long ones. Also with many kinds of rock plants you have only a small amount of new wood to work with. Even if it is only a quarter of an inch long, it will root just as well as if it were longer. It will do no good to go below the new growth to get longer cuttings. They should always be made of growth of the current year. The ones made early will usually be longer than those made later, because the wood will be soft further back from the tip.

The wood should not be too soft or too hard. A good general rule is to test it by bending the outer two or three inches of the stem back. If it snaps off cleanly, it is at the right hardness. If it bends double without snapping, the wood is too young or you haven't gone far enough back from the end. Don't go so far back that you get into last year's growth. The cutting should be taken near the point where the stem snaps cleanly. After a while you get so you can tell almost by instinct when the wood is at the right stage, even without testing it. If you take cuttings before the hot period, the wood tends to be softer; if you take them afterward, it tends to be harder. You should try to get wood that is as firm as possible for that time of year.

We try when possible to use terminal growth which has not blossomed or made flower buds. Side shoots are better than long leaders, because the leaders are apt to be soft too far back.

Take off the bottom leaf, or pair if they are opposite leaves. You shouldn't have too much leaf surface on a cutting, because it is going to have a hard time anyway getting enough water from the sand, without any roots, to make up for the transpiration loss through the leaves.

To prevent the cuttings from drying out from transpiration loss, you can either keep them in a very close atmosphere, when they may never need water, or watch them and water them when necessary. If you have your cutting frame in a shady place, and especially if it is enclosed on the sides and top, and you have compacted the sand well, you may not have to water the cuttings at all after the first time. If the weather is very dry, or you don't have a humid atmosphere around the cuttings, you may have to moisten them occasionally with a fine spray. With our basic method we find it is not necessary to use any of the fancy methods like polyethelene or constant mist.

Some plants with fleshy roots will grow from root cuttings when they are difficult to root from stem cuttings. We take them in the spring, about the end of April or the first of May. We use for root cuttings a mixture of sand and peat. Cut the roots into pieces an inch or an inch and a half long, and set them horizontally in the sand. You don't have to worry about which is top and bottom. They will root whatever way you set them if they are horizontal. Sometimes instead of taking the plants up to make root cuttings, we just cut them off in the ground

with a spade or trowel and let them send up new growth in place. This is an easy way to get new plants of kinds that will grow from root cuttings.

Some plants can be divided into so many sections that it is almost foolish to bother with cuttings. Even though some of those plants root easily from cuttings, it is much easier to increase them by division.

A good rooting pot can be made by using a shallow flower pot about 10 or 12 inches across, putting a 2-inch pot in the center, and filling in between it and the rim of the larger pot with sand. By pouring water into the pot in the center, you can easily keep the sand moist. It will stay moist a surprisingly long time even outdoors.

MIST SYSTEMS

RECENT EXPERIMENTS have shown that many woody plants, both deciduous and evergreen, root far more readily if exposed to an intermittent mist. Apparently no experiments in the rooting of cuttings of alpines have yet been conducted, but a moribund pot of meconopsis seedlings, set under mist in a torrid alley, revived and prospered, suggesting that the fortunate possessor of a mist installation may be able to grow these, and other lovers of cool temperatures from the Himalayan monsoon regions, in any part of the country.

An article by Dale V. Sweet, in the "Handbook on Propagation" just issued by the Brooklyn Botanic Garden, discusses the subject, while a mimeographed leaflet issued by the Department of Floriculture and Ornamental Horticulture of Cornell University, and free, at least to residents of New York, entitled "Recommendations for the Installation of a Mist System for Rooting Cuttings of Nursery Crops", by William E. Snyder and Charles E. Hess, gives full information, complete with detailed drawings, on setting up such a system.

It is unfortunate that the expense of a mist system places it beyond the reach of many amateur gardeners, while the actual construction calls for much more ability than that of the average "do-it-yourselfer".

BOOK REVIEW

Handbook on Propagation. Various authors. 80 pages, illustrated. New York: Brooklyn Botanic Garden, 1957. $1.00.

The current number of *Plants and Gardens,* profusely illustrated with excellent line drawings and photographs, offers a very adequate summary of the various technics used in propagating plants. Seeds, softwood and hardwood cuttings, grafting and budding, layering, plant hormones, plastics, mist, are covered in the concise and lucid manner that characterises these handbooks, while the illustrations show precisely how to perform any of the tasks considered. Articles on trees and shrubs from seed, and on difficult plants, are less satisfactory because space limitations prevent discussion of individual species; in the latter article, a few species of interest to rock gardeners are mentioned. Separate articles deal with the propagation of garden perennials, house plants, tree peonies, and crab apples. Details are given for the construction of a propagating frame used for rooting blueberry cuttings, which, it is suggested, may be useful for other difficult material. A list of books on propagation, with brief comments on them, concludes the number.

As space limitations have made it necessary, in this *Bulletin,* to assume that the reader has at least slight familiarity with the making of cuttings and layers, and other basic operations, one who finds need for more rudimentary information will find almost all such questions answered in the *Handbook.* while there is at the same time much of interest to the more experienced grower.

MEDIA FOR PROPAGATION OF CUTTINGS

HAROLD EPSTEIN, *Larchmont, N. Y.*

IN VISITING COMMERCIAL NURSERIES and amateur gardens, it is interesting to notice the many materials and methods that are used for the vegetative increase of plants from top cuttings. As in all phases of horticulture, we are always seeking easier, less laborious and more foolproof means of accomplishing results.

In seeking to root cuttings, there are basically two major factors involved. First, there is the choice of a rooting medium and second, the physical setup for utilizing the material to induce efficient rooting. This, of course, excludes all of the details relating to the proper time and method of taking the cuttings. Over a period of years I have experimented in a rather amateurish manner with various factors. Originally I started with the use of the basic clean, sharp and gritty sand. This is still preferred by a substantial group of propagators who retain implicit faith in its efficient use. While I have no serious criticism of this medium, I found that it did not seem to satisfy my requirements for a medium that could retain moisture without constant care and attention. In order to overcome this, I had for a period of time used as a rooting medium vermiculite, which certainly is retentive of moisture, but this very certain asset seemed to be its undoing, for it did the job of retaining water too well with the consequent rotting of roots and cuttings. In fact, vermiculite has a tendency toward breaking down and eventually becoming a slimy, soggy mass, hardly a fit subject for rooting of cuttings. Even a dilution of 50% of sharp sand did not seem to fully overcome this difficulty and I eventually discharged the material completely. Do not misunderstand. I do not condemn vermiculite as a rooting medium, but as a tool in my hands and under my conditions it just did not horticulturally serve its purpose.

Another medium then utilized (after seeing its successful large-scale use on the west coast) was perlite. This is an almost white substance appearing almost like bone meal, but is a volcanic glass mineral produced in the western states. It is primarily used for insulation and for aggregates in the production of building blocks. Perlite is an extremely light weight material, sterile and of long life and has proved to be excellent in the rooting of most cuttings, from high alpine plants to soft tropical plants. In my experience with it, particularly during the hot, dry summers, the surface of a pan of this material has a tendency toward drying. This leaves a surface of this light weight material and unless care is exerted, it is easily blown off by too vigorous a supply of water. While it has been a very satisfactory rooting medium, it still seemed not quite ideal.

A fellow horticulturist suggested the possibility of merging both the vermiculite and perlite and a sample batch of 50% of each was used a few years ago. This combination with varying percentages of each (never more than 50% vermiculite) has proven an ideal medium for my conditions. It has overcome the disadvantages of each of the individual substances and at this time is the only rooting material being used by me for a great variety of both soft and woody cuttings.

Another factor for more efficiently caring for cuttings being rooted is the use of Polyethylene. Before leaving on a holiday of several weeks during the summer, pans of cuttings that had been well watered and drained were inserted into Polyethylene bags that were fastened securely so that there was no loss of moisture. These pans of cuttings remained in these bags for about six weeks

with only an occasional opening for inspection and aeration. No other water was added during this period. This system or the many variations of utilizing Polyethylene for retaining moisture almost completely eliminates needed care and attention and is a boon to the amateur who cannot devote much time to the welfare of cuttings.

Summarizing, these are all personal experiences with only a few materials. But the human element is still an important factor and varying degrees of personal attention can make other materials equally as efficient.

PROPAGATION OF CONIFERS FROM CUTTINGS

R. M. WARNER, *Milford, Conn.*

CONSIDERABLE SUCCESS in the propagation of conifers (chiefly ornamental forms of hemlocks) from cuttings by the methods briefly described here have been obtained over the past sixteen years.

A bottomless wooden frame measuring three by six feet (to take a standard hotbed sash) and about eighteen inches deep has been used to provide the protection for the rooting bed. This frame was set up in a shady and protected place on the bare ground, and into it went a compost consisting of approximately 70% native peat (the black muck found in any local swamp) and 30% builders' sand, both screened and well mixed and firmed, to a depth of approximately three inches. It has been my practice to pile up a considerable heap of peat a year in advance, which gives ample time for mellowing so that at the time of use it approximates well rotted leaf mold in its physical qualities.

Around the middle of August, or as soon after the first of the month as the cuttings have matured their growth, the bedding is completed. The best results are obtained when all the cuttings are inserted in one or two days.

The cuttings used have varied in length from one to five or six inches according to the type of conifer. The basal wood must be at least one year old, and with one dwarf hemlock the wood was at least four years, yet gave good results. The sort of cut across the base of the cutting does not seem to make much difference, though perhaps the long slanting cut is best, and in some cases a heel can be left on the cutting. It is important to take cuttings from the youngest plants that are available and from the lower parts of the plant.

Before inserting, the cuttings are stripped of the lower part of their foliage, of course, and dipped in a rooting powder—of which Hormodin #3 and Rootone have been used. It is possible that some of the liquid solutions would be more effective. The cuttings are placed in the rooting medium, on a north-south slant quite close together and partly overlapping like shingles on a roof. An opening is made for each cutting so as not to brush off the auxin, and the compost is firmed over each cutting as placed individually.

After each batch is set, they are watered into place. When all are in place the frame is made tight by placing a single sheet of newspaper which reaches over the edge of the wooden frame from the compost inside to the ground outside all around the frame. The cuttings are well watered and the sash put on and covered with a single thickness of newspaper which is held in place by strips of wood. No further attention is needed for about five days, when inspection should be made to check for dryness and signs of mold, and a little ventilation given by raising one end of the sash half an inch or so. As time goes on a little more air and light can be given, but very little water is needed and the quickest way to kill a batch of cuttings is to overwater. Constant mist spraying cannot be used with conifers. During the next two months the cuttings are callusing and because of the type of foliage there is little transpiration.

The most successful practice has been to transfer the cuttings to a similar bed, except with a bench bottom, in the greenhouse which was left cold until around the first of February. This transfer was generally made around Christmas time, and at that time some of the cuttings would already be rooted. The greenhouse was never run at more than 52°F., but the cuttings had the benefit of mild bottom heat and had double glazing over them. When the greenhouse became crowded in the spring the cuttings were moved back to the outside frame and left there until time for putting them in the nursery. The frame was removed when needed for starting a new lot of cuttings.

The last four winters have been spent in Florida and the cuttings were left out through the winter mulched with leaves but without the protection of the sash, and the results have been poor. If cuttings are to be left to winter outside, sand should be placed to a depth of half an inch over the bed to prevent heaving, and if the glass were left in place, the rooting would be better, no doubt.

There is a wide difference in the rooting behavior: some conifers root quickly and in large percentages, while others are slow and difficult. The longest in memory was a cutting of *Tsuga sieboldii,* a Japanese hemlock, which took two years; but that was the lone survivor of perhaps fifty and was taken out of season. Other cuttings taken from a small seedlings of the same species rooted about 80% by Thanksgiving. One of the most easily rooted conifers is the dwarf Alberta spruce, *Picea glauca conica;* another is the China fir, *Cunninghamia lanceolata.*

For propagating valuable dwarf conifers no method is more dependable than mound layering, followed by division of the rooted branches. This obviates the waste of material when the necessarily short cuttings fail to root, as they frequently do.

PROPAGATION MADE EASY

G. G. NEARING, *Ramsey, N. J.*

YOU WILL OFTEN SEE mention of rules of propagation. There are no rules of propagation. There are systems of propagating, and if you choose to follow a particular system, then you may find rules useful, but they apply only to that system. If you take a rule from one system and try to apply it to another system, you may easily suffer failure of an entire crop.

There is a system generally accepted by most commercial growers, for rooting cuttings of woody plants, and the so-called rules of propagation, as generally stated, apply to that system. Forty years ago it was generally conceded that cuttings of Rhododendrons could not be made to root in commercial quantities. Since I wished to root Rhododendron cuttings (E. H. Wilson said cuttings would make better plants than grafts), I worked out a new system by which they can be rooted very successfully, and it is this system which I want to discuss here, because it roots also thousands of other plants with a minimum of care and attention.

One of my friends built for a commercial nurseryman a sample of the special propagating frame which I devised for Rhododendrons, and after using it one season, the nurseryman built himself a dozen more with the remark. "I can grow anything in that." A woman whose specialty was wildflowers, built two of the frames, and years later handed me a bulky list, too long to print here, of the plants she had propagated successfully in them. At the head of the list was trailing arbutus, which she rooted in great quantity, and which grew for her like a weed.

Today Rhododendron cuttings are rooted by the thousand in greenhouses where forty years ago propagators agreed they could not be rooted. These propagators took a good look at my special frame to see why it worked, then changed a couple of their rules to make the greenhouse do what the special frame does.

But the frame still has advantages over the greenhouse, particularly in that it saves labor, and if ever there was a time when labor saving saves money, that time is now. For the one-man nursery, the part-time propagator, the enthusiastic amateur, a frame which will go a week or two without even being looked at, and still produce a good crop, is surely a godsend. And the same frame is also efficient for seed propagation.

The fundamental change from old-time conventional propagation is this: when the sun shines on a greenhouse, the temperature rises to a point where cool air must be brought in, so the ventilators are opened. Even if the glass is painted, the greenhouse must be ventilated. But with the ventilators open, humidity goes down. In the days before there were mechanical humidifiers and unlimited money to throw around, cuttings requiring high humidity could not be rooted successfully in a greenhouse. Rhododendrons are among the cuttings which require high humidity.

Now if you had a bed of sand with a lot of moisture at the proper distance under it, and if you had it enclosed by glass which didn't need to be ventilated, you could maintain high humidity. How can you get rid of the need for ventilation? By not letting the sun shine on the glass. Then if the sun doesn't shine on the glass, how can you maintain light enough to supply the needs of plant growth? That was the problem.

It was solved like any other difficulty, by hard thinking and experiment. The natural way to interrupt sunlight is to place a shield to the south. But morning and afternoon sunshine can be disastrously hot. So the east and west must also be shielded. Since in midsummer the sun comes almost overhead, there must be overhead shielding too. Actually in the heat of summer, the sun rises in the northeast and sets in the northwest, but if the shield cuts out all direct east and west rays, only the very early morning and late afternoon rays can reach the glass, and these at such a low angle that little heat penetrates. (Look that up in your physics book.)

In practise the shield should project a few inches northward of the north edge of the frame, above, to the east, and to the west. All the light must come from the north, and in order to get enough of it, you must have your hood as wide open as practicable, painted white on the inside (or aluminum) to give reflection. In a group of frames where some cannot be given full exposure to the north sky, they are so placed that the back of one hood reflects light into the hood to the south of it, and this is even more efficient than the light of the north sky.

The frames are carefully faced to open exactly north, and before building them, I sight a line on the North Star (Polaris). For this reason I had intended to publicize my device as the North Star Frame, but it has come to be known generally as the Nearing Frame. My patent expired years ago, and anyone is free to build the frame under any name that suits.

So much for the shading. Now for the frame itself. It is a box covered with a glass sash, not absolutely tight, but nearly so. The width of this box from north to south should not be more than 3 feet, because the height of the hood for that width is 6 feet, (anything lower would not let in enough light, and to extend it higher would invite trouble from the wind). The hood does not fit against the edge of the box, but a space of several inches is left, so that

G. G. Nearing

The ingenious Nearing Frame solves many problems of propagation.

a free updraft of air will cool the inside of the hood.

The box has a bottom, reasonably tight, and no provision is made for drainage. This must give any professional propagator the shudders, for one of the rules of conventional propagation is to supply perfect drainage. Well, I have rooted hundreds of thousands of cuttings without drainage, and if there is anything wrong with my system, I should have found out by now. Those who are drainage minded must remember that the only way to keep high humidity is to have plenty of water near, and if you drain it all away, how is it going to provide the humidity? However the box must not be water*proof*.

Now in this box, which is about a foot deep, I place a layer about 4 inches thick, consisting of 3 parts screened peat moss, 1 part screened spent mushroom manure, and a little dusting sulphur, all mixed together very thoroughly, after a couple of handfuls have been added of the same layer from the most successful box of the previous year. The mixture seems to be kept in proper condition by bacterial or fungus action, and this inoculation is a decided help.

I wish I could find a satisfactory substitute for the spent mushroom manure. I have tried everything imaginable, but nothing else works as well. To find a supply of it is often a nuisance. There are hundreds of mushroom houses in southeastern Pennsylvania, where the Mushroom Growers Association, Kennett Square, Pa., will usually recommend a grower who is willing to ship his spent manure. Unfortunately many growers are turning to straw culture, and whether their spent product can take the place of the composted horse manure always used in the past, I do not know. It is my belief, that the dead spawn (mycelium) in the mushroom manure is the important ingredient, for I have tried other forms of manure with always inferior results.

The 4-inch layer is very light and spongy of course. It is covered with a layer about 1 inch thick, of 1 part sand, 1 part Michigan Sedge Peat (peat

moss will do if necessary). The layers are each carefully leveled, before the next layer is put on, and the upper layers are spread very gradually and carefully, a very little at a time, for if any quantity is dumped in one place, it will depress the layer below, spoiling the efficiency of the medium. A third layer, about 3 inches of sand, is now added, a handful at a time.

The quality of the sand is supremely important. A coarse grade of concrete sand (builder's sand), but containing also plenty of fine grains, is best. Sand that is either all fine or all coarse will not do.

When filled, the box is ready for the hose. A fine spray is maintained steadily for several minutes, until water stands at least ¼ inch deep all over the surface of the sand. (The box should be carefully leveled before filling, and soil should be banked around it to within a couple of inches of the top). After thorough watering, the weight of the sand compresses the peat beneath it, and the total depth of the medium is reduced to about 6 inches, eventually 5½ or less. My boxes are just the size to fit a 3 X 6 ft. sash, and I make the lower layer with 3 bushels peat moss, 1 bu. mushroom manure, adding 1 3-inch pot of sulphur. The middle layer is ½ bu. sand, ½ bu. peat, the top layer 3 bu. sand.

Cuttings of broad-leaved evergreens and dwarf conifers are made in June, July, August, September, October, November, or in fact any time of the year when the wood is in good condition. I empty all the boxes in September and refill most of them in October, sticking most of my Rhododendron cuttings in November. Cuttings which have not rooted by September are stuck in a new frame in October or November to root the next year. Some varieties are slow, but make no charge for their time. If a branch of something desirable breaks off during the winter when the sand is frozen, I throw it on the sand and leave it there until spring thaw, then make it into cuttings and stick them. Last winter a foot-long branch of *Pieris japonica albomarginata* broke off in January and lay untouched on the sand until near the end of March. I then made it into 79 cuttings, of which 72 were rooted by September, and 5 put back to root next year. The reason for the low percentage was that I had run out of mushroom manure, and used only peat in the lower layer of that box.

Cuttings of Rhododendron are made 2¼ inches long or shorter. If cut much shorter, they root more quickly, but are slower in forming a vigorous plant later on. No "hormones" are used, or any other nonsense. I tried them all out hopefully many years ago, and find I get better results without them. Those who use them seem to be hypnotized by the advertising. I used to make my living writing advertising copy, so am more or less immune.

The frames are given a soaking as described (until water stands on the surface), about once every two weeks in fall, during winter only when the sand has thawed out completely, twice a week in spring, and once a week in summer. If kept too wet, the leaves tend to rot. It is best to let them get fairly dry occasionally.

The same frame can be used for seed propagation. I use 4-inch pots standing in metal pans, so that I never need to water overhead, but the pans must be allowed to dry out between waterings, and only a fraction of an inch of water is run into the pans at any time. Pots are much better than flats, because they soak up the right amount of water and do not breed fungi.

For Rhododendron or other ericaceous seeds, the pots are filled about two-thirds with broken soft brick, the small fragments on top to prevent the compost from sifting down through the brick. The pot is then filled almost level full with a compost of 3 parts Michigan Sedge Peat, 1 part top soil, 1 part sand. This is pressed down hard with the thumbs, making a space at the top of the pot about ½ inch deep, which in turn is filled with a different compost, 4

parts sand, 1 part Michigan Sedge Peat. This sandy compost is heaped high, then pressed down hard with a piece of lath, and scraped off level with the top of the pot.

It is important to fill the pot completely. The space conventionally left at the top is intended to hold water after overhead watering. This is exactly what the seedlings don't want. I never water overhead, but give the seedlings only what moisture the pots suck up from the shallow pans in which they stand. All ericaceous plants prefer this treatment, and so do hundreds of other items. I use no chemicals. Damping-off is controlled by the cultivation of a moss, as described in a previous Bulletin.

At the other extreme is the fringed gentian, *Gentiana crinita,* which I used to grow in quantity. For this I would fill the pots with only a very sandy loam, and the gentians germinated and grew very well. They proved so easy, in fact, that I lost interest in them. Why waste my time on weeds?

No heat is ever used in the frames, because anything propagated with heat must be carefully hardened off—much more carefully than most propagators seem to think necessary. It is easier to let the plants alone, and not upset the cycle of the seasons for them. Of course the pots stay frozen most of the winter, and it is then that the full pot shows its superiority to the one not completely full. For water sometimes leaks in through the sash, and any drip on the seedlings must run off.

Nearly any plant can be grown in this frame either by seed or cuttings. But of course species which like a lot of hot sun do not thrive so well with all direct sunlight excluded, as they do in a frame exposed to the sun. I do not recommend the frame for cactus or other succulents, yet even cactus will do well enough if not left in the shade too long.

Rock garden plants, cuttings of which have rooted well in the frame include dwarf Rhododendron, Azalea, Erica, Calluna, Leiophyllum, Kalmia, Andromeda, Pieris, Leucothoe, Epigaea, Gaylussacia, Vaccinium, Daphne, Hypericum, Euonymus, Corema, Sarcococca, Pachistima, Skimmia, Cotoneaster, Berberis, Juniperus, Chamaecyparis, Picea, Tsuga, Taxus, Cephalotaxus, and many others. The frame has been used to raise seedlings of various Gentiana, Primula, Dianthus, and in fact, almost all dwarf plants which can be grown from seed.

A list of all the species and varieties which have been propagated in this way would fill many pages, and not make very interesting reading. Suffice to say that the majority of difficult plants respond, while the easy ones can be propagated in the open ground.

SEEDS OF DESERT PLANTS

RECENT EXPERIMENTS have shown that the seed-coats of many desert plants contain chemicals which inhibit germination until there is sufficient rainfall to dissolve the chemicals and wash them away from the seeds, at which time the soil will be sufficiently moist to give the seedlings a fair chance of survival. This report seems to indicate that such seeds, instead of being sown in a dry medium, should be thoroughly drenched from above, probably two or three times, to make them germinate. Fresh seeds of *Beckwithia andersoni,* treated in this manner, have not yet responded, but it may be that this species requires low temperature as well.

Incidentally, it is now known that watering pots from below results in a deposit of salts on the surface of the soil, which tend to inhibit plant growth. While it may be advisable to water plants, and seed pots, by setting them in a pan of water, to make sure that all of the soil is moist, from time to time they should be given a thorough overhead watering to carry away these harmful salts.

NOTES ON VARIOUS PLANTS

THESE NOTES, originally intended to cover only a few species, suddenly started lengthening as rapidly as Alice's neck when she nibbled the wrong side of the mushroom. As they are based on the experience of only one gardener, not especially green-fingered, obviously they cannot include everything in cultivation which might be grown in a rock garden; nor does space permit mentioning even a tithe of such plants. In spite of sympathy for the problems of the beginner, it was decided to omit most plants which come fairly well from seed, or which can be increased easily by division. Also there are many desirable plants, among them shortias and *Jeffersonia dubia,* with which too little has been done in this garden to venture information on their increase. Ericaceous plants, it is hoped, will be dealt with fully in an article not yet at hand; no mention is made of any of them in what follows. The resulting hodge-podge may be completely baffling to the novice, who will not always know whether a species about which he seeks information is omitted because it is easy (as is usually the case, if the plant is a familiar one) or because the writer has not solved the problems it presents. It is hoped that more skilful gardeners, instead of sneering at the author's incompetence, will pass along for general dissemination information regarding more successful methods of propagation of various species.

Acantholimons are rare not because their cultivation presents any serious problem, but because they are extremely difficult to propagate. Although seed is frequently set, very little of it seems to be viable. When available, it should be sown in pots kept only moderately moist; the fruit jar treatment is too humid. Cuttings and layers seldom root. Hills offers suggestions on treatment.

Aethionemas are unlikely to come true from seed, and any particularly good form should be propagated from soft cuttings.

Alyssums, even the rarer shrubby sorts, come readily from cuttings; after potting up, water rather sparingly. *A. spinosum* never germinated, from many sowings, till given the fruit jar treatment, when it came promptly and freely; seedlings should be kept on the dry side, and set in the garden as soon as possible.

Androsaces are not difficult from seed: many species germinate in a few weeks from early spring sowing, but the Aretians usually lie over till the second spring. They should be pricked out while small, and not exposed to full sun; they are difficult to winter in the alpine house, and covering with rock wool may be advisable. *A. languinosa* is very easy from cuttings taken at any time during the growing season. Individual rosettes of *A. villosa* and *A. lactea,* and probably of other species, taken with as much stem as possible, for an anchor, and inserted in the cutting box so that the rosette is flat on the rooting medium, will root rather slowly but surely, if not washed out when watering. The annual or biennial species, once introduced, self-sow freely, but are so tiny that they never get in the way.

Anemone seed germinates fitfully: within a few weeks, the next season, or not at all, and fall sowing here has given no better results than seed of the same lot held over till spring. *A. narcissiflora, A. rivularis* and *A. magellanica* are the easiest to germinate, while that labelled *A. baldensis,* from the most august and unimpeachable sources, has invariably proved to be the last-named species. *A. caucasica, A. alpina* and *A. sulfurea* may germinate well, but I have yet to bring one of them to blooming size, and cannot find the cause of their unwillingness to grow. *A. patula obtusiloba* has the reputation of being almost impossible to germinate.

Aquilegias rarely come true from garden-saved seed, breeding back, as

Professor Edgar Anderson has pointed out, toward *A. vulgaris*, so that most seed is not worth the trouble of sowing. *A A. viridiflora, laramiensis, flabellata* and *ecalcarata (Semiaquilegia adoxoides)* invariably have come true here, and young seedlings of several other Asiatic species so far show no similarity to *A. vulgaris; A. scopulorum* occasionally produces a volunteer that is true to type, but most are not. This species and *A. jonesii,* which have fleshy roots with a thick cortex, may be propagated by detaching individual roots in midsummer; planted vertically in a sand bed with the tops just below the surface, they will make good plants by the following spring.

Arabis albida, in double, pink, and variegated forms, may be increased by cuttings of individual rosettes at almost any time; it may also be layered by covering branches with sandy soil. *A. androsacea* is usually unwilling to root its woolly rosettes, and may be divided cautiously, but is often slow to reestablish.

Armeria caespitosa may be increased from cuttings of rosettes with an eighth to a quarter of an inch of old wood at the base, taken soon after flowering. The new plants grow very slowly at first. Other species are easy from cuttings taken in early summer, preferably with a bit of root attached.

Asperula suberosa divides easily in late summer (first find a plant of it!), but is so fragile that is must be handled very carefully. Hills suggests soft cuttings, but I have had no success with them.

Astilbes are fairly quick and easy from seed, and can be divided; the large fleshy roots of some species should be cut with a knife into pieces each of which contains both roots and top growth. Early spring is a good time for division, but it may be done much later in the season if the plants are shaded and watered well. They may go dormant during hot weather, and should not be discarded until there is no evidence of life the following spring.

Choice forms of *aubrieta* may be propagated from cuttings in the same way as arabis, but these should be taken soon after flowering, and are slower to root.

Calceolarias, the hardy species, usually germinate well but may be difficult to keep alive through warm weather. *C. biflora is* the easist under our conditions.

Campanulas are easy from seed if they can be protected from slugs, which prefer them even to *Omphalodes luciliae.* A collar of window screening extending an inch or two above the top of the pot guards them somewhat more effectively than slug poisons, but very young slugs can crawl through the mesh and cause much damage, so both methods of protection should be used. If the seed-pot can be left relatively undisturbed for a year, a second crop of seedlings, often more profuse than the first, will pop up as soon as the pot thaws. Most perennial species can be propagated easily either by division or by soft cuttings taken in early summer, though the latter sometimes are slow to strike. Various species, among them *CC. cochlearifolia, garganica, muralis, raddeana,* and *tomassiniana,* grown here in pots for a year and then shaken out, have given a large number of nicely rooted individuals ready to be set out in the garden. Monocarpic species can be grown only from seed; as these are all plants of hot and dry Mediterranean regions, they need sun and not too much water, and may resent moving after they attain any size.

Celmisia seed seems to be of low viability; the suggestion has been made that the seeds be planted vertically, but this does not solve the problem. As various species are now being cultivated successfully in Great Britain, it may be that seed from them will be more successful than that formerly imported from New Zealand.

Celsia acaulis is delightful, and easy from seed which may however delay germination for a year. Get the young plants in a sunny place in the garden as soon as possible, for they seem to resent even lath shades when grown in pots.

Corydalis may be either prompt or extremely reluctant to germinate: C. S. Van Houten reports that he is still, after four years, hopefully nursing a seedpot of *C. cashmeriana.* Once established happily, they will usually look after their own propagation, so be on the watch for strange seedlings in early spring; the youngsters go dormant as soon as their parents do.

Cyananthus come fairly well from seed, but often does not survive the first summer; cuttings taken in spring, a couple of inches in length, root quite readily, but often fail to reappear the following spring. Those surviving the hazards of babyhood are not difficult in moist peaty soil, with a fair amount of sun. *C. integer* of lists, correctly *C. microphyllus,* is the easist and most permanent.

Cyclamen are not difficult from seed, especially if one heeds the advice passed on by a member of the Society in its early days, and soaks the seed for 24 hours in warm water before sowing. Tiny corms are formed first, and two or three months will elapse before the first leaf, a true one, appears. Do not plant in the garden until the corms are about the size of a penny. They will flower in two or three years.

Cytisus and genista: cuttings in late June or July, taken while still growing at the tip, but with the wood firm, may give a fair percentage of success, but this varies from species to species: *Cytisus decumbens* roots very easily, while *Genista horrida* still baffles me; some species may take several months. Cuttings should be about two inches long, at least.

Daphne: consult the Bulletin, vol. 14, no. 1: p. 8. *D. arbuscula* I find the easiest to strike from cuttings, and if leggy specimens are repotted with an inch or so of soil over all except the tips of the branches, these will layer themselves within a year, and can be detached and potted up singly. *D. retusa* is temperamental, sometimes rooting quickly, at others sitting through two seasons, callousing, and even flowering, without making any effort to root. *D. cneorum alba* and *D. petraea* I find most difficult to strike, but Warren Wilson rooted cuttings from my plants by using bottom heat—at the same time that I was getting nowhere.

Dianthus alpinus, if one can get the true plant, comes readily from cuttings, but an easier and surer method is to pot up a plant: in a year or so it will throw up suckers from underground, rooted and ready to be potted singly. Almost no success has come from my efforts to strike or to layer most of the other small species, even, in the case of *D. pindicola* from collected seed, when dozens of trials were made at all seasons of the year. When cuttings of these miniatures do strike, they grow unwillingly and usually succumb after a few weeks. Can anyone tell me how to root them successfully? Needless to say, garden seed of dianthus rarely reproduces its parent.

Dicentra peregrina pusilla: see vol. 14, no. 1: p. 26.

Dodecatheons germinate easily from early spring sowings, but in a few weeks the leaves usually turn yellow and disappear. Do not throw out the seedpots, for the plants are behaving normally and will show new growth very early the next spring. One or two seedlings remained in growth all the past summer. The species was unfamiliar to me, and I do not know whether this is its normal behavior.

Douglasias may be propagated by cuttings consisting of single rosettes, in the same manner as androsaces or Kabschia saxifrages.

Drabas, Gabrielson notwithstanding, are not easier here than saxifrages: in fact the choicer kinds are as troublesome as Aretia androsaces. Many species germinate easily, but our choicer Rocky Mountain ones and *D. (Petrocallis) pyrenaica* are often most reluctant. The seedlings transplant badly, and *DD.*

acaulis, mollissima and *polytricha,* not hardy in the open, find the alpine house too damp in the winter. *D. bryoides imbricata* has been here for twenty years, but never more than a plant or two at a time. The tiny rosettes root readily, with roots as fine as spider webs, but because of their minuteness, are all too easily lost. Presumably other species can be increased by rosette cuttings, although I have never tried it, and the more vigorous ones divide readily—as does *D. bryoides imbricata* when, on rare occasions, there is a plant large enough to make divisions feasible.

Dracocephalums come readily, though not usually profusely, from seed, but one usually gets only one or two species under an assortment of names.

Dryas octopetala cuttings taken in July, with a quarter-inch of old wood at the base, strike easily, but the young plants are exceedingly temperamental and will often collapse after making considerable growth, especially when set in the garden. If they survive the first winter they seem fully established. I have never succeeded in making divisions reestablish satisfactorily, although there seems no reason why they should have failed, except that the plant thoroughly resents root disturbance.

Edraianthus pumilio is not difficult from seed, except that one rarely gets it, but one of its clusterhead relatives. It can, once obtained, be increased from cuttings of rosettes, perhaps half an inch long, taken after flowering.

Erinacea anthyllis can be propagated by means of cuttings a couple of inches long, with two or three "prongs" (branches), taken soon after flowering, but these root slowly, and the percentage of success is low; the older the plant, the fewer the cuttings that root.

(To be concluded in April)

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