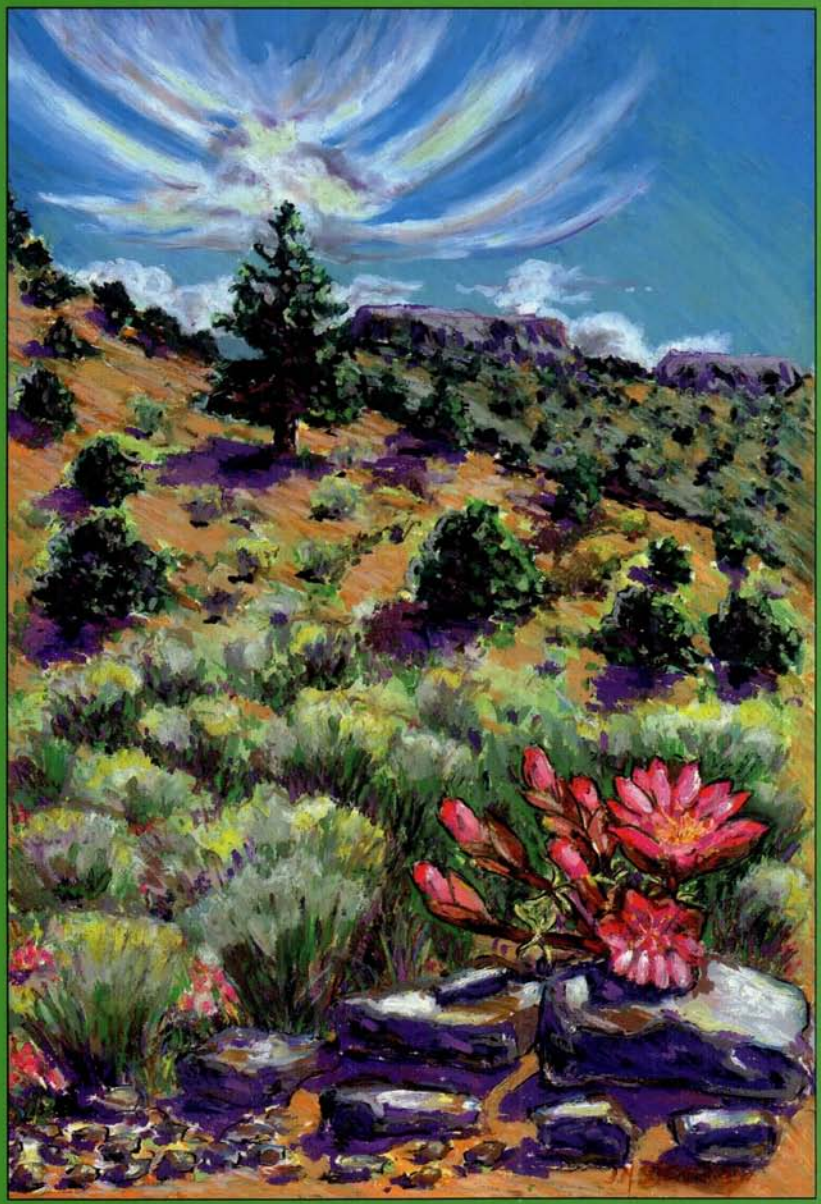
ROCK GARDEN



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COVER: *Lewisia rediviva*
by Jill Starkey, Del Norte, Colorado

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ROCK GARDEN QUARTERLY

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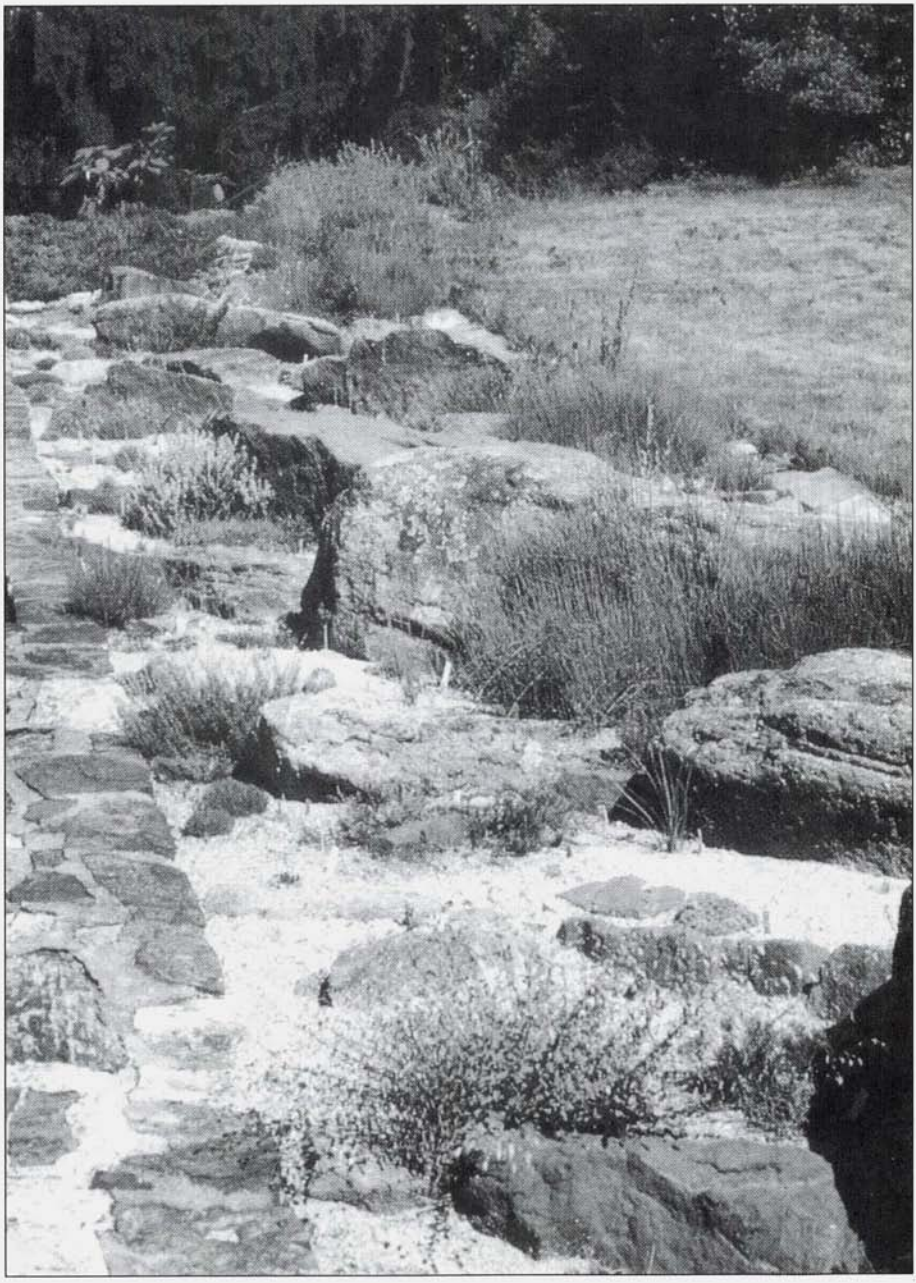
VOLUME 56 NUMBER 2 SPRING 1998

FEATURES

DEPARTMENTS



SAND BEDS

HOME FOR THE WESTERN AND THE DRY

by Michael Slater

I grew up watching westerns on television and reading Zane Grey novels. Both of these sources presented a "Wild West" alluring to youngsters like me. The adventurous and romantic notion of the West still influences me strongly. However, these days, instead of yearning to run off to Wyoming and become a cowboy, I yearn to grow the plants that fit into my mental image of the West.

Deserts, dry plains, canyons, mesas, buttes, colorful rocks and defiant vegetation: this is what I want to have a little bit of here in my garden in Pennsylvania. My goal is to grow plants that remind me of the dry parts of Colorado, Wyoming, Utah, or Idaho right here in the Mid-Atlantic States. Also, many little plants from the sections of Asia, southern Africa and South America with cold winters and hot, dry summers are highly desirable. Thousands of species and varieties of great rock garden plants come from these climates. In the wild these plants, from *Acantholimon araxanum* to *Zauschneria latifolia* var. *garrettii*, routinely survive temperatures well above and below what we experience in our garden, so they should be growable but...

Summer wetness and humidity encourage fungal growth and rotting of many plants. For weeks on end in July and August we may have temperatures of 90–100°F (32–38°C) with humidities greater than 80% in the middle of each afternoon. When such high humidity is present, the nighttime temperatures often stay above 80°F (27°C). Winter can be a problem if water from frequent winter rains or melting snow stands around the plants. A beautiful little plant can rot and turn to mush after only a day or two of such weather.

Dry sand beds are one answer. Dry sand will help plants from low rainfall climates resist moisture and humidity problems, partly because there is NO organic matter that can harbor fungi at the surface or in the top several inches of soil. Plants from dry climates have not co-evolved with the vast array of fungi found in our damp part of the world. Also, the sand should drain away all water and dry rapidly at the surface. Deeper down the open pores of the sand will bring adequate air, and thus oxygen, to the roots of the plants. I certainly can't claim that dry sand is the only way to grow these plants, but it is certainly one good way.

In the history of the *Rock Garden Quarterly* and its predecessor, the *Bulletin of the American Rock Garden Society*, there have been only two articles about dry sand beds. It has been 50 years since Carleton R. Worth first wrote about western plants that throve in dry sand even though neglected during WWII. And it has been eighteen years since Norman C. Deno described how to make and utilize a dry sand bed. Professor Deno followed this article with a significant chapter in *Rocky Mountain Alpines*, the magnificent and indispensible book compiled for the 1986 Interim International Rock Garden Meeting in Boulder, Colorado.

This book is where I first learned about dry sand beds for growing western plants. The list of plants grown was tantalizing and included eriogonums, western phloxes, penstemons, drabas, and acantholimons. I soon had the exciting opportunity to visit Norm's garden. I will never forget the following spring when he demonstrated the toughness of his 6'-diameter mat of *Eriogonum umbellatum* by just laying down on it! After seeing that, I had to make a sand bed for myself! I say make rather than build, because little building is usually needed.

Dry sand beds are such an easy and successful system for growing drought-loving plants that I am puzzled as to why more people don't have one as part of their rock garden. Maybe it is because we rock gardeners have a great fascination (obsession?) with soil mixtures, formulas, and recipes. We just KNOW that if we could only find the right formula or the correct secret ingredient, we could grow anything! Sand beds don't satisfy this need to tinker and formulate at all, as sand is the only ingredient in the mix. How disappointing! Nothing to shovel and stir, no careful layers to lay, nothing but sand.

Here are complete instructions for turning a flat, level, sunny lawn into a dry sand bed:

1) Kill the grass (and weeds). Use glyphosate, and wait a week, or use any method you find acceptable.

2) Put down an even layer of sand 6–8" deep. I have used as little as 4"in part of one bed and 12–18" in another case, and both seem to grow plants well.

3) (Optional) Add rocks in whatever quantity and arrangement pleases you and fits your budget.

4) If your new sand bed is in contact with remaining lawn, a barrier is desirable to keep grass rhizomes from invading. See any basic gardening book for edging ideas.

5) (Optional) Create an edge, out of some hard material like stone or landscape timbers, to keep the sand neatly in place, thus creating a low raised bed. Avoid making your sand bed raised too high, it will be TOO well drained, and nothing but true desert plants, like cacti, will grow there.

6) Plant your plants.

If you are interested enough to have read this far you are probably asking: What kind of sand should I use? How much should I buy? How do I get it home? Don't the plants need some food??? How much sun is needed? My garden is on a hill, can I still have a sand bed? Can I dig out a hole and fill it with sand and still have a dry sand bed? How do I place the rocks I want to use? Doesn't the rain wash the sand away? What is the best time of year to make and plant a dry sand bed? What if I don't like the color of the available sand? Here are some answers, drawn from my experience.

WHAT KIND OF SAND SHOULD I USE?

I prefer what is called builders' sand. It is the sand generally used to make concrete. It contains a mixture of particle sizes from medium sand up to little pebbles.

My first sand bed (photo, p. 90) was made with a fine-grained, even-sized-particle sand called masonry sand (the kind used to make mortar). Norm Deno also has a sand bed made of masonry sand. The only problem I have had with it is that rain-splashed sand coats the leaves of smaller plants. I had to add a thin stone mulch to alleviate this problem on this bed.

HOW MUCH SAND SHOULD I BUY AND HOW WILL I GET IT HOME?

The supplier you buy from will be able to tell you how much the sand you are buying will weigh per cubic yard. You must then apply a little simple geometry to calculate how much you will need for the square footage and depth of the bed you are planning. Or some suppliers sell by the cubic yard, since wet sand weighs more per yard than dry sand. Be prepared for a big truck! Our latest sand bed measures 8' x 40' and is about 12" deep (OK, maybe 18" deep in spots) and needed about 16 tons of sand. I had ordered 18 tons, but they had as much on the truck as the truck would hold. If you buy enough sand, the delivery may be free. Have the delivery truck dump it where you want your bed if at all possible!

DON'T THE PLANTS NEED SOME FOOD???

First of all, even small plants will quickly send their roots down deep, and they can grow into the underlying original soil that hasn't been disturbed.

Secondly, I scatter a little bit of time-release fertilizer tablets around every other year (or every third year) just to give the plants a little bit more food. But mainly I like the plants to stay small and tight. Lush plants would be out of character in this type of garden, so I don't feed them much.

John Good, from Wales, states that he uses a fertilizer formula created by E.B. Anderson many years ago. It consists of 7 parts bone meal to 1 part sulfate of potash (K^2SO^4). He scatters the mixture over his scree beds in late winter at a rate of 1–2 ounces per square yard, and rainfall washes it in. This fertilizer is very easy on the plants and won't burn the foliage. He states that it is probably best not to apply this every year, as there is a danger of build-up of too much phosphate and sulfate in the ground, especially on heavy soils. Take into consideration the existing fertility of your soil before you apply fertilizer—you may not need additional potassium.

HOW MUCH SUN IS NEEDED?

Two of the three sand beds we have get NO SHADE at all from 8 a.m. until 5 p.m., and we are on a slightly sloped, south-facing hillside. The third bed gets shade from about mid-afternoon on. The plants of the Wild West don't get any shade at home, since trees are not part of their ecosystems, so the more sun, the better.

I have seen one sand bed on a north-facing slope, in another garden. It doesn't dry out at the surface for many days after any rain. The owner has a great deal of trouble with liverworts growing on the sand surface.

MY GARDEN IS ON A HILL, WHAT CAN I DO? DOESN'T THE RAIN WASH THE SAND AWAY?

Several of our sand beds are on a slope (5°–10°), and I have used rocks with as little space as possible between them to make terraces down the slope. Under the influence of rain and time the sand tends to be self-leveling and must be held back like water behind a dam. I have found many plants that do well in the vertical crevices between the rocks, plugging the space so sand can't wash through. Sempervivums, rosularias, and jovibarbas are particularly good for this purpose.

Use sand with little pebbles in it, such as the builders' sand mentioned above, and you will find that rain will wash the tiny grains down from the surface of the sand, leaving behind the largest grains and tiny pebbles and making a nice, though thin, gravel mulch with no work on your part.

Sand color changes as it ages in place. The sand we receive is usually a funny yellowish color when delivered. The surface soon gets bleached by the sun to a light gray that contrasts very effectively with the plants, showing them off to great advantage.

CAN I DIG OUT A HOLE AND FILL IT WITH SAND TO MAKE A DRY SAND BED?

I found I wanted to do exactly this when I made sand beds at the top of an already existing mortared stone wall along our driveway. For me it worked just fine. I simply dug out about 12" of soil along the top of the wall, threw in a little bit of organic matter in the form of compost 0.5–1.0" deep (because there was only poor subsoil at the bottom of the ditch). The void was then filled with sand. This can only work if the surrounding soil is a very well drained, as with the sandy loam soil we have throughout our property. I have no real problems to report, but the lowest end of one bed does stay damp for a couple of days after a rain, and only in that spot do we have any trouble with weed seeds germinating. On moderately to poorly drained soils, such as heavy clays, I think you must either raise the bed above ground level or install an underground drainage system. Otherwise, water will pool in the sand bed.

Helichrysum splendidum, Ephedra minuta, Teucrium marum

WHAT IS THE BEST TIME OF YEAR TO MAKE AND PLANT A DRY SAND BED?

The bed can be made in any season. However, I have found successful planting in the summer is very difficult to achieve in a dry sand bed. Keeping plants watered well enough to get them established is even more difficult than it would be in a regular garden. Planting in the spring and autumn is much more successful. So if you build a sand bed during the summer, while you are waiting for the fall planting season to arrive, be prepared to have your neighbor asking you why you have built a giant sandbox in your yard. Of course, once you start tucking in hundreds of little plants, the neighbors will think you are even crazier than they had previously suspected!

WILL I EVER NEED TO WATER?

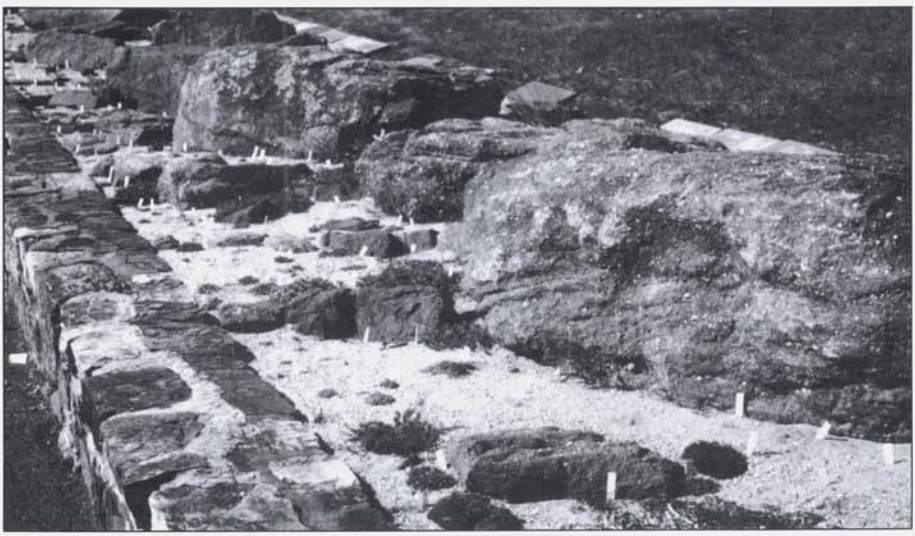
Probably not. I don't water the sand beds at all, although I individually water one or two plants close to the house. They probably don't really belong in a sand bed anyway.

WHAT KIND OF ROCKS CAN BE USED IN A SAND BED, AND HOW SHOULD THEY BE PLACED?

The rules and recommendations on rock garden design in *Rock Gardening* , by H. Lincoln Foster are a good place to start. For my sand beds I used our local, reddish sandstone conglomerate. I like the color (it strikes me as very western and wild), and I have been able to get it when I need it. Just remember, the sand's surface is self-leveling, and no slope can be maintained over time without placing rocks for terraces or putting on a thick gravel mulch.

I have found that my dry sand beds give me great pleasure and provide an easy and relatively carefree place to grow dryland plants here in southeastern Pennsylvania. There have been a few problems which I will mention.

NEIGHBORHOOD CATS may come to view your sand bed as their own giant-sized litter box. Their activities can easily smother small, treasured plants. When



this happened, I found that covering the favored area with chicken wire easily discouraged the feline activity. Over the first seven or eight years of our sand bed gardening, this was a very minor problem. Then a new and very determined cat moved in next door. When I covered his selected spot with chicken wire, he just moved to the next available space. Commercial cat repellent failed, as its label predicted, to change the cat's established behavior. In the end I resorted to covering the entire bed with a shield of chicken wire and turkey wire. I found the turkey wire, with its 2"-wide holes, to be harder for cats to walk on. This actually didn't look too awful, but I felt deprived of contact with my plants. I couldn't reach them to pick off a dead leaf here, or pull a little weed seedling there.

Early the following spring I began preventive measures. I took a large number of dried hot peppers (*Capsicum* varieties) and ground them finely in an electric coffee grinder I use for spices. I mixed this hot red pepper powder with diatomaceous earth. Then I used our vegetable garden duster to spread the powder over the entire sand bed. With reapplications after rains, the cats caused no problems at all last year. Caution: Stay upwind, and don't breathe this very irritating dust!!!

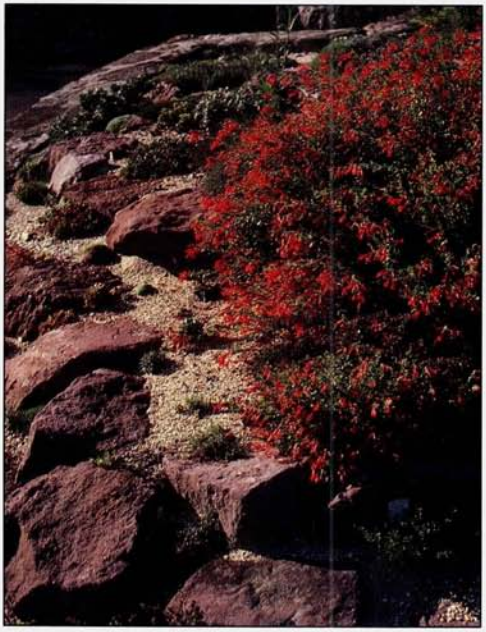
WEEDS growing from seed are no problem at all. If any do germinate and grow, they are incredibly easy to pull out. Since the sand, as it arrives, is free of weed seeds, maintenance is much less than that for any other garden I have. Rhizomatous grasses are another story—they can be an incredible nuisance if they get into your sand bed. But of course that is true of any rock garden. An ounce of prevention is worth a pound of cure, so I recommend either an industrial-strength weed barrier at the edges of the bed, or careful, regular edging with glyphosate herbicide.

VOLES (*Microtus pennsylvanicus* [that really is its name! Haven't we been blessed!] and its cousins) seem to find tunneling in the sand very easy. After one autumn and winter when many, many bulbs and a few buns were devoured, I followed the vole-trapping suggestions made by Helen Sykes in "The Vole Story" (*Rock Garden Quarterly*, Vol. 53: pp. 59–61) with great success. We have had little trouble for two years now, but I always am ready for trapping them when I see any sign of vole activity.

People who live in dry climates with low humidity may get a chuckle out of reading all of the preceding. What I go through to grow dryland plants here in the humid eastern part of North America, is, I suppose, comparable to the trials of people in Denver who try to grow rhododendrons and primulas. It isn't completely futile, but is it worth the trouble?

Yes, the dry sand bed is more than worth it. (However, I can't really answer you about rhododendrons in Denver.) Not every dryland plant will be happy in my climate, but with guidance from past pioneers (the western theme again!) I have found dry sand beds to be a relatively carefree way to grow many of the dryland plants I desire.

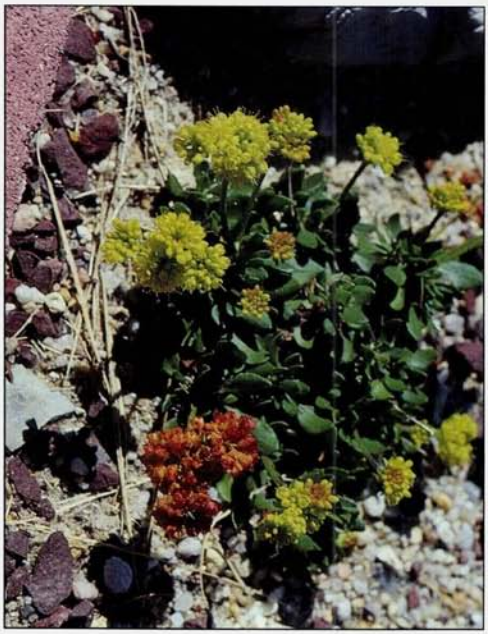
The variety of plants that have done well in our dry sand beds is very large. The vast number of choices really give me a chance to travel around the world through the seeds I plant. A brief survey of outstanding performers follows.



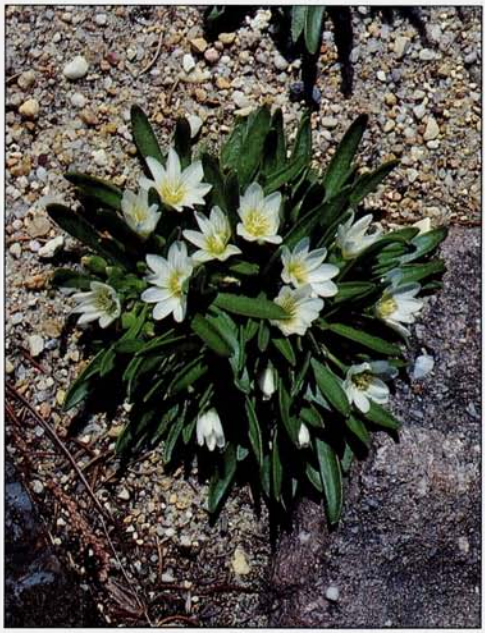
Zauschneria latifolia var. *garrettii* (syn. *Epilobium canum* ssp. *garrettii*, pp. 83, 94, 96)

Draba cappadocica

Eriogonum umbellatum var. *porteri* (p. 93)



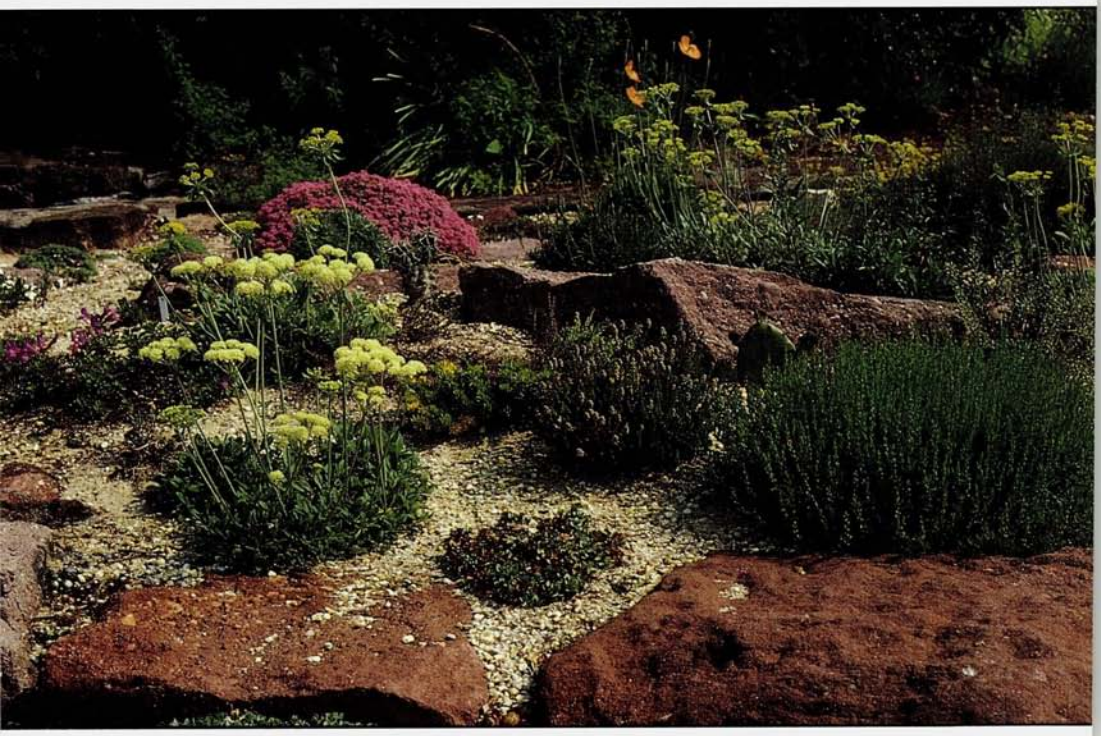
Lewisia nevadensis in sand bed (p. 93)
photos by Michael Slater



First sand bed in Slater garden (pp. 83–96)

Second sand bed in Slater garden

Photos, Michael Slater



Penstemon linarioides var. *coloradoensis* (p. 94)

Townsendia jonesii (p. 93)

Viola pedata var. *concolor* (p. 96)

Delosperma cooperi under chicken wire (p. 94) Photos, Michael Slater

Buns look great in a sand bed, and many that are considered difficult to grow do very well there. Choice species of *Acantholimon, Dianthus, Draba, Gypsophila,* and *Arenaria* perform a fine imitation of sea urchins in a tidal pool.

Acantholimon has been one of the outstanding genera in my sand beds. They get very little in the way of brown spots in the cushion, and they have beautiful but spiny leaves. *Acantholimon araxanum* and *A. ulicinum* (syn. *A. androsaceum*) are my current favorites.

Draba cappadocica is the best of the crucifer tribe I've grown from seed lately. The golden flowers barely rise above the somewhat fuzzy, gray bun.

Several little gypsophilas have good foliage and make good buns in the sand bed, but don't bother growing them for the flowers. *Gypsophila tenuifolia* has nice, almost grass-like leaves and sparse, pinkish flowers on stems around 6" tall. *Gypsophila aretioides* needs far too many adjectives for the size of the plant! It is the most amazing, 4"-wide, rock-hard, little, gray mound. People who haven't seen it before can't help touching it, but neither can the owner. Ours had two (yes, TWO) flowers several years ago. The best thing that can be said about the flowers is that they didn't obscure the wonderful bun!

Mat-formers like *Veronica oltensis* and *Thymus necefii* add a different note that I like. Be wary of fast spreaders like *Veronica liwanensis*: it looks fine, but it wants to take up far more space than I am willing to let it have.

Little daisies are wonderful, and there are a few of the choicest ones that really seem to thrive in dry sand. *Townsendia jonesii* (photo, p. 91) is a superb mound with large and very pale lavender daisies nested in the foliage. It also appears to be truly perennial, in addition to setting a large amount of seed. It is the best *Townsendia* I have grown. The yellow-flowered *Erigeron linearis* (photo, p. 123), at about 4" high, is very nice (watch out for the forms without ray flowers!) The very tiny *E. scopulinus* is the most wonderful little Asteraceae of all: grow it in any sand bed, rock garden, or trough!

Gray-leaved plants give a special flavor to any garden, but their contribution to the character of a dry sand bed is exceptional. Try *Helichrysum splendidum* or *Hymenoxys subintegra,* or *Artemisia frigida* if you really want to knock the socks off your visitors.

Eriogonum is one of my favorite genera. Some of the tiniest and most appealing ones thrive in the dry sand. *Eriogonum kennedyi* var. *alpigenum* and *E. k.* var. *austromontanum* are the smallest, grayest, and tightest little mats I grow, after *Gypsophila aretioides. Eriogonum umbellatum* var. *porteri* (photo, p. 89) is a great small form of this ubiquitous western sulfur flower. I could go on and on, but I will content myself with mentioning *Eriogonum strictum* var. *proliferum* with fascinating gray or gray-green, spade-shaped leaves, which instead of being held out flat like most plants, twist the stem 90° so the leaf blades are held perpendicular to the ground. This makes for an interesting effect. I assume this habit is an adaptation for coping with too much solar radiation in the plant's native habitat.

Bulbs and other plants that go dormant in the summer seem to do very well in dry sand. *Lewisia nevadensis* (photo, p. 89) and *L. pygmaea* are mainstays in my latest sand bed. Many varieties of crocus and bulbous iris thrive. I have put some *Calochortus* seedlings in, and they are still present after two years. I wonder how long they will take to bloom?

Shrubs and sub-shrubs and dwarf conifers in small numbers accent the nearby tiny mats and buns. This helps the sand beds seem a little more wild and less

artificial and garden-like. *Cowania mexicana*, a stiff, upright shrub from the Southwest, several varieties of *Calluna vulgaris*, *Arctostaphylos uva-ursi* (both East Coast forms and a form from Alaska), plus a few small and interesting dwarf conifers, such as *Juniperus chinensis* 'Shimpaku', are all welcomed in and are thriving. Remember the native soil is not that far down, and these shrubs will have their roots down there quickly, so you can consider any shrub that you know grows well in your area in full sun.

Succulents, of course, are in their element! Cacti, *Delosperma* species, sempervivums, rosularias, *Orostachys*, and sedums are incredible and indispensible. Try *Echinocereus baileyi*, *E. viridiflorus*, *E. caespitosus*, *or Coryphantha vivipara* if you like wonderful little ball cactuses. *Delosperma nubigenum* and *D. cooperi* (photo, p. 92) are reliable through every winter for us, and I keep trying all I can from seed. The succulent foliage is nice, and the incredibly bright colors of the flowers are great. *Delosperma congestum* seems as if it is going to be the next good doer. As mentioned above, the sempervivums and their cousins make good plants to hold back the sand in vertical crevices. I prefer selections with gray or reddish foliage, as they complement my red rocks and gray sand.

Penstemons large and small are spectacular against my large, reddish boulders. Although not considered among the most difficult and desirable of the penstemon clan, *Penstemon cardinalis*, *P. strictus*, *P. barbatus* and *P. palmeri* make tall, colorful spikes. Lower down, *Penstemon linarioides* var. *coloradoensis* (photo, p. 91) puts on a good display of clear, light blue flowers above narrow, gray leaves. Meanwhile *Penstemon pinifolius* makes dense forests of small, pine-like foliage well decorated with bright red flowers. The lowest of all is *Penstemon caespitosus* 'Claude Barr', with small blue flowers nestled in its ground-hugging mat of dark leaves.

Quite a few plants with interesting foliage can be grown in dry sand, and they will lend an exotic air to the bed. Try *Cheilanthes fendleri* on the north side of a rock, where its roots can stay a little bit cooler. The small, gray dagger-like leaves of *Yucca harrimanae* look good in small groups. In the dry sand, mine all have leaves less than 6" long.

Lastly, both in the date of its grand floral display and alphabetically, is the Queen of the Summer in our sand beds, *Zauschneria latifolia* var. *garrettii* (photo, p. 89). The mound of gray-green foliage covered with red-orange trumpets in August and September makes the space sacrificed for this 3–4'-wide plant worthwhile. (*Zauschneria* has been sunk into *Epilobium* by taxonomists recently. This name change will have to stick and be accepted before this gardener changes his labels! I like the name *Zauschneria*, and it doesn't look like an *Epilobium* to me!)

Michael Slater and his wife Jan live and garden in Mohnton, Pennsylvania. Mike's horticultural interests are wide, including showing at the Philadelphia Flower Show and a deep interest in woodland wildflowers, as well as in the plants of western North America. Photos by the author.

Plants For Sand Beds

These are some of the plants that have done well in the Slater dry sand beds with full sun (no shade at all) and no supplemental water, even during drought.

Acantholimon araxanum, A. acerosum, A. armenum, A. bracteatum var. *capitatum, A. dianthifolium, A. glumaceum, A, hohenackeri, A. ulicinum* (syn. *A. androsaceum), A. venustum*
Achillea ex `King Edward'
Aethionema oppositifolium (syn. *Eunomia opp.*)
Alyssum caespitosum, A.propinquum
Arabis androsacea, A. bryoides
Arctostaphylos uva-ursi
Arenaria hookeri, A. saxosa (name not verified (n.v.); looks a lot like *A. montanum*), *A. pseudacantholimon* (n.v.), *A. stelleriana, A. tetraquetra, A. t.* var. *granatensis* (scorches some during the summer but survives), *Armeria juniperifolia* (syn. *A. caespitosa), A. gerardii* (syn. *A. setacea*)
Artemisia frigida
Asperula gussonii (*AGS Encyc.* says it should have bluish foliage; mine is bright green. Do I have *A. nitida*? I do water this one occasionally, although I'm not sure if it really needs it.)
Bruckenthalia spiculifolia
Calluna vulgaris `Dainty Bess', `Minima', `Mrs. Ronald Gray'
Cheilanthes fendleri
Conradina verticillata
Cowania mexicana
Delosperma aberdeenense, D, cooperi, D. macei (n.v.) and *D. nubigenum* (small yellow flowers)
Dianthus freynii, D. petraeus ssp. *noeanus* (syn. *D. noeanus*), *D. simulans*
Draba cappadocica, D. densifolia, D. rigida var. *imbricata, D. rosularis*
Echinocerus triglochidiatus, E. viridiflorus
Ephedra frustillata, E. minima, E. minuta, E. sinica
Erigeron aureus, E. compositus, E. elegantulus, E. scopulinus, E. simplex
Eriogonum caespitosum, E. douglassii, E. ericifolium var. *pulchrum, E. jamesii, E. jamesii* var. *flavescens, E. kennedyi* var. *austromontanum, E. kennedyi* var. *alpigenum, (E. ovalifolium* var. *nivale* and *E. o.* var. *purpureum* seem to live through two years, bloom, and die. More seedlings are coming on though!), *E. strictum* var. *proliferum, E. umbellatum, E. umbellatum* var. *porteri*
Erysimum kotschyanum

Genista 'Vancouver Gold', *G. sylvestris* (syn. *G. dalmatica*)
Globularia cordifolia
Gypsophila aretioides, G. tenuifolia
Helichrysum splendidum
Hudsonia ericoides (none lived more than three years.)
Ipheion uniflorum
Ipomopsis aggregata (This seems to be monocarpic for me.)
Leptospermum humifusum (a hardy Tasmanian!)
Lesquerella alpinum, L. arizonica, L. kingii
Lewisia nevadensis, L. pygmaea, L. rediviva
Origanum libanoticum
Paronychia sessiliflora
Penstemon angustifolius, P. aridus, P. barbatus, P. barbatus (yellow form), *P. caespitosus, P. cardinalis, P. caryi, P. davidsonii, P. eriantherus, P. fruticosus, P.* hybrid (purple, from *P. barbatus* x ?), *P. laricifolius* var. *exilifolius, P. laricifolius* var. *laricifolius, P. linarioides* var. *coloradoensis, P. jamesii, P. kunthii, P. neomexicana, P. palmeri, P. pinifolius, P. procerus* var. *tolmei, P. secundiflorus, P. strictus, P. virens*
Petrophytum caespitosum, P. hendersonii
Phlox 'Pink Star', *P.* 'Schneewitchen', *P.* 'Tamanonagalei', *P. diffusa, P. hoodii, P. pulvinata, P.* 'Tiny Bugles'
Physaria alpestris
Pinus sylvestris 'Hillside Creeper'
Pterocephalus pinardii
Ptilotrichum spinosum (syn. *Alyssum spinosum*)
Rosularia species
Sempervivum many varieties (good between rocks to hold back the sand in the terraces of sloped sand beds)
Teucrium marum
Thymus necefii
Townsendia exscapa, T. incana, T. jonesii, T. parryi, T. rothrockii
Veronica bombycina var. *frederyana* (variety n.v.), *V. liwanensis, V. oltensis*
Viola pedata, concolor (photo, p. 92) and bicolor forms
Vitaliana primuliflora (recovering nicely from the vole attack)
Yucca glauca, Y. harrimaniae
Zauschneria latifolia var. *garrettii* (syn. *Epilobium canum* ssp. *garrettii*, previously *Z. garrettii*)

DRY SAND BEDS

A RETROSPECTIVE

by Norman C. Deno

Thirty years ago a dry sand bed was constructed in the front yard. The biggest plus has been finding how easy it is to maintain and weed this bed. Not only is the medium soft, so that weeds are easily extracted, but one can crawl around on hands and knees and not get "mucked up," and the sand is nice and soft on one's knees. Any sand adhering to one's slacks or pants is readily brushed off. Also the plants stand out nicely as individual little tufts and mounds. Another nice surprise was that *Phlox bifida* and *Phlox subulata* thrive and self sow. Hybrids appear. Some are tiny dwarfs with flowers a third of an inch across.

The biggest minus was to find that two nasty tiny weeds (*Cardamine pensylvanica* and a *Veronica*) love these beds. It is an around-the-year job to remove them, because both grow throughout the winter.

The plants that benefit from the dry sand environment can be divided into three groups. Group (A) naturalizes, flourishes, and self sows abundantly. Examples are Barr's *Aster kumleinii* (*A. oblongifolius?*), *Helichrysum* sp. Basutoland (*H. milfordiae* ?), *Pulsatilla vulgaris*, *Sisyrinchium campestre*, and *Talinum teretifolium*. For years *Linum capitatum* grew well, but recently the numbers have declined.

Plants in Group (B) grow vigorously and set abundant seed, but there is little or no self sowing, because the seed does not get sufficient drying in our climate to destroy the chemical systems that block germination (D-70 germinators). Examples are the dwarf drabas and some of the penstemons and townsendias from the western United States. Colonies of these can be maintained, but only by collecting the seed, drying the seed for about six months, and broadcasting the seeds back onto the dry sand beds. For example, failure to do this led to *Townsendia parryi* (photo, p. 112) disappearing in a year. Particularly delightful in this group are the colonies of the white *Draba dedeana* and colonies of dwarf yellow drabas centering around *D. aizoides*.

Plants in Group (C) grow and flower moderately but set little seed, perhaps because only a single clone is present. This group is subject to rotting of the plants if they are not periodically divided. It is also helpful to

keep the base of the plants free of any debris, so that the plant quickly dries out after our summer rains. Examples are acantholimons, *Arenaria hookeri, Eriogonum flavum, Eriogonum umbellatum, Dryas octopetala, Penstemon caespitosus, Penstemon davidsonii,* and *Penstemon teucrioides.*

Perhaps the biggest disappointment has been that many of the plants introduced by Claude Barr have gradually faded away. They grew for some time and were even propagated for Don Hackenberry to sell. However, they required constant division and cleaning to keep them from rotting, and ultimately they died out. Examples were *Phlox alyssifolia, P. andicola,* and *P. hoodii* (photo, p. 126). It was sad that *Anemone caroliniana, Clematis occidentalis, Leucocrinum montanum, Melampodium leucanthum,* and many of the penstemons could not be kept going, as they did flower beautifully for a time. These could possibly have been kept going by giving more attention to constant division and cleanliness around them. However, without natural self sowing, no plant is permanent.

A number of western plants will grow in the sand beds, but they grow equally well in the gravel or dryish clay along the road. Examples are *Delphinium bicolor, Erythronium mesochoreum, Lithospermum incisum, Nemastylis acuta, Oenothera brachycarpa, Opuntia* species, *Ruellia humilis, Thermopsis rhomboidalis,* and *Tradescantia bracteata.* All of these maintain themselves by self-sowing.

Echinocereus cacti have been a special project here. Even in the dry sand beds they tend to rot when they reach several years in age. A breeding program is in progress designed to breed in better resistance to decay. Already in three generations there seems to be improvement. The hybrid strain has been bred from *E. baileyi, E. fendleri,* and *E. pectinatus.* Certainly the dry sand beds are the best place for these plants. Readers will recall that these *Echinocereus* species germinate only when treated with gibberellic acid-3. Possibly other gibberellins would work, but this has not been tested.

Particular mention is made of *Asphodeline lutea.* This grows well in the dry sand beds but has not as yet been tried elsewhere. This is an underappreciated plant. The foliage is absolutely evergreen all winter and resembles a dwarf *Yucca.* The flower spike is attractive, bearing inch-wide, yellow stars. The flowers open randomly up and down the spike so that the effect is not as attractive as if the flowers opened in some more consistent pattern. A breeding program on asphodelines ought to be rewarding.

Have fun with your sand beds. They do look nice, and they are an easy way to bring a new range of attractive plants into cultivation in your garden.

Norman and Janet Deno live and garden on several acres in State College, Pennsylvania. Norman has a long-standing interest in naturalizing large populations of choice plants. He has also done very extensive research on the germination of seeds.

TOWNSENDIAS

HALYCON DAISIES OF THE ROCKIES

by Panayoti Kelaidis

La primavera pasa,
dejando entre las hierbas olorosas
sus diminutas margaritas blancas.
—Antonio Machado

Springtime comes by,
Leaving among the fragrant grasses
Her diminutive white daisies.
—Antonio Machado

Even people who think they hate daisies usually make an exception for townsendias. Of course, it doesn't hurt that most Easter daisies form attractive mounds of foliage and bloom—occasionally even dense cushions—as self-respecting alpines are supposed to do. And most members of the genus have the sense to bloom early in the season, when our appetite for flowers and color is insatiable. The commonest townsendias are lovely plants in troughs or pots, and the rarest are intractable enough to prove a challenge for most gardeners in most climates. And there are those few elusive ones, the holy grails that help elevate certain genera to a loftier level. An allure gradually gathers around certain plants—like *Townsendia*—which have such a pleasing proportion of flower to leaf and subtle, but intriguing variation from species to species. Some have powdery white foliage, others leaves that are dark green with a bluish cast and waxy. The flowers are commonly white, but then there are deep violets, luminous lavenders, pure pinks, and even icy yellows. When you grow any plant in this genus well, it can create such a delightful miniature spectacle in the garden (even if only for a single year) that you will strive forever to repeat the performance.

But the real magic awaits those of us fortunate enough to live near townsendias in the wild, or those intrepid tourists who seek them out, for townsendias occupy practically every sunny ecological niche in the great American West, which is to say, some of the loveliest country in the world. Early in March you can walk the shortgrass prairies for miles and among the sere winter tufts of grass you find thousands of snowy mounds of Easter daisies in the brash spring sunlight, tucked ever so cleverly here and there—some brushed with pink, all displaying a fascinating variability. Throughout the foothills, up to the highest peaks, you keep encountering new species, new variations year after year, growing among dwarf pines and oaks, in the openings of spruce woods, and on windswept tundra and screes of the highest summits.

Townsendias create the first great floral spectacle each spring throughout the most dramatic scenery in America—astonishing because the plants are so diminutive and their setting so vast and awesome.

There are only two dozen or so names bandied about in *Townsendia*, so that one would think the application of names would be clear sailing. Alas, the course of taxonomy, like true love, never did run smooth, and Easter daisies are no exception. One can rarely find a collection of more than a few townsendias where the same name is not ascribed to completely different plants, and identical plants have different names on their labels. There is a measure of variability in the genus, so we can blame the plants themselves in part for this predicament. And many townsendias have huge geographical ranges that overlap, so a traveler in unfamiliar territory might be forgiven plucking a bit of seed in the wild and then labeling it with a likely name encountered in a selective, or incomplete, regional flower guide.

Although not many mail-order nurseries offer townsendias, nor are you apt to encounter them in a garden center, these plants produce tremendous quantities of seed in the wild or in the garden. Plants are passed around a little carelessly between home gardeners, labels fall out or are accidentally shuffled. Seed is collected, and you can't read your own scrawl, or—horror of horrors—you can't find a pencil, or forgot altogether to label the plant, thinking that, like some high school crush, you would never forget its name. The good news is that one of the so many new companies offering native seed is apt to carry any of the genus in a given year.

May I suggest we take a stroll through the genus? For garden purposes townsendias fall into certain subgroups that share characteristics with one another. These distinctions are not altogether air-tight, nor do they have morphological, nor botanical significance. The plants nevertheless have a certain resemblance within each subgroup.

STEMLESS MINIATURES (Great Plains and Northern Sagebrush Steppe)

Townsendia hookeri (photo, p. 106, 107)

If you have grown one miniature townsendia, it very possibly might be the Great Plains Easter daisy, the most widespread and possibly most numerous plant in the genus. There are still stretches of the Great Plains where *Townsendia hookeri* grows so thickly that in some years it tints the ground white in early spring when it comes into bloom, dappling the plains like an untimely snow.

I have found *Townsendia hookeri* growing all the way to treeline in the central mountains of Colorado—as well as in the mountain parklands and across the Wyoming and New Mexico desert and sagebrush steppe. It is found on the Great Plains from Canada to Texas. It has been known to open its first flowers in January, and even in cold years a few plants can be found by late February. You can follow the plant up the southern Rocky Mountains, on south-facing slopes among *Yucca glauca*, *Pediocactus simpsonii*, and other xerophytes in open ponderosa pine woods into the months of May and even June, and on more than one slope of the Mosquito Range among creeping junipers and bristlecone pines you can still find scattered plants of this amazing species blooming in early July (a six-month altitudinal *tour de force* if there ever was one.)

Typically, this stemless Easter daisy has linear, nearly filiform leaves that are

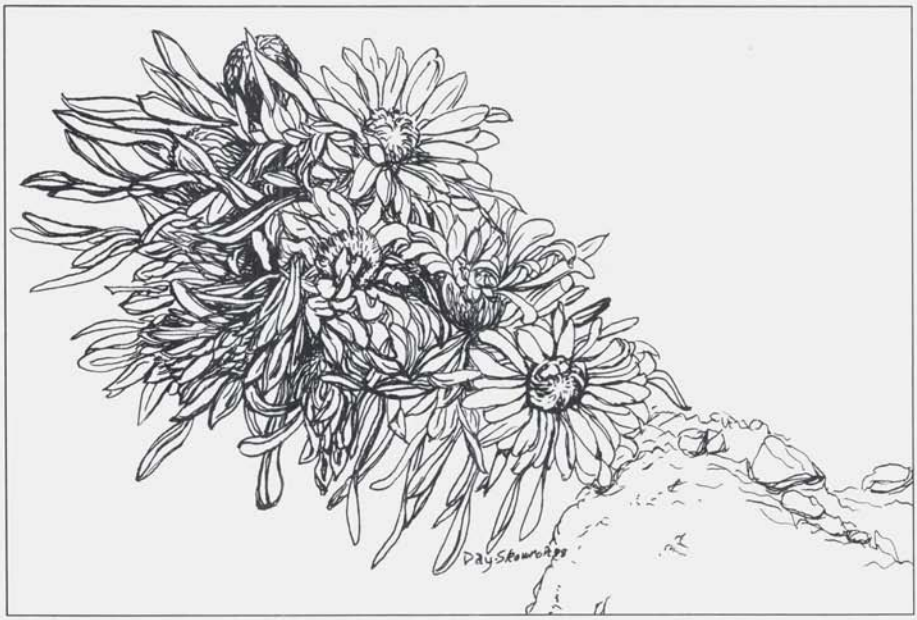
silver-gray in color, from one to over 2" in length crowded into dense mounds that form a rather amorphous, tufted cushion whose individual rosettes are not clearly distinguishable. Pads can spread to 4" or more across. Flower heads, with disc flowers in the center and ray flowers on the outer edge, are an inch or a bit wider when fully open, the rays usually bright white, although pale pink forms are common in some localities.

Gardening literature impugns this magnificent plant as short-lived. It may be so in rich compost or overly wet climates. In nature, plants must persist for many years, and I can vouch that Gwen has one individual in a trough that is 14 years old right now and going strong. If that qualifies as biennial, let's contact the *Guinness Book of World Records* immediately. One phenological record this species retains every year in our gardens is that it is the first plant to produce seed every year: we have found the first perfectly spherical powder puff of seed sitting atop the silvery bun in early April, long before most prairie wildflowers have even emerged from dormancy.

The secret to growing the common Great Plains Easter daisy? Remember that its home landscape is very sunny year around, and although rain or snow can come in any month, it never stays long, so drainage is essential. It may grow on clay, loam, or granitic gravel in nature, but often among a fine tapestry of *Selaginella densa* and tiny grasses and other forbs. Wedge it between rocks, make sure its soil drains perfectly, and that it has lots of nutrients, let it be as alkaline as you can muster, and provide some shelter if you have prolonged rains or wet weather, and you may find this to be longer lived than you had bargained on.

Townsendia exscapa (photo, p. 106, 107)

A second widespread Easter daisy on the Great Plains often grows near *Townsendia hookeri*, causing much consternation and confusion. Once you have grown the two species side by side, you aren't apt to confuse them again—*T. exs-*



capa is an altogether larger, more robust plant with flower heads often twice the size of *T. hookeri*. It seems to have a more southerly distribution overall and often grows among oaks and in the open pinyon and ponderosa pine community.

The daisies are of a particularly shimmering version of that multifaceted color we call white. Since this species can get so much larger, it's more suitable for growing in a rock garden setting than the smaller *Townsendia hookeri*. Remember, however, that the buds only open on bright days and in warmer weather. A blooming clump in nature can go through a half dozen snowstorms and continue flowering freshly during the thaws between the deep freezes. A plant in the middle of its blooming cycle can endure a night of 0°F and commence blooming again as soon as the weather warms up—and behave as though nothing had happened.

Townsendia glabella (photo, p. 109)

The regions where the smooth Easter daisy grows are still relatively sparsely settled, so few people have had a chance to see this startling plant in its full glory. The landscape of southwestern Colorado and the Four Corners country to which this species is restricted is known for its archaeology, scenic grandeur, and diversity of ecological habitats. We've found this Easter daisy growing in the foothills of the La Plata Mountains (a spur of the great San Juan Range); in the pastoral, hilly country where giant ponderosa pines grow in parklike formation with rugged cedars; in dense copses of Gambel's oak; and in sagebrush-dotted grasslands. The townsendia is generally found on shaly hillsides or rocky ridges, where the woods and shrublands can't maintain a toehold. As the townsendia wanes, the meadows burst forth with an amazing profusion of wildflowers, including dwarf species of *Mertensia,* the highly local, yet abundant clove phlox (*Phlox caryophylla*) with its wonderfully variable pink mounds of bloom, and *Penstemon linarioides* var. *coloradoensis,* like a blue-leafed, blue-flowered pineleaf penstemon.

Townsendia glabella forms much larger mats than the previous two species, with silvery leaves, the color of which is the result of a glaucous bloom on the leaves rather than tiny hairs, as in the Great Plains species. The flowers are little over an inch across, produced so thickly that the mats (which can approach a foot in diameter) positively glow in the distance. In a well-drained scree this species can persist for many years.

Townsendia incana (photos, p. 105)

Just as the Great Plains Easter daisies dominate the southern Rocky Mountain parklands and shortgrass prairies, another miniature Easter daisy can be found in nearly every corner of the deserts that occupy the high dry plateaus and basins between the Rockies and the Sierra Cascade crest. The intermountain Easter daisy is utterly distinct from other species. For one thing, it forms mats of considerable extent at times—a foot is not unheard of—with rather distinct, gray rosettes covered with hairs. Although the occasional blossom opens in late April in the wild, this species generally waits to bloom until hot weather sets in. Expect the showiest displays in May most years, or even June on higher ridges. Thenceforward, all the way to autumn, you can find a few scattered daisies of this species. In a garden, where it receives an occasional drink, flushes of bloom recur throughout the warm summer months.

This is very much a desert plant in nature—and you are sure to find it in all the great sagebrush desert country of western Colorado, southwestern Wyoming, and throughout Utah. It is abundant throughout the Uinta Basin, where it can often be found with several other earlier blooming Easter daisies that form much smaller tufts. Throughout the San Rafael Swell, Capitol Reef, the endlessly colorful and outrageous landscapes of the Canyon Country—wherever pinyon and juniper and sagebrush grow—you are apt to find the open mats of this canyon country Easter daisy, together with *Eriogonum ovalifolium* or *E. shockleyi* and the usual rabble of paintbrushes, penstemons, fleabanes, and the enormously variable assemblage of wildflowers that make this region America's most surreal flower garden. Look up, and a soaring natural arch may be in view, or a forest of orange rocks.

There is tremendous variability in foliage size, flower color and size, and garden performance among various accessions of *Townsendia incana* we have grown over the years. Its protracted bloom period and trim habit make it one of the most valuable garden plants in the genus for xeriscapes or sunny rock gardens.

Townsendia strigosa

This is a smaller species, forming trim mounds rather like the Great Plains Easter daisies, but with much wider, hairy, spatulate leaves. It is restricted to rocky habitats and steppe far to the north and along the western margins of the intermountain region. It often opens its first flowers before the crocuses in our home garden—always a clear white color.

HIGHLY LOCAL STEMLESS MINIATURES
(Southern Colorado Plateau and Great Basin Desert and Steppe)

Townsendia jonesii

In a few narrow valleys of southcentral Utah, a variable miniature townsendia occurs that qualifies as endangered by most measures. It is restricted to a harsh, barren environment, mostly on alkaline clay and sparsely vegetated shales, and is vulnerable to traffic, the vagaries of weather, and the impact of overcollecting. Superficially, Jones' Easter daisy resembles many of the other species in the stemless group, having tiny, glabrous mounds and flowers of a tepid lavender or off-white. A few colonies bear primrose-yellow heads (this is one of only two yellow-flowered townsendias), which make the subspecies distinct and desirable for rock gardeners.

Until such time that seed can be responsibly produced by reputable seed dealers, I myself would question the ethics of growing this plant from wild-collected seed. To place one's personal drive for collecting above the integrity of wild populations strikes me as a violation of all that rock gardeners ought to hold sacred. There are many thousands of desirable rock garden plants that are firmly established in cultivation or common enough in nature that growing them does not place us in ethical ambiguity. Until you have mastered the cultivation of the other species and forms of *Townsendia* described herein (and have them cheerfully self-sowing), I would consider it the height of immaturity and vulgarity to indulge oneself at the expense of any plant in such peril as *Townsendia jonesii*. Real connoisseurs learn restraint.

Townsendia aprica

The comments under *Townsendia jonesii* could be repeated for this plant, which may (if anything) be rarer. I have searched for it on several occasions at the few localities where it has been recorded and never found a plant. The habitat is high, cold desert in central Utah, a sparse pinyon pine woodland with *Juniperus osteosperma,* on harsh, shale-derived, clay soil that is a quagmire when wet and dusty the minute it dries.

I have purchased seed twice and had a few tiny specimens, which I must admit were incredibly beautiful. The foliage is powdery white, and the rays a wonderful yellow color. They did not produce viable seed for me in semiarid Denver and did not persist more than a few years. This is a plant best left to professional botanic gardeners and designated nurseries to propagate and tame, to spare the tiny wild populations from further decimation by amateurs.

Townsendia mensana (photo, p. 110)

Somehow, I am not so worried about this tiny morsel from the Uinta Basin, even though it doesn't seem to be particularly common at any location, nor is it found over a vast range in nature. I have run across it enough times and in a variety of sites, so that I do not think it is quite as vulnerable as the species above.

Nor do I think it has as much allure for horticulture. It must certainly be the tiniest townsendia—a mature, full-sized plant will often be 2" or less across. The filiform leaves are barely an inch long in some, and the daisies are correspondingly diminutive. The rays vary somewhat in color, from pale lavender and pure white to a distinctly yellowish hue. Since this, too, is a desert plant, it will prove challenging in all but semiarid climates. In nature it grows alongside such magnificent wildflowers as *Eriogonum tumulosum, Sclerocactus wrightii, Penstemon duchesnensis*—in fact, dozens and dozens of rare Uinta endemics—and, of course, the ubiquitous *Townsendia incana.* Seed of the latter was offered in the 1980s under the name of *T. mensana,* and plants so labeled are occasionally seen in collections; but the true plant rarely is. Even Rickett's 3rd *Rocky Mountain* volume illustrates what surely must be *T. alpigena* under the name *T. mensana.* True *T. mensana* is a miniaturist's delight, however, and a strain amenable to growing in pots would certainly find a niche in our art.

Townsendia minima (photo, p. 110)

This endemic of the Aquarius Plateau and a few neighboring spots in southwestern Utah has been classified as a subspecies of *Townsendia alpigena,* a designation I find hard to accept myself. It is best treated as a species. A large proportion of the wild population of this plant is found inside the boundaries of Bryce National Park, a spot of dazzling beauty.

This region has such a high concentration of unique and beautiful plants and landscapes that one day I suspect much of the Plateau will be managed as a research natural area. Perhaps by then a strain of this wonderful Easter daisy will be developed that tolerates garden culture. After all, *Penstemon caespitosus* var. *desertipicti,* which grows along with it, the various endemic phloxes, such as *P. jonesii,* and that most entrancing of columbines, *Aquilegia scopulorum,* have all proven to be eminently growable in our gardens.

Townsendia incana growing wild in Utah (pp. 102–103) Photos, Panayoti Kelaidis

Townsendia incana in unwatered cultivation in Denver, Colorado (pp. 102–103)

Townsendia hookeri (pp. 100–101)

Townsendia exscapa (pp. 101–102)

Townsendia hookeri on the Great Plains (pp. 100–101)

Townsendia exscapa, large-flowered form (pp. 101–102) Photos, Panayoti Kelaidis

Townsendia eximia (pp. 113–114) Photo, Panayoti Kelaidis

Townsendia grandiflora (p. 113) Photo, Paul Maslin

Townsendia florifer (p. 114)

Townsendia glabella (p. 102) Photos, Panayoti Kelaidis

Townsendia mensana (p. 104)

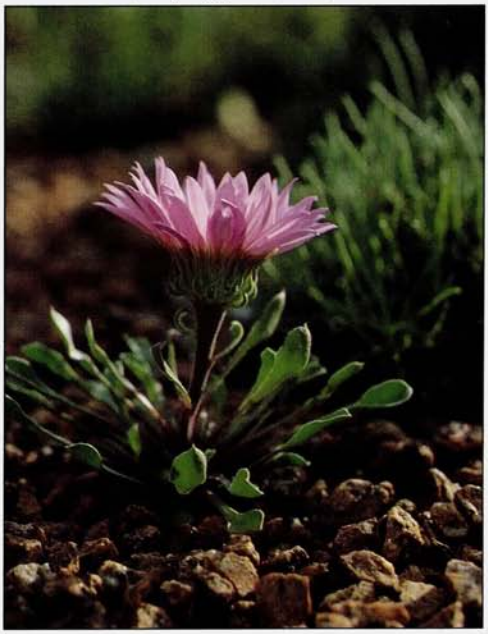
Townsendia minima (p. 104)

Townsendia rothrockii in the Mosquito Range (pp. 115–116)

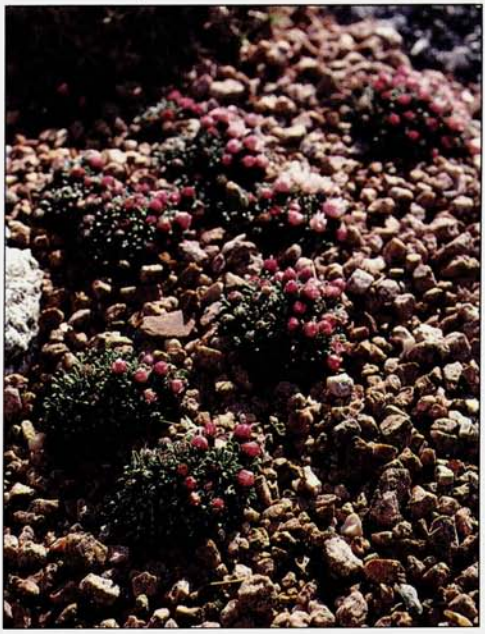
Townsendia leptotes, cultivated from Idaho seed (p. 116) Photos, Panayoti Kelaidis

Townsendia alpigena (syn. *T. montana*, p. 116)

Townsendia parryi (pp. 97, 114)



Townsendia spathulata in cultivation (p. 116)



Townsendia minima forms especially dense mounds of glabrous, tiny rosettes less than 1" in diameter, wonderfully symmetrical domes with age. The flower heads are a tad smaller than the rosettes, produced in early spring, and almost always a pure white color. The white is all the more beautiful when contrasted with the bright pink soil, the army of ruddy rocks that tower nearby, and the starkly contrasting caerulean blue of the southwestern sky.

TOWNSENDIAS WITH STEM LEAVES (biennials, low to middle altitude)

Townsendia grandiflora (photo, p. 108)

If you have hiked anywhere in the southern or middle Rockies or the Black Hills in early summer, or on the Great Plains from New Mexico all the way to Montana, you are almost certain to have seen this delightful native plant. Memorial Day daisy, or even Fourth of July daisy would be a good name for *T. grandiflora*, for it blooms long after the miniatures discussed above.

Although on hungry soils or overgrazed sites *Townsendia grandiflora* can occasionally appear to be stemless, if you examine a plant carefully, you will see a distinct stalk beneath the daisies. In the garden, it is apt to produce obviously branching stems 8" or more in height, with stem leaves, and a luxurious mound of flowers that bloom through much of the summer season in the garden.

The daisies are certainly among the largest in the genus—invariably more than 2" across, sometimes twice that. The rays are always a creamy white color that doesn't glow quite as brightly as the whites of the stemless sorts. But the color combines better, perhaps, with the wealth of early summer flowers that blend in such wild abandon in the lush meadows.

It seems to be most common on the piedmont mesas at the base of the Front Ranges of the Rockies, growing in clearings among ponderosa pines. It can often be found in dry meadows even among the aspens, and far out onto the Great Plains on rich loams in lusher prairies. Wherever it occurs, you're not apt to overlook it.

Townsendia eximia (photo, p. 108)

Far more local than its white-rayed cousin *Townsendia grandiflora*, this lavender-rayed giant is restricted largely to the Spanish Peaks, those two giant volcanic cones that loom over the plains of southcentral Colorado. It also occurs on the Sangre de Cristo Mountains a few dozen miles farther west.

The first year you can expect a neat rosette or cluster of blue-gray, cartwheel leaves that are pleasant enough. Year two will see these expand with leafy stems and even branch into a mound 6–8" tall with giant 4"-wide, lavender daisies each with a yellow disk boss. They stand out dramatically in the garden. Alas, like *T. grandiflora* on the plains and foothills below, this is biennial and must either self-sow or be deliberately perpetuated from seed each year. It is worth the effort.

If you grow this species alongside *Townsendia grandiflora*, you can expect the two to hybridize, producing a rather uninspired race with tepid-colored rays. The two species are obviously closely related.

But in nature, *Townsendia eximia* is a much higher elevation plant, usually found in clearings just below treeline or on sparse meadows above the trees to over 12,000' in elevation, making this one of the loftiest species in the genus.

Never abundant in nature, this species is at least firmly established in gardens, so wild populations need not be exploited.

Townsendia florifer (photo, p. 109)

Another biennial, this time from the northwestern tier of states, this wonderfully appropriately named, floriferous biennial produces a very hairy rosette of gray-green foliage 2–3" across the first year. The next year this transforms into a mound of bright pink daisies—the purest pink color of any plant in the genus in my experience. There are also paler forms. *Townsendia florifer* is most abundant on the endless sagebrush flats of eastern Washington and southern and central Idaho, extending southward to Nevada and Utah. It often grows with that wild assortment of miniature steppe gems that abound in this region: *Lewisia rediviva*, first and foremost, of course, *Eriogonum ovalifolium* in many color forms and subspecies, and its spreading cousin, *E. caespitosum*. Other favorite companions include *Penstemon pumilus* and *P. eriantherus, Sphaeromeria nuttallii, Lesquerella alpina*—the list extends almost as far as the crystalline horizon of this extraordinary floristic region. Alas, like many of these dryland companions, *Townsendia florifera* is not easily accommodated in wet climates. Alkaline soil, sun, and drainage are the secrets to cultivation of the most prized western species.

Townsendia formosa

This long-stalked townsendia is likewise monocarpic, somewhat resembling *Townsendia parryi* in overall habit. The basal rosettes are somewhat broader and more silvery blue. The stems are usually at least 5" tall with obvious, clasping leaves, and the daisies are a pale lilac color.

It is common at middle and upper elevations in the rich, lush mountains that rise from the Chihuahuan and Sonoran deserts around the Mogollon Rim in New Mexico and Arizona. These islands in the sky are often densely forested, and experience frequent summer showers. A few thousand feet below, creosote bush and mesquite, ocotillo, and a wealth of cacti and agaves flourish through months of dry heat, but on the summits of the White Mountains or Mt. Baldy primroses and buttercups and delphiniums bloom near icy streams. Nearby you will be sure to stumble on these townsendias in midsummer among grasses and on rocky outcrops.

Townsendia parryi(photo, p. 112)

This is the one townsendia most rock gardeners are apt to have encountered in the wild, since it occurs quite commonly in the Bighorns, the Beartooth, and Yellowstone National Park (perhaps the most popular mountains in the West among rock garden tourists). And it has the good sense to wait and bloom in the summer months, when rock gardeners are most apt to visit. *Townsendia parryi* is found in sagebrush meadows just above the valley flats with a profusion of paintbrush, penstemons, and buckwheats that make this ecological zone so fabulously rich in color. It accompanies and ultimately leaves the sagebrush behind, growing in lush montane and subalpine meadows, climbing onto tundra here and there across its range. It is most common in the middle Rocky Mountains of Idaho, Montana, Wyoming, and southern Alberta.

Townsendia parryi has proven more amenable to cultivation than any other Easter daisy, producing a wonderfully symmetrical, blue-green rosette 3" across,

decorative in its own right, the first year. The next year you can await a wonderful display of bright lavender-purple heads roughly the same size. The contrast of vivid ray flowers and yellow disk flowers make an eye-catching combination. Incidentally, the Rickett's photograph (Volume 3 of the *Rocky Mountain* series) purporting to be this species must certainly be *Xylorhiza glabriuscula*, a very different plant. Stem height in *T. parryi* varies from only an inch or two to as much as 5" tall in some forms. In many gardens, *Townsendia parryi* self sows consistently, although in others seedlings rarely appear. Any plant this lovely could surely never be considered a pest!

STEMLESS MINIATURE TOWNSENDIAS (largely alpine)

As wonderful as the dryland and montane townsendias may be, for rock gardeners there will always be a special allure for those that grow at the loftiest elevations. In *Townsendia*, ironically, these have proven to be more easily grown, more permanent and rewarding in most climates than the fussy lowlanders. Each of these has a distinct, compact beauty that makes them worth attempting in the choicest trough or alpine crevice garden.

Townsendia alpigena (syn. *T. montana*, photo, p. 112)

The commonest form of this species occurs throughout the middle Rocky Mountains of Utah, Wyoming, Montana, and Idaho. Unlike most townsendias, which have ray flowers in pastel shades, the typical form of this species has vibrant rosy-violet rays and a golden central disk, making it a standout in any garden. The foliage is dark green with a hint of blue, forming trim, rounded rosettes attractive in their own right. Flowering begins in mid-spring, and occasional flushes of flowers appear throughout the summer season.

This species grows quickly and easily from seed and does well in scree or crevice gardens. In the limestone ranges of the central Wasatch, it intergrades with a white-flowered subspecies that is very different in overall effect and worth growing as well. But for those who have seen *Townsendia alpigena* on sparse tundra or screes in its native habitat, the deep violet form instantly recalls vast vistas on the Tetons, the Absarokas, or the steep, loose screes of the northern Wasatch Front. For us it is a must, one of the best Americans in the rock garden.

Townsendia rothrockii (photo, p. 111)

The townsendia that climbs to the highest elevations is restricted to the central mountains of Colorado and a tableland on the western slope of the southern

Rockies. In the garden, the 1.5" flower heads have clear lavender rays, produced in late April or May, while on the summits of the Mosquito Range *Townsendia rothrockii* occurs at 13,000' in swales where snow accumulates to tremendous depths. The tundra on the Mosquitoes may not be as lush as that of the Gore or Elk Mountains farther west, but Leadville limestone supports a fantastic diversity of species. The tundra is a Persian carpet of color when the first flowers open on this daisy in July. We've returned in September and found it still blooming. It never ceases to amaze me that a plant that blooms in early April in Denver may still be in fresh bloom five months later 8,000' higher and 50 miles away.

In its most desirable manifestations *Townsendia rothrockii* forms dense tufts of smooth, glaucous, blue-green foliage. In addition to the high alpine race, a slightly larger, paler-flowered race of Rothrock's Easter daisy occurs at approximately 9,000' on the sandstone barrens of the Uncompaghre Plateau in western Colorado. Here it shares crevices and potholes in the rugged caprock with a tremendous range of wildflowers blooming in late May and early June. These include a tiny race of *Fritillaria atropurpurea, Pediocactus simpsonii, Penstemon crandallii, Delphinium nuttallii,* and a strange swarm of hybrid manzanitas. This form, perhaps half again as large as the high alpine race from the Mosquito Range, probably represents the original source of the mysterious *Townsendia wilcoxii* that has been circulating in seedlists for almost 20 years. The latter is a synonym for *T. hookeri,* a very different plant in bloom and foliage.

Townsendia leptotes (photo, p. 111)

Not far from a few alpine stations of *Townsendia rothrockii* I saw my first colonies of this rather uncommon miniature *Townsendia.* Almost as small as *T. mensana,* this high mountain plant is distinguished by somewhat wider, gray-green leaves with conspicuous hairs. The flowers are in the pale lavender to white range, not terribly large, but attractive nonetheless. In its alpine phase *T. leptotes* occurs from southern Colorado to Montana, although nowhere in any special abundance. It grows in much drier, more exposed aspects than Rothrock's Easter daisy, often in the company of *Eritrichium aretioides, Physaria alpina,* and *Draba oligosperma.*

There are several lower elevation forms of note. One occurs quite commonly in southcentral Colorado on a strange blowout barrens composed of an odd chalky substrate derived, apparently, from a volcanic tuff. Here its companions include *Aster coloradoensis* and the famous, miniature astragalus with spiny-tipped leaves, *Astragalus tridactylicus* ssp. *implexus.*

An especially brilliant color form with dark blue-lavender rays appears to belong to this species as well. It has been collected in the foothills of eastern Idaho. Unfortunately, this form may no longer be in cultivation.

Townsendia spathulata (photo, p. 112)

On high, exposed limestone ridges of the middle Rockies, this trim, mound-forming cushion plant can grow in great abundance on the shattered crazy pavement that is home to a plethora of other desirable, ornamental alpines in a host of families.

In the garden, the blunt, spatulate leaves covered with silvery hairs make for a wonderful foliage effect year around. The flower buds are formed in the autumn and redden as spring approaches and are every bit as attractive as the

flower heads themselves, bearing more color. The heads open early, in March or April in the garden. In the mountains the seed is ripe in early June. The rays are a cool white, often stained with deep violet or purple at the base, making for a stunning two-tone effect.

Although often growing near tree-line, this species is sensitive to over-watering and as a consequence it may not live long in the open garden. *Townsendia spathulata* would be particularly appropriate in troughs and makes for an outstanding plant in a pot as well.

Townsendia nuttallii

This relatively recently named species seems somewhat intermediate between the *T. spathulata* and *T. hookeri*, sharing the narrow leaves and silvery hairs of the latter and the lilac-stained flowers of some forms of the former. It has a middle Rocky Mountain range. Obviously, great benefit would come from a thorough study of the interrelationships and distributions of this section of the genus.

Townsendia condensata

This is one townsendia that need never be confused with any other. The typical form of this species is restricted to some very remote screes and other habitats from southern Alberta to southern Utah and the White Mountains of California. In nature the species appears to be monocarpic, and in the garden it is invariably biennial. It forms an astonishing ball of cottony, woolly leaves the first year, unlike anything in the Northern Hemisphere, giving it an uncanny, albeit accidental resemblance to members of the genus *Chaetanthera* of the Andes. The second year, each ball of wool produces a comparatively immense, stemless blossom 2" or more in diameter, rather like *Townsendia parryi* in form, and often a strong lilac in color. Apparently blooms can also be pale, almost white, although I have not seen these forms.

Considering its vast range in nature, this is apparently a rather local species that relatively few rock gardeners have seen or collected. Most of the germplasm in cultivation stems from a Ron Ratko collection in California's White Mountains in the early 1990s, and the plant appears identical to specimens we have seen from Idaho and Wyoming.

Surprisingly, considering its rarity in nature and its strictly high

alpine distribution, this has proven easily grown in a crevice garden in Denver, self sowing quite enthusiastically for the last several years. In fact, it has proved to be a minor pest in one bed, smothering a few androsaces and threatening a tiny daphne before a fierce summer severely reduced its numbers.

A large proportion of the plants that bloom in the garden, in my experience, develop a strange fasciation in the flower—the ray florets forming a horseshoe or smiling shape, unlike the perfect circle one invariably finds in wild plants. This appears to be a response to the longer growing season at low altitudes and perhaps to the richer garden soils. Even with this peculiarity, this must rate as one of America's greatest alpine treasures, worth every effort to naturalize in the choicest beds of a rock garden.

If the typical subspecies of *Townsendia condensata* were not treasure enough, the additional subspecies *absarokensis* is also worthy of cultivation. On the steep ridges of the Absaroka Mountains, often well below treeline, a somewhat less hairy race of this species occurs that produces a large, initial inflorescence not unlike the type. The plant then branches near the base, and a sequence of fresh flowers emerge throughout much of the summer season, creating an almost mat-like effect. The later flowers are generally smaller, and the plant still appears to be monocarpic, but the mounds with a dozen or more flowers make it utterly distinct from the single-headed, wildly, woolly alpine elsewhere in its range.

A visit to localities where this subspecies grows can be a little thrilling: signs along the highway beneath its ridgetop home warn you of the presence of grizzly bears in the vicinity. You never quite forget these signs as you noisily climb up faint trails, through open forests of lodgepole pine and Douglas fir. Dozens of species of fascinating wildflowers occur on the surprisingly sparse slopes hereabouts, including *Physaria acutifolia* in a compact phase and several penstemons, even the dazzling *Penstemon absarokensis*. There are a wealth of fleabanes, buckwheats, and such peculiar specialties as *Zauschneria garrettii*, the northernmost and earliest member of the genus to bloom. Long before zauschneria comes into blossom, however, the townsendia reigns supreme, presenting unearthly mounds of lilac bloom over the woolly rosettes.

It is hard, sometimes, to tell: do we dote on Easter daisies because of their shimmering flowers or because they grace our gardens so early in spring? Or do we love them for their neat habit and wonderful rosettes and cushions? For me, townsendias recall the endless azure skies of the western landscape, cool breezes, and crisp sun. There are always precipitous cliffs and serrated peaks looming in the distance, or the gaudy hoodoos of some unearthly badland (or, as Farrer said, goodlands). Often as not, a hawk or golden eagle may be soaring somewhere not that far overhead—or even far below. Often as not, nearby you hear the voices of your family and dear friends. Perhaps these flowers represent not just the summits of our mountains, but of our lives.

Panayoti Kelaidis grew up in eastern Colorado, admiring townsendias and other wildflowers on the short grass prairie. He gardens in Denver, Colorado, and his interests are broad, including all plants suitable to the rock garden and the zone 5, continental, semiarid climate. Drawings by Rebecca Day-Skowron.

LITHOSOL WILDFLOWERS
OF THE COLUMBIA BASIN

by Douglas N. Reynolds

When I left my university post in Kentucky to take a teaching position in Washington State, I looked forward to the chance to live at the foot of the Cascades and explore their alpine flora. Having spent fifteen summers amongst the alpine plants of the Beartooth Plateau of Wyoming and Montana and Glacier National Park in Montana, I looked forward to learning a whole new set of plants.

My new home was in Ellensburg, one hundred miles east of Seattle in the Kittitas Valley, which extends from the foothills of the Cascades to the Columbia River. Little did I realize that in the next few years I would take many more trips east into the sagebrush-steppe than into the subalpine and alpine meadows of the Cascades. The plant communities I found in the Columbia Basin were unknown to me before I moved to Washington, but the incredible springtime floral display quickly captured my attention.

The Columbia Basin covers 160,000 square miles of central and eastern Washington and extends into Oregon and Idaho. Lying in the rain shadow of the Cascades, the central part of the Basin receives only seven inches of precipitation per year, and as much as 20" at the edges of the Cascade foothills and at the Idaho border. The temperature regime is continental with hot summers, during which 90-100°F days are not uncommon, and cold winters, when temperatures can easily reach zero. Most gardening classifications consider the area to be zone 5.

Another important climatic feature affecting the vegetation is when precipitation occurs. Over 80% of the scant yearly moisture falls in autumn and winter, with only an inch or two falling from June to August while temperatures are the hottest. The yearly total of the central Basin's precipitation is less than 50% of that of Tucson in the Sonoran Desert, yet, despite the opinion of the locals who call this area a desert, ecologists classify the central Columbia Basin as a shrub-steppe, reflecting the dominance of shrubs such as big sagebrush, *Artemisia tridentata*, and perennial bunchgrasses, such as bluebunch wheatgrass,*Agropyron spicatum*, and Idaho fescue, *Festuca idahoensis*. The shrub-steppe survives because the precipitation falls during the cold part of the year while evaporation is low. As a result, soils become

saturated in winter and remain moist into June. If more of the yearly precipitation fell during the warmer months and evaporated, such a high cover of woody shrubs and perennial grasses could not develop. The warming temperatures and soil moisture in spring stimulate growth and reproduction before the extreme heat and dry conditions arrive in July, after which most plants become dormant.

The topography of the Columbia Basin also has a major effect on the plant communities, especially because of its effects on soil depth and exposure. The region has a varied topography of cliffs, rock outcrops, and deep canyons. These habitats have been created by huge volcanic eruptions, continental glaciation, and the greatest floods the world has known. Beginning about 17 million years ago, fissures near present-day Lewiston, Idaho, opened up and produced a series of eruptions of basaltic lava that continued periodically for the next 10 million years. It is rare for such huge amounts of basaltic lava to erupt on continents; the causes are still under debate. The flows covered much of the Columbia Basin and even extended to the Pacific Coast in some areas, forming some of the spectacular haystack rocks for which the Oregon Coast is so famous. Hundreds of individual flows occurred, covering over 180,000 square miles with a layer of basalt from 2,000–5,000' thick.

The next major event to affect the region was the continental glaciation of the last Ice Age. While the continental glaciers only reached the edges of the Basin, they altered the climate, diverted the Columbia River, and provided some of the wind-blown sediment deposited over much of the basalt bedrock to depths of up to 180'. As the glacial advance came to an end, the stage was set for the greatest floods in earth's history. It is these that are most responsible for many of the landscapes we see today throughout the Basin.

About 16,000 years ago, a lobe of the ice sheet blocked the Clark Fork Valley in western Montana with a wall of ice about 2,000' high. Water backed up behind this ice dam to form Glacial

East bluffs above the Columbia River, *Eriogonum thymoides* on basalt (pp. 119–134)

Castilleja thompsonii (p. 133)

Photos, Douglas Reynolds

Meadow with *Artemisia rigida, Eriogonum thymoides* in the Columbia River Basin with the Stuart Range in the background. (pp. 119–134)

Erigeron poliospermus (p. 133)

Meadow with *Balsamorhiza, Phlox hoodii* in late April in the Columbia River Basin (p. 132)

Erigeron linearis (p. 93, 132)

Photos, Douglas Reynolds

Wildflowers, including *Pediocactus simpsonii*, along the Vantage highway, Washington

Ranunculus glaberrimus (p. 131) Photos, Douglas Reynolds

Meadow on lithosol with *Eriogonum thymoides* and *Penstemon gairdneri*, Columbia River Basin (pp. 119–134)

Lewisia rediviva (p. 132) Photos, Douglas Reynolds

Balsamorhiza hookeri with *Phlox hoodii* (p. 132)

Phlox hoodii (p. 132)

Lomatium gormannii (p. 131)

Penstemon gairdneri (p. 133)

photos, Douglas Reynolds

Viola trinervata (p. 131)

Sisyrinchium douglasii (p. 132)

Trifolium macrocephalum (p. 132)

Astragalus purshii (p. 132)

Photos, Douglas Reynolds

Crocidium multicaule

Lake Missoula, which covered 3,000 square miles at its maximum extent, with depths reaching up to 2,000'. This lake contained more than 500 cubic miles of water, about half the volume of Lake Michigan. Montana's Flathead Lake today is only a small remnant of the lake that once covered the area. As water built up behind the ice dam, the dam floated off its bedrock base, was breached, and collapsed, unleashing a tremendous volume of water to rush out and drain across eastern and central Washington, following the land's contours, to flow into the Columbia River and eventually reach the sea. These floods were like no others ever seen on earth so far as we know. It has been estimated that a wall of water, 2,000' high travelling at 45 mph raced across the landscape. At the flood's peak, 400 million cubic feet per second of water were flowing, equal to ten times the combined flow of all of the earth's rivers today! These tremendous floods created a landscape in central and eastern Washington called the Channeled Scablands, which are visible from space as a network of channels in the soil and deep cuts in the dark basalt below. From ground level, it is an area of bedrock outcrops, deep coulees, and spectacular cliffs, hundreds of feet high. As the lake drained and the ice lobe continued to advance, the sequence of lake filling and flooding repeated itself as many as 85 times over a period of several thousand years.

These events, accompanied by more commonplace types of erosion occurring on ridge tops and slopes, have produced a mosaic of deep and shallow soil areas throughout the Basin. I find most fascinating the plant communities that have developed on the areas stripped of soil. These areas of lithosols (literally, rock-soils) are very rigorous habitats that may consist of everything from areas of bare bedrock, broken only by occasional cracks in the basalt, to areas of shallow soil up to 10" deep over the basalt bedrock. The soils are a mixture of angular pieces of basalt, weathered from the bedrock below, and fine soil particles derived from the windblown sediments that form the deeper soils. They are usually slightly acidic to neutral, pH ranging from 6.2–7.0. These shallow soils become saturated in winter, because the bedrock below inhibits

drainage and the cold temperatures subject the shallow soils and plants growing in them to frequent frost heaving. In summer these areas bake dry by June, and surface soil temperatures can reach 150°F.

Lithosol is a harsh environment to be sure, but like other challenging environments, including alpine tundra and deserts, plants have adapted. In fact, contrary to what one might expect, lithosols often have a more diverse assemblage of species and spectacular spring flowers than deep soil areas where physical conditions are not so harsh. The dominant sagebrush and bunch grasses cannot tolerate conditions here, and thus a great variety of smaller species can grow without competition. These species are generally small and low-growing rosette or cushion plants. Because there is only a narrow window of time between the frozen soils of winter and the bone-dry conditions of summer, virtually all lithosol species flower in April and May, creating a wonderful floral display.

One of the best places to observe a great variety of Columbia Basin species is the areas of "patterned ground," which consist of mounds, stone nets and stripes that cover many square miles of ridgetops and gentle slopes above Kittitas and Yakima Counties, Washington. Here are found mounds of deep soil, about 40' in diameter and 3' high, looking like islands set in a sea of shallow soils. These mounds are especially well developed and easy to view along the Wenas Road on top of Manastash Ridge, southwest of Ellensburg. The formation of the mounds represents the most recent geological event to shape the land and affect plant communities. The origins of the mounds are still debated by scientists—more than thirty theories have been proposed during the last hundred years. One group of theories postulates that the erosion of channels in an overlying blanket of deep soil left the mounds behind. Another set of theories holds that the mounds were formed by local deposition of soil on a plain of bedrock. Explanations range from simple water erosion to ice-wedge and frost activity, to burrowing and nest building by pocket gophers, to trapping of blowing sediment by plants. Whatever their origins, these mound areas now show an unparalleled floristic diversity.

Plants

Species of the shrub-steppe can be divided into three basic groups based upon their life forms: annuals, perennials, and shrubs.

Annual species escape the harsh conditions of summer by growing and reproducing only when there is moisture. By the time soils have dried and temperatures are high, these plants have died, and only their dormant seeds remain in the soil, awaiting the return of moisture and cooler temperatures. There are two kinds of annuals found in the shrub-steppe. Winter annuals germinate in the fall when rains return, and their seedlings survive the winter to get an early start in the spring. Summer annuals, on the other hand, don't germinate until spring and don't have to survive the freezing temperatures of winter, but they must develop quickly to produce seeds before the soils dry out. One risk, if you will, of the annual strategy is that if seed production or germination fails, the population will go extinct.

Perennial species, on the other hand, have the advantage of being able to reproduce in several different years and will persist if, at least in some years, reproduction is successful.

Unlike annuals, however, they cannot put all of their resources into reproduction early on but must build a resistant plant body to survive the cold winter and hot summer. Thus they may require a number of years before they can devote energy to flowering. Many herbaceous perennials in the shrub-steppe die back after flowering in the spring and survive the harsh summer conditions below ground. A few species, mostly woody shrubs, flower later and retain their leaves throughout the summer, tolerating the extreme heat and drought. Examples of species with all these types of life histories occur in both the mounds and in adjacent lithosols.

Let's take a tour of some of the showiest lithosol species in approximate order of their bloom times. In general, the earliest bloomers are the ones that require the most moisture. These are generally found along drainages, under larger plants, or along the edges of mounds, where the soil is a little deeper and holds more moisture. Many of the mounds, for reasons not clearly understood, are surrounded by rock rings, which also catch and hold early season moisture. All of these species die back as the summer progresses and survive the hot and dry conditions as dormant underground seeds, tubers, or rootstocks.

The first species to appear in March, when snow may still cover northern slopes, is one of the biscuitroots, *Lomatium gormannii* (photo, p. 126). Many more species of *Lomatium* occur throughout the sagebrush-steppe region. These species can be difficult to tell apart. Most have deeply dissected leaves and very aromatic foliage, as is common in the family Apiaceae. The flower colors of the different species vary from white to yellow to maroon. This and other members of its genus, such as *L. triternatum*, form starchy tubers just above the bedrock. After the leaves of the plant die back in early summer, the tubers are all that remains. Along with bitterroots (*Lewisia*) and camas lily (*Camassia*), these species were a major food source for the Native Americans of the region. *Lomatium* species are also a major food source of the pocket gophers that nest in the mounds and whose diggings are evidenced by small piles of soil that cover the lithosols.

Hiking on a hot August day soon after I arrived in Washington, I was skeptical when someone told me that the area where we were walking was blanketed with buttercups and violets in springtime. Having grown up in the East, I thought of violets and buttercups as moisture-loving, woodland species. Yet the sagebrush buttercup, *Ranunculus glaberrimus*, does indeed adorn the mound edges and other wet areas in March and April, its large blossoms providing much early season color (photo, p. 124). The sagebrush violet, *Viola trinervata* (photo, p. 127), doesn't need as much moisture and can be found in shallower soils a little farther out from the mounds. This is one of the prettiest violets I have seen, two reddish-purple, upper petals above three lavender petals with yellow bases. It rarely seems to produce seed, whether from lack of pollination or because the soils dry out before seed can mature, I don't know. Another early species that often accompanies the buttercups and violets is yellow bells (*Fritillaria pudica)* with its single or double, nodding blossoms. After pollination, the nodding stems straighten out and elongate, holding the winged seeds higher off the ground, where they can be more easily dispersed.

Four other species are frequently found in this zone at the mound margin or rock ring. *Hespirochiron pumilis* doesn't seem to have a common name. From a distance its flowers look like those of a strawberry, although it is in the waterleaf family (Hydrophyllaceae). The appearance of bigheaded clover, *Trifolium macrocarpum* (photo, p. 128), with its spectacular, three-inch heads of pink flowers, belies its relationship to the lowly lawn clover. Likewise its leaves contradict the literal translation of its generic epithet, "three-leaf," occurring in multiples of six beautifully mottled leaflets. Its flowers have a lovely fragrance as well. The early season showstopper, however, is the grass-widow, *Sisyrinchium douglasii* (photo, p. 127), whose beautiful, magenta blossoms wave on stems 8–12" high. Not so noticeable as an individual, but striking in groups, is the goldstar, *Crocidium multicaule*. Edges of the mounds are sometimes a solid yellow mass of this tiny annual.

As we move farther away from the mounds out into the true lithosol habitat, many plants have small leaves and a cushion habit. This reduced surface area of the plant results in less water loss and more rapid heat loss, a benefit to plants in areas where the soil temperatures can reach 150°F on a sunny day. One of the most beautiful species, because of its flowers, compact growth form, and silvered-haired leaves and seed pods, is woolly-pod locoweed, *Astragalus purshii* (photo, p. 128). The silver hairs reflect sunlight, cool the plant surface, and retard evaporation. This species seems to occur in some of shallowest soil areas, where only a few inches of gravelly soil covers the bedrock. Another cushion plant of the lithosols is cushion phlox, *Phlox hoodii*, whose needle-like foliage can be totally obscured by a continuous cover of flowers, ranging from pure white to pinkish to bluish (photo, p. 123, 126).

Two other species of cushion plants, easily confused by the casual observer, are goldenweed, *Haplopappus stenophyllus*, and linear-leaved daisy , *Erigeron linearis (*photo p. 123). Both form solid cushions, often 6" in diameter or more, covered with yellow, daisy-like flowers in April. Two shrubby members of *Haplopappus* are also found in this region. *Haplopappus resinosus* grows on very exposed, rocky cliffs, and *H. bloomeri* occurs at the highest elevations of shrub-steppe, about 5,000', where it meets the wind-shaped forests of whitebark pine, *Pinus albicaulis*.

The signature species of the lithosol is the bitterroot (*Lewisia rediviva*, photo, p. 125). First discovered and collected by Lewis and Clark, this plant's name means, literally, "revived from the dead" or "reborn." It was named for its ability to burst into flower even months after being collected as an herbarium specimen. This plant is a long-lived perennial which becomes active when the fall rains return. It pokes its leaves above the surface in November to form a succulent green rosette that can photosynthesize on mild winter and early spring days. By May or early June when it flowers its leaves have frequently withered away, but then the thick taproot supplies energy for a massive display of 3"-wide flowers; some plants produce a dozen or more. The flowers of this plant are tremendously variable and range in color from near white to dark pink, with the tips of the petals varying from rounded to sharply pointed. At peak bloom time in May the stark and barren landscape looks as if someone has scattered pink rose blossoms across it.

Hooker's balsamroot (*Balsamorhiza hookeri*, photo, p. 126) is one of the few

lithosol species whose flowers rise more than a few inches above the soil surface. Several closely related species, *B. careyana* and *B. saggitata*, may sometimes grow only feet away in deeper soil. Hybrids between these species are often found in intermediate areas. *Phlox hoodii* also has close relatives, *P. longifolia* and *P. speciosa*, that occur in deeper soils nearby.

Many Indian paintbrush species in the West have striking red or pinkish bracts and occur in wet, subalpine meadows. The sagebrush-steppe has a more discrete relative, *Castilleja thompsonii*, whose pale chartreuse bracts lend subtlety to the floral display of the lithosols (photo, p. 121). Like most paintbrushes, it is a semi-parasite and forms root grafts to one of the species of *Artemisia* to steal its resources.

Penstemons are a major group of herbaceous plants in the American West with more than 80 varieties known from the Pacific Northwest alone. The sagebrush-steppe has its own representative, *Penstemon gairdneri* (photo, pp. 125, 127), in the lithosols and a number of other species such as *Penstemon speciosus* in deeper soils. A mature plant of Gairdner's penstemon bears many stems full of bright lavender flowers, creating an incredible display along with the massive yellow show of *Eriogonum thymoides*, a woody, shrubby false buckwheat of the lithosols.

One last non-woody species I must mention is Simpson's barrel cactus, *Pediocactus simpsonii*, one of two cactus species native to this region (the other is *Opuntia polyacantha*). This cactus grows in shallow, gravelly soils or on rock outcrops and has disappeared from many roadside areas due to indiscriminate collecting. It is very difficult to transplant successfully, and probably all those individuals collected have simply rotted away. Fortunately, in conducive habitats away from roads, it can be common, and in May a hillside may be dotted with its red blooms. The cactus reproduces vegetatively by producing more stems to form clumps up to a foot in diameter. Nothing is more beautiful than to find a cluster of this ball cactus, each ball bearing several blossoms.

The flower display of the lithosols fades in late May and early June as the flowers of the bitterroots dry and blow away. Only one species, *Erigeron poliospermus*, brightens the landscape in August with its display of light purple flowers (photo, p. 122).

Remaining throughout the year are the small shrubs. Few woody species grow here, and those show the rigors of the environment in their natural bonsai form, with stunted stature and twisted branches. Big sagebrush, *Artemisia tridentata* has its own close relative in shallow soil: stiff-leaved sage, *Artemisia rigida* is deciduous and its leaves smell of sage and lemon. There are also a number of woody *Eriogonum* species. Ecologists don't fully understand why one species is found in one area and absent from another. It may have to do with the jointing in the bedrock below, and the consequent effect on drainage. No other soil or climactic characteristics seem to differ. I have mentioned *Eriogonum thymoides*, a low-growing, deciduous shrub with tiny, fleshy leaves. There is great variety within this genus in leaf size, pubescence, and flower color. Other compact species with showy flowers include *E. douglasii* and the snow buckwheat, *E. niveum.*, which has leaves snow-white with a dense covering of tiny, fine hairs, and a branching inflorescence of bright white flowers that turn to pink as they age.

The beautiful natural flower gardens of the lithosols inspire one to try

to recreate them in the garden. Many of the species I have described have characteristics that are perfect for the rock garden: compact size, large, showy flowers, and, frequently, attractive foliage to boot. Two difficulties in adding these to your garden, however, are that most are not available commercially, and, even if obtained, they can be very difficult to grow successfully.

As with all native plants, one needs to pay attention to conditions in the species' natural habitats and attempt to duplicate them in the garden. Transplanting is not to be encouraged and usually fails; cuttings may succeed more frequently, but seeds are the best way to experiment without endangering natural displays. I and my students have done germination tests on many of these species and found that most require a lengthy cool, wet stratification treatment. This simulates the winter conditions they would experience in nature and breaks dormancy, so that seeds germinate when placed in warmer temperatures. Many species grow slowly and some, especially those that form bulbs, require special attention to the rhythms of their natural environment. Most lithosol species need good drainage during the growing season, and then a period of drying out and a chance to go dormant in summer. If kept continuously wet, they may rot or flower longer than in nature and use up resources necessary to get through the winter. Thus, these species do best when grown in an area by themselves, and they will probably not do well in areas with a wet summer unless drainage is exceptional.

In the last two years, we have germinated and successfully grown *Lewisia,* and a few species of *Lomatium, Erigeron,* and *Eriogonum.* Give these species a try, and they will reward your skill and patience. During the last several years seeds of many of these species have been available in the NARGS Seed Exchange.

The sagebrush-steppe of the Columbia Basin has not received much attention from botanists and wildflower enthusiasts. It is a region that has been heavily altered by grazing and agriculture and the invasion of weedy species. Fortunately, the lithosols can't be farmed, because of their shallow soils, they produce too little foliage to support cattle, and few weed species can survive in their rigorous environment. We are fortunate that these plant associations remain today to produce one of the most spectacular and little-known spring wildflower displays in the country.

Two of the best books about Columbia Basin plants and geology are Ron Taylor's *Sagebrush Country* (Mountain Press, 1992) and Marge and Ted Mueller's *Fire, Faults, and Floods* (University of Idaho Press, 1997).

Douglas Reynolds has been gardening in Ellensburg, Washington, for the last four years. He is currently transforming a typical suburban lawn into beds of native shrub-steppe perennials, including sagebrush, rabbitbrush, and bunch grasses. He has a 60' rock garden where he grows small native plants such as erigerons, penstemons, and lewisias. In addition, he and a partner have a small native plant nursery called Rain Shadow Nursery. Fax number (509) 962-2730, e-mail reynolds@cwu.edu. Photos by the author.

PENSTEMONS
FOR EASTERN CANADA

by Todd Boland

Every alpine enthusiast has his favorite genus of alpine plants. Some concentrate on *Campanula*, while others prefer *Dianthus*. Although I love all alpines, I too have a favorite, the genus *Penstemon*. My fascination with one of North America's largest plant genera began when, upon a visit to my local botanic garden, I spied a lovely, low shrub that was literally smothered in purple-pink blooms. The label called it *Penstemon fruticosus* var. *serratus* 'Holly'—quite a mouthful. Thankfully, most penstemons do not have such involved names. Visiting all my local nurseries, I was disappointed to find that penstemons were not locally available. Not to be discouraged, I obtained the address of the mail-order alpine nursery where the botanic garden had obtained its plant.

That was 12 years ago, and since then, through mail-order nurseries and seed exchanges, I have tried my hand at over 40 species. Some have been surprising successes, others dismal failures. Obviously, the large number of species (the current estimate is around 250) means that there are plants that can be grown in any number of garden situations. Some species may be utilized as low shrubs in the perennial border; others will be at home in the wildflower garden, and perhaps most importantly, many are appropriate in the rock garden.

Despite the large number of species that exist, relatively few are in cultivation. Geographically, most are native to western North America, with a few eastern species, a few Mexican species, and one outlier species in Japan. The habitats of penstemons are quite varied, from deserts to grasslands, open forest to alpine meadows. Regardless of geographic origin, their common cultural requirement is excellent drainage, especially in winter. In the Northeast, that is where the challenge of growing penstemons begins.

Northeastern North America is blessed (or cursed) with abundant rainfall, especially from autumn to spring. My growing area in St. John's, Newfoundland, is probably the wettest, averaging about 60" per year. If snow would fall in late autumn and simply remain until spring, life would be far easier for the plants, but coastal areas in the Northeast do not have this luxury. Our snow is often wet and sloppy and may remain for only a

week or so, until the weather turns mild again, and the snow turns to slush then re-freezes in the next cold spell. This freeze-thaw cycle, combined with saturated soil, is not the preferred living condition of any penstemon—and is tolerated by very few. Therefore, penstemon growers in the Northeast must ensure excellent drainage for these plants; scree conditions are ideal. However, even with this precaution, some species are better suited to our climate than others.

Due to the abundant rainfall, all flower beds in Newfoundland must have adequate sand mixed into the soil to aid in drainage. For the perennial border types of *Penstemon*, that is generally enough. Alpine species require more stringent measures. In my rock garden, I mix in copious amounts of 3/8" granite grit to allow for good drainage. I also use a one- or two-inch layer of gravel mulch to help keep the crowns dry. You do not need rich soil for penstemons; most naturally grow on poor, gravelly soils. If the soil is too fertile, growth will be soft, increasing the chances that your penstemons will succumb to winter wet. In addition, plants in rich soil have a tendency to flower themselves to death! It may be wise to advise new penstemon growers immediately that many species are naturally short-lived, so that even a perennial favorite may suddenly die some winter. It is always a good practice to collect seed as a back-up. Fortunately, most penstemons will reach flowering size in as little as two or three years from seed.

The first penstemon I grew was, not surprisingly, *P. fruticosus* var. *serratus* 'Holly' (photo, p. 137). This species is a member of the Section Dasanthera, the 4–10"-high, shrubby penstemons that hail from the Pacific Northwest. Some of these species are native to fairly wet regions, but they always grow on well-drained sites in nature. They seem to be among the species most tolerant of high rainfall and humidity. They are not quite as hardy as some other penstemon species, and their evergreen leaves make them susceptible to winter desiccation. However, they are among the best of rock garden plants. Although many penstemons have true blue flowers, this Section is restricted to pink, mauve, and purple shades. I have tried all the species in this group, including *P. barrettiae, P. cardwellii, P. davidsonii* and its subspecies *menziesii, P. ellipticus, P. fruticosus* and its subspecies *scouleri* (the cultivar 'Purple Haze' is particularly floriferous, photo, p. 140), *P. lyallii, P. newberryi,* and *P. rupicola*. The only one I have failed with is *P. newberryi; P. barrettiae* is apt to loose most leaves in years of little snow cover.

Penstemons from the Section Penstemon I like to call the candelabra penstemons. They generally have flowers that are small but numerous, arranged in whorls at the tops of upright stems. The plants may be quite leafy at their bases, but generally they bear no leaves on the upper half of the flower stems. This Section contains both tall and low plants, so some are better suited to the rock garden than others. Among the low species I have had luck with are *P. albertinus,* (photo, p. 140) *P. aridus, P. confertus, P. gracilis, P. hirsutus* 'Pygmaeus', *P. humilis, P. procerus,* and *P. virens*. Among these species, blue is the most common flower color, but *P. hirsutus* 'Pygmaeus' is a two-tone pink-and-white, while *P. confertus* is a unique straw-yellow. In the perennial border or larger rockeries, try *P. attenuatus, P. ovatus* (photo, p. 140), or *P. whippleanus*. This latter species has unusual, deep maroon-purple flowers.

All the species in the Section Ericopsis are ideal rock garden or

Penstemon fruticosus var. *serratus* 'Holly' in Todd garden (pp. 135–6)

Penstemon venustus in Todd garden (p. 141) Photos, Todd Boland

Lewisia rediviva ssp. *minor*, in Nevada (p. 142)

Lewisia rediviva, three color forms in Henry Grant garden, Hamilton, Montana (p. 142)

Lewisia maguirei, three phases, Watson's form (pp. 142–3) Photos, J. S. DeSanto

Lewisia disepala, Watson's form center, typical on either side, from California (p. 142)

Penstemon fruticosus 'Purple Haze' (p. 136) photos, Todd Boland

Penstemon ovatus (p. 136)

Penstemon albertinus (p. 136)

trough subjects, since most are under 4" in height. They produce small, heather-like foliage or elliptical leaves. Plants have mat-like growth, with flowers nestled among the foliage. I have found them to be a challenge to grow but have had success with *P. caespitosus, P. crandallii,* and *P. teucrioides.* I particularly like the last species, since it has blue-gray foliage which turns reddish in winter. Although I have not yet tried them, *P. abietinus, P. laricifolius,* and *P. linarioides* are also recommended species from this section.

Penstemon from the Section Saccanthera, Subsection Serrulati, are relatively easy in the Northeast but tend to be a bit large for the conventional rock garden. These robust subshrubs have relatively large, coarsely toothed leaves and characteristic, horseshoe-shaped anthers. If space allows, try *P. glandulosus, P. serrulatus (P. diffusus)* and *P. venustus* (photo, p. 137). Be forewarned, in my garden these species tend to self-seed profusely.

Most of the penstemon species that are naturally native to eastern North America do well in the Northeast. Most are too tall for the rock garden, but they are great subjects for the perennial border or wildflower garden. Some to try include *P. cobaea, P. hirsutus* and *P. digitalis. Penstemon digitalis* 'Husker Red' is a particularly attractive cultivar with dark red foliage and white flowers. In warmer climates, the leaves lose some of the red pigmentation in summer, reddening again with the first cool weather in fall. In Newfoundland, our cool summers allow the foliage to stay red all season.

Not surprisingly, most of the western prairie, Great Basin, and desert species do poorly in the Northeast, but I have stumbled across a few exceptions. *Penstemon hallii, P. rydbergii, P. secundiflorus,* and *P. strictus* (including the cultivar 'Bandera') have been surprisingly successful. *Penstemon secundiflorus* has the added bonus of lovely, blue-gray, waxy leaves. The species *P. albidus, P. euglaucus,* and *P. glaber* have survived in my garden long enough to flower once!

My favorite penstemon of all is *Penstemon nitidus.* Having seen drifts of this intensely azure-blue penstemon in southern Alberta, I was desperate to try it. Unfortunately, all my repeated attempts have failed. Meanwhile, plants in my brother's garden in Calgary are spreading like weeds!

The last penstemon of note is the unique *P. pinifolius.* This shrubby penstemon has needle-like leaves and bright scarlet flowers. There is also a yellow-flowered cultivar 'Lutea'. Although native to the Southwest and Mexico, this species seems to thrive just about anywhere in the country. Plants are long-lived for the genus, although they have a tendency to become straggly with age. Fortunately, they root very easily from cuttings.

Alpine enthusiasts who concentrate on other plant genera have the possibility to try most of the species, but if penstemons are your favorite, then your chances of trying them all are slim. I have tried my luck with most of the conventional species, but with over 200 species remaining that I have not grown, I think the challenge may continue for quite a number of years to come.

If you are interested in more information and a seed exchange limited to penstemons, contact the American Penstemon Society, Ann Bartlett, Secretary, 1569 Holland Court, Lakewood, CO 80232. Annual membership, $US10.

Todd Boland gardens in St. John's, Newfoundland, zone 6. Other gardening interests include primulas, saxifrages, campanulas, dwarf rhododendrons, and ferns.

A Rare Color Variation

in Three Species of *Lewisia*

by J. S. DeSanto

When the species of the genus *Lewisia* are classified into groups, subgenera and sections (as in Holmgren, 1954; Elliott, 1966; Hohn, 1975; and Mathew, 1989), all agree that *Lewisia rediviva, L. maguirei,* and *L. disepala* are closely related. The three species share the characteristics of deciduousness and disarticulating pedicels leading to the total disappearance of the plant above ground soon after flowering. They also share a rare color variation apparently limited to this section of subgenus *Lewisia.*

Lewisia rediviva (bitterroot, pp. 132, 138) is the most widespread species of the subgenus. It also shows the widest range of flower color, varying from pure white through all shades of pink and red to a very rare purple form. Current taxonomy includes *L. rediviva* ssp. *minor* along with the typical *L. rediviva* subspecies *rediviva,* but this may well be a questionable differentiation. Subspecies *minor* is ivory (champagne? photo, p. 138) in flower color, as are many populations of ssp. *rediviva* from California, Nevada, Utah, and Oregon. White-flowered bitterroots are part of almost all bitterroot populations, but they seem to be increasingly rare at northern locations in Montana, Alberta, and British Columbia.

Lewisia maguirei (photo, p. 139) is restricted to limestone-dolomite formations in the Quinn Canyon and Grant Ranges of Nye County, Nevada. With extremely rare exceptions, the flowers are an off-white color with a faint yellow tinge.

The range of *Lewisia disepala* (photo, p. 139) is limited to granitic domes and summits in and near Yosemite National Park. It is, incidentally, difficult to find in flower, as the exposed granite on which it grows is free of snow long before the surrounding terrain. The flowers appear early (sometimes in February and occasionally as late as June) often necessitating over-snow travel to reach them. It, too, shows little flower color variation; almost invariably, the flowers are pale pink.

In 1871, Sereno Watson wrote that bitterroot was "sometimes green with white flowers, but more often purplish" in the first report of what is now known as either "Watson's phase" or "yellow bitterroot." In this color phase, the stem and sepals are a dis-

tinct yellow-green, while the petals are white, or, in very rare cases, red. The white-petalled flowers have either white or pink anthers. The petals of a few specimens shade from faint yellow at the base to white.

In his report, Watson did not specify the location of the "green-with-white-flowers" bitterroot. All we know is that it was along the Fortieth Parallel, probably in Nevada. Watson's phase has been seen by this writer in southeast Oregon, the Bitterroot Valley of Montana and is reliably reported from Teton County, Montana. It can be expected in any bitterroot population, although always in very limited numbers. Leonard Wiley suspected its existence and looked for it many years ago without success.

The yellow-green variation is found in at least one of the three known locations of *Lewisia maguirei*. Coincidentally, a deep red phase was seen nearby. None of the three color phases were in bloom, but the herbarium specimens clearly show the differences.

The same color variation was recently noticed among *Lewisia disepala* populations on the Sierra National Forest in California. As in bitterroot, petals of the yellow-green variation tend toward a pale yellow shade. Compared to a typical *L. disepala*, it is quite distinctive.

Watson's phase is probably the result of a mutation disrupting the production of the pigment anthocyanin. Other pigments become apparent when anthocyanin is blocked. In Watson's phase, the green of chlorophyll and the yellow of a flavonoid or carotenoid pigment are "unmasked" by the absence of anthocyanin. When all three pigments are present, the result is the brownish, dull red of typical bitterroot stems and sepals. Loss of anthocyanin to the petals results in white, if there is no other pigment, and faint yellow, if a yellow pigment is present. Seeds from Watson's phase may come true if the parents were the same. So far, only pink-flowered bitterroot with typical stems and sepals have been produced from Watson's phase seeds.

Jerry DeSanto spends his summers in the mountains of western North America and grows native alpines at his home in southwestern Alberta.

Germination of *Lilium regale* Seed Under Various Storage Conditions
Lela V. Barton (from the *Lily Yearbook*, N. Am. Lily Soc., 1947)

Temp. (°F)	Moisture Content(a)	Open or Sealed	% Germination (Years of Dry Storage) 1	2	3	5	7	11	13	15
70	9.9%	O	88	42	0	0				
		S	87	35	0	0				
	4.5%	S	91	89	87	74	31	0		
41	9.9%	O			16	0				
		S			87	87	37	17	8	
	4.5%	S	89	86	96	94	93	76	49	0
23	9.9%	O	98	78	95	87	92	80	83	74
		S	91	87	92	90	96	91	85	81
	4.5%	S	93	89	96	86	88	91	89	93

(a) The seeds with 9.9% moisture content had been dried in the open. The seeds with 4.5% moisture content had been dried over calcium oxide.

The Way We Store Seed

Should we Change it?

by Norman C. & Janet L. Deno

It has been traditional to store seeds in the dry state and to store them either at room temperature (70°F) or the refrigerator (40°F). It is now doubtful that these are optimum conditions for storage. First, many seeds can be stored in the moist state. This possibility does not seem to have been considered, despite the fact that many seeds lie outdoors overwinter and are in effect in a state of moist storage during that time. Second, it should be considered that dry storage of seeds at temperatures well below freezing is probably superior to dry storage at higher temperatures.

The following discussion is largely speculative, since it has been difficult to find precise studies already done, and my own program of research on seed storage has just begun. The purpose of writing this article is to alert gardeners and growers to new possibilities and to enlist cooperation in this research.

Currently seeds in my study are being stored under six conditions. These are: moist, at temperatures of a) 70°F; b) at 40°F; and c) at 0°F; and dry at d) 70°F; e) at 40°F; and f) at 0°F. These temperatures were chosen because of their wide range, and because they are readily accessible to both professional and amateur growers. Room temperature is approximately 70°F; 40°F is the common temperature of refrigerators; and 0°F is the temperature of most freezers.

Considerable research has been done storing seeds at very low temperatures in liquid nitrogen, in connection with attempts to preserve biodiversity, and there is a National Laboratory in Fort Collins, Colorado, that is charged with an extensive program to this end. However, such conditions are inconvenient and uneconomic for most growers. Further, it remains to be shown how much is gained from storage at such low temperatures, compared to the more convenient 0°F. Also, it is unknown just which species have seeds that tolerate very low temperatures.

In the following discussion the term D-70 means that the seeds require a period of dry storage at 70°F before the seeds will germinate at 70°F. Usually three months of dry storage is sufficient, and in some species the dry storage at 70°F can be as short as three weeks. The term 40–70 designates species whose seeds require about three months at 40°F before they will germinate at 70°F. The term 70–40 is the

reverse with three months at 70°F being required before the seeds will germinate at 40°F. All of these requisite conditioning treatments serve to destroy chemical systems blocking germination.

It is convenient to organize the following discussion into six questions. In all of this discussion it is critical to recognize that every species will have its own death rate curve, depending on the conditions of storage and on any treatments such as the use of dessicants. Storage will remain a species-by-species problem, although it can be expected that optimum conditions will generally be the same for species with similar germination patterns. For example, it is expected that most D-70 germinators will store satisfactorily in the dry state and will survive better at 0° than 40°F, and better at 40°F than at 70°F.

Seeds that germinate in 40–70, 70–40, or more extended patterns can be held moist at 40°F or 70°F without germinating. It remains to be determined how such moist storage compares to dry storage. With *Eranthis hyemalis* aerobic, moist storage at 70°F is superior to dry storage at 70°F. These seeds have a 70–40 germination pattern. That is, the seeds require three months moist at 70°F before they will germinate at 40°F. After eighteen months moist at 70°F or 40°F there is no sign of dying, and such seeds germinate in a 70–40 pattern the same as fresh seeds and at exactly the same rate. The moist storage must be kept aerobic, as the seeds were dead in one month if stored in sealed Ziploc bags. It is not clear why dying was so rapid in the sealed systems.

Dry storage of seeds of *Eranthis hyemalis* is less satisfactory. When stored dry at 70°F, dying becomes evident in the 60th week, and death is complete by the 72nd week. Viability is retained somewhat longer if dry stored at 40°F; however, even here dying is evident by the 80th week and is extensive by the 100th week.

Moist storage is not confined to species with 40–70 or 70–40 germination patterns. It is obviously applicable to species with more extended germination patterns. It is also applicable to species in which there is a large difference between the germination rate at 40°F and 70°F. For example, Salix *arctica* seeds can be stored for three months moist at 40°F. Such seeds when shifted to 70°F germinate on the second day, just as if they had been placed directly in moist paper towels at 70°F. It will take further work to find out how long the seeds of *Salix arctica* can be stored moist at 40°F. The success of this moist storage at 40°F depends on the fact that the rate of germination of *Salix arctica* is enormously slower at 40°F than at 70°F. In contrast, seeds of *Salix arctica* cannot tolerate dry storage at 70°F. Seeds stored under this regime are dead in two weeks.

Another group for which moist storage is applicable are seeds that require light or gibberellins for germination. These could be stored moist in the dark.

What Temperature Is Best ?

The data of Lela Barton, p. 144, show that the lifetime of seeds of *Lilium regale* increases markedly as the storage temperature is lowered from 70°F to 40°F to 23°. The question immediately arises as to whether storage lifetimes might be even longer at even lower temperatures such as 0°.

It is likely that the lower the temperature, the slower the rate of dying. The fact that many seeds endure temperate-zone winters shows that they can survive temperatures of 0° and below. Thus it is likely that many seeds will store better in freezer compartments than either at refrigerator or room temperatures, and this could be true for both dry and moist storage.

The common practice of storing seeds in refrigerators rather than freezers arises from a misconception. Vegetables are stored in refrigerators, because if placed in the freezer ice crystals form, and this ruptures cell walls. This leads to rapid rotting because of bacterial and fungal attack. Seeds are much more resistant to the formation of ice crystals, and at least some of them do not form ice crystals even down to liquid nitrogen temperatures. Each species will have to be tested to see how far the temperature can be lowered and still retain viability.

Should Seeds Be Dessicated Before Storage ?

The data of Barton on *Lilium regale* show that storage life is increased if the moisture content of seeds of *Lilium regale* is reduced from 9.9% to 4.5% by the use of chemical dessicants. Two other studies, described below, show similar effects.

S. Ramyarangsi (*Proc. Intl. Bamboo Workshop*, 1988) found that storage life of seeds of *Thyrsostachys siamensis* increased as the moisture content was lowered. The death rates at 80°F followed a zero-order rate curve. The moisture content and half-lives were 10% (7 months), 8% (12 months), and 6% (17 months). Incidentally, when the seeds were dry-stored at 35–40°F there was no sign of dying up to 27 months for seeds with any of the three moisture contents.

In the November 1997 issue of the *Avant Gardener* a procedure is described (developed by Dr. D. K. Pandey in India) in which seeds are treated with a solution of 25 gm of calcium chloride in 75 gm of glycerol and stored in aluminum foil. Seeds of carrots, onions, peas, and peppers so treated retained viability for six years, whereas sun-dried seeds were dead after six years.

Seeds with an impervious seed coat have the longest life in dry storage, and some seeds of this type remain viable for over 100 years when dry stored at 70°F. Dessicants or sealed storage should not have any effect on this group. Low temperatures might increase storage life, but many species of this type store so long at 70°F that any increase in storage life would be of marginal value. Finally, it is very likely that many seeds cannot survive drying, much less drying over dessicating agents. *Eranthis hyemalis* and *Salix arctica* are examples.

Should Seeds Be Stored in Sealed or Unsealed Packets ?

Barton's data show a small beneficial effect of storing the seeds of *Lilium regale* in sealed containers. Thompson and Morgan have begun the practice of distributing seeds in sealed packets. Susan H. Woods of West Wind Technology Inc. sent bamboo seeds in a sealed zippered bag containing a packet of dessicant. Such sealed storage would keep out adventitious moisture and preserve a low moisture content in seeds that had been dried over dessicants. It also could prevent access to oxygen, which will be discussed in the following section. However, *Eranthis hyemalis* seed cannot be stored alive in sealed containers. More careful study is needed.

Should Seeds Be Stored Under Aerobic or Anaerobic Conditions ?

There are a few reports claiming increased storage life when seeds are stored in inert atmospheres such as nitrogen or carbon dioxide. It was clear that this would not work for moist storage of *Eranthis hyemalis* seeds. However, some seeds in fruits are prevented from germination simply by lack of access to water and/or oxygen. Data conclusively proving this for *Cucumis melo* was presented

in the First Supplement to *Seed Germination Theory and Practice*. This raises the question as to whether such seeds would benefit from storing under anaerobic conditions either moist or dry. This is another area that needs precise, controlled studies.

Are Complex Storage Patterns Ever Beneficial ?

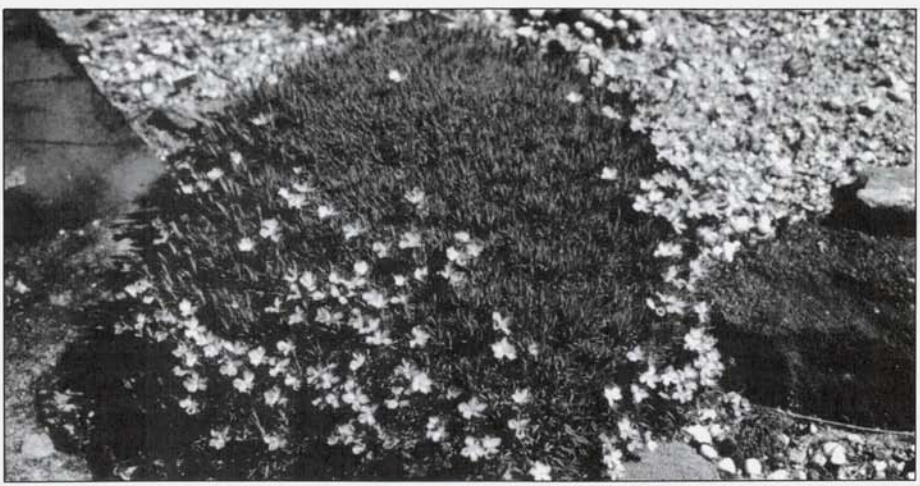
This is a subtle question that has not been recognized. For example, let us take a species with a D-70 germination pattern and one in which three months of dry storage is necessary in order to remove the chemical system blocking germination. Will it be better to start dry storage at low temperatures with fresh seed or with seeds that have had three months of dry storage at 70°F? I have no idea. It has at be studied.

Conclusions

Seed storage has been not yet been studied enough. No doubt one factor contributing to this lack of research is that such studies take many years and are not applicable to graduate programs such as doctoral degrees theses or research programs of young faculty members. And without the research there is no accurate way to predict the optimum storage conditions. Each species will have its own death rate curve and viable lifetime under each storage condition, so that there will be no simple answers. There are many unexplored possibilities.

My major concern at present is that there must be a storehouse somewhere of data on storage of seeds of agricultural crops, and I have not been able to locate it. Certainly this arena of knowledge is of much economic importance. Any help in finding such information would be much appreciated.

Norman and Janet Deno live and garden near State College, Pennsylvania. Their garden features many populations of naturalized species. Norman has done extensive experiments into the germination of thousands of species of seed. Norman's book *Seed Germination Theory and Practice* is available from the author. Please address all inquiries to Norman C. Deno, 139 Lenor Drive, State College, PA 16801.



Musings from a Rock Garden

SEED TIME

One of the highlights on a rock gardener's yearly calendar is named, simply, seed time. It stretches from December to April of the next year, where it overlaps other highlights of the year. For many rock gardeners, these two modest words hide some of their most exciting, frustrating, exhilarating, and disappointing activities. As will become clear later, these contradictory modifiers are entirely appropriate, though the negative ones may scare and discourage the faint of heart, the strong in pocketbook, and perhaps those who are just hesitant to embark on a long and uncertain venture.

It all begins with seed lists. These little brochures that start arriving toward the end of the year contain hundreds or even thousands of Latin names arranged more or less alphabetically. The lists from various rock-gardening societies are immediately recognizable by their microscopic print and dense columns, usually without any indication of what it all means. It is a most welcome distinction of the NARGS lists that at least some vital data, such as size and flower color, have been included in most of the entries. The commercial catalogs, on the other hand, frequently contain much more, with terms like beautiful, choice, best of all, gem, indispensable, and other emanations applied liberally throughout. Occasionally and parenthetically, the word difficult or challenging may also occur. But regardless of the list's origin, the avid rock gardener, sometimes lovingly referred to as a seed nut, puts everything else aside, surrounds himself with encyclopedias, floras of different regions, gardening books, index cards and notes, perhaps even a computer, and begins the exciting and very tedious work of selecting the candidate seeds. Many, many hours later, with all joints stiff and aching, the weary searcher declares a partial victory, finishes another cup of coffee, and proceeds with ordering his selections.

A fairly simple task with commercial outfits, this becomes a virtual Monte Carlo with any of the club seed exchanges. There, you have to come up first with an astronomical, so it seems, number of choices and then declare a certain, though much smaller, number of preferences.

While your commercial selections are almost certain to be filled, your seed exchange prospects may be quite dubious. If you get two-thirds of them, you are in luck. Nevertheless, once the selections are made, recorded, and the envelopes sealed, a lovely calm settles over your rock gardening mind: the deed is done.

In theory—and weather permitting—the next task would be preparing for the time when the seeds arrive, i.e., getting the seed flats, pots, or whatever containers are preferred, ready for sowing.

However, procrastination is a common malady, judging by my own behavior, and a brief rest on laurels at the end of the year is tempting. The time is also appropriate for New Year's resolutions, one of which concerns a more orderly approach to selecting seed. Every year I, and I suspect quite a few others, resolve to put down on cards or into a computer the names of any and all desirable plants I have read or heard about, all those I have had, lost, and want to have again—simply I promise to create a wish list that will remove the dreadful tedium of the endless hours at selection time. No matter that I have repeated the same resolution over the last twenty years: this time I'll stick to it.

When the seeds finally arrive, and the species received are somewhat mournfully compared with those selected, the rock gardener dives into a sea of frantic activity. The names have to be recorded, labels written, and the sowing medium prepared. Some growers dust up their chemistry sets and pull out bottles with sulfuric acid, hydrogen peroxide, gibberellin, and other exotic potions, some sharpen up their files and other abrasive instruments, some start collecting paper towels and liberate space in the refrigerator. As there is no end to prescriptions on how to make seed germinate, the gentle reader will be spared the details, but whatever procedure is followed, it is always messy, and many a marriage got to a brink on that account. It is also of interest that immediately after the seed shipment arrives the weather turns utterly miserable. In our parts, it is the time of first blizzards, freezing rains, and fierce winds. I suspect that the highly touted influence of El Niño is largely secondary to that of the seed arrival.

Nevertheless, there comes a day when all the seeds are planted, the trays and containers safely tucked in, and the rock gardener may relax, waiting for the weather to get warmer. Those who sow seeds in a controlled environment don't know what they are missing. The weather report, which has always been a favorite of gardeners, becomes even more exciting, particularly the long-range forecast, regardless of its being usually wrong.

Eventually, the temperature starts rising, and the seed nut begins the daily routine of misting and inspecting the surface of every seed tray for signs of germination. As a rule, most seeds will germinate when the rock gardener is tending to visiting relatives, cleaning up a flooded basement, or attending an important conference. Also, similarly to the effects of seed arrival, germination seems to provoke record-breaking late storms. But no matter, the barely visible plantlets have to be watered, sheltered from heavy rain or sleet, moved around for more or less sun, protected from slugs and other predators, simply coddled. Of course, the rock gardener declares airily that they are just left alone to fend for themselves. There have been some setbacks: some seed has clearly been mislabeled, one flat was turned over by a raccoon, a squirrel or some other dexterous varmint removed and possibly devoured some labels, and too many of the containers didn't show the slightest sign of germination. But despite these mishaps, the rock gardener is as delighted as any proud parent would be. When the cotyledons reveal the first true leaves and the future beauty of the plant, the seedlings make a visible progress every day, the picking and transplanting period is at hand. Even some of the old seed left over from years past have now germinated, and, because spring has finally arrived, the sun smiles in unison with the happy grower.

Of course, if you buy, exchange, get as a gift, or in any other way acquire a more or less mature plant, you save yourself a lot of trouble, but you miss the excitement of seeing the first few tiny sprouts in a seed pot, the discovery of germination in a three-year-old tray of androsace seed, the delight in lining up small pots of newly transplanted seedlings, the possession of 50 vigorous seedlings of a lychnis that was supposed to be Silene hookeri*—all this and much more.*

—Alexej Borkovec

TRAVELS WITH PLANTS

Honest horticultural lust being what it is, rare is the homeward-bound gardener who returns without a plant or two—or many. Nurseries are, of course, the *real* destination of every trip in the first place. "Why," grumbled my husband, "do we have to go to Western Hills Rare Plant Nursery again? We were there a couple of years ago." My reasoning was so simple and obvious, at least to a gardener. We lived in Connecticut, and the nursery was in Occidental, California. Since we had already reached the West Coast, a 90-minute detour was a mere bagatelle, a brief happenstance. It would be absurd to come so close and pass without looking. We will gloss over the length of time actually spent at the nursery. We will forget the previous trip, when a lovely clump of variegated society garlic *Tulbaghia violacea* 'Variegata', a gracious gift from the director of the University of California–Davis botanic garden, perfumed the entire aircraft every time someone opened the overhead bin.

Perhaps even an innocent trip within your own neighborhood to visit a friend engenders plants. "Oh, what a lovely plant," you sigh in guileless admiration. "I wish I had such a treasure in my garden." Gardening friends being kindly souls, a seedling or small division looking for a new home is frequently shared.

Whether local or coastal, travelling with plants within the United States is fairly simple (although California, Arizona, New Mexico, etc., may have their petty quibbles about dirt). Gardeners will remember always to park their cars in the shade to keep plants from overheating. Gardeners look for motel/hotel rooms with balconies, where travelling plants may safely take the air. A small trail of fine gravel or spilled soil on the carpet is unintentional and easily dealt with by the maid and that powerful hotel vacuum cleaner.

It's different when you cross international boundaries on your return to your garden in the United States. American citizens may bring in a dozen plants each. If you have an import permit, you can bring in even more. Permits are available at no charge through APHIS (someone had a sense of humor—the acronym stands for Animal and Plant Health Inspection Service), PEQ/Permit Unit, 136 4700 River Road, Riverdale, MD 20737, telephone (301) 734-8645. Allow ample time to have your permit request processed. The government will want to know what you intend to bring in, from what country, and at which port of entry

you'll arrive. I went for genera or even plant families—"Oh, I'll be bringing in *Arisaema*, Amaryllidaceae, Liliaceae...returning through JFK, Newark, or Boston..." Well, planes do get diverted you know—I just wanted to cover all bases.

There are Department of Agriculture regulations concerning the importation of plants from abroad. Certain categories of plants are prohibited or restricted. *Cyclamen, Galanthus, Sternbergia* are under CITES Appendix II, requiring government-level export and import certification of their propagated origin. Cactuses and orchids are similarly restricted. *Salix* species have a post-entry quarantine restriction. *Cannabis sativa* would be a real problem.

The bottom line for allowable plants is: no diseased plants or plants infected with insect pests are allowed. That's okay; you wouldn't want diseased, pestilential plants in your own garden, nor wish them on anyone else. NO dirt—I mean soil—is allowed. It doesn't matter if plants have been grown in a non-soil medium; this must also be removed. Inspectors will want to examine roots, since certain pests (nematodes, for one) afflict plant roots. So clean your plant roots before you arrive at customs. Believe me, you will be gentler about cleaning roots than the inspectors. Sounds serious doesn't it?

Seeds are much simpler to import. They are allowed, easily transportable, compact, and have a great survival rate. Packets of seed provide flats of plants to fill your garden (and share with garden visitors) unlike that one shocked little plant you bring home to recover from abuse and adjust to an entirely new home.

Bulbs are easy to import if they are dormant—and not on a CITES certification list. They are asleep and need no sunlight or water, and they are already free of soil. However, even dormant bulbs must be clean and healthy. One September in Holland I bought some bulbs. Simple, I thought, the USDA maintains an inspectorate, and I'll just pop in and get a phytosanitary certificate. Such plant health certificates allow you to just whiz through customs at the airport. I had disregarded the fact that my return was on Labor Day Monday, and, good citizens and all, the USDA inspectors even in Holland were off work. My friends took me to the Dutch department, where the bulbs were whisked around a corner and out of sight. Great rustling and knippering for fifteen minutes, and the gentleman reappeared with my bulbs and a teaspoon's worth of loose tunic scraps. "Aha," he announced proudly, "now your bulbs are clean, and I may issue a certificate!"

Actively growing plants are another story. The no-soil stipulation is the bugaboo. Some points to consider: Plants are not going to enjoy having all the soil washed off. The closer to your departure you clean them, the better. Don't use the bathroom sink at the motel. I cannot emphasize this too strongly. It is all too easy to clog the plumbing. Shake loose soil into the wastebasket, then repeatedly flush the toilet while holding the plant roots in the water. Maintain a strong grip at all times during this process. If you are staying in a high class hotel, the bidet is even more suitable for this final washing, which I discovered while staying at Amsterdam's Hotel Des Indes Intercontinental in April 1997.

Once clean, roll each plant individually in a sheet of newspaper, then slip the packet into a plastic bag. If it is early spring, when new growth is just starting, or late fall, when plants are entering dormancy, I clip off old leaves. Fewer leaves reduces the possibility of insect eggs or juvenile or adult pests. That's also why you wrap individually—if plants are grouped together, and one has a pest, they will all be considered infested.

Clutching your bag(s) or box(es), you arrive at customs. The USDA now employs beagles trained to sniff out contraband—sausages, fruit, and plants. Think about this while you fill out your landing card and answer its questions about plants and agricultural products. Most, but not all, major airports maintain inspection stations. Kennedy in New York City does, nearby Newark, New Jersey, does not. I haven't found any advantage to travelling one way or another; it all depends on the temperament of the agent on duty when you arrive. Have a list, with Latin names, of your plants. A duplicate, one for you and one for the agent, is a good idea, also. Frequently it has been my experience that when I have a few plants, obviously in good health, we're cleared through. When I came back from Japan with a rather large shopping bag full of plants, they were taken to the inspection station for comprehensive checking, to be forward to my home at a later date. By the way, if insect pests are found, and you're offered a choice between dipping and gassing, do chose dipping. Plants hate being gassed and will not soon forgive you. In fact, many will perish right then and there.

Sooner or later, you and the plants arrive at home. Forget jet lag and the dirty laundry: the plants have priority. After the root cleaning and travel, the plants are invalids needing gentle care. I find potting, using a gritty open mix, is better than planting out in the garden. Bare roots tend to clump together, and you'll want to get them spread out in the pot as you work. Briefly soak the roots in water. I usually add some liquid fertilizer at quarter or half strength, selecting one lower in nitrogen, higher in phosphorus and potash. While still wet, place the roots on a tray of dry sand, cover with sand, then shake gently. The sand clings to the roots, separating them and making it easier to distribute them when repotting. Water them in to settle the potting medium, unless you're dealing with succulents or similar. Keep even sunlovers lightly shaded for a few days, and then place pots in an appropriate situation. Some will die, leaving you miserable, and a heart-warming number will survive, thus proving you can indeed bring them back alive.

Judy Glattstein gardens in the Garden State. Having moved to New Jersey two years ago, her current garden work-in-progress involves shade-tolerant, drought tolerant, deer-proof plants for clay soil.

ERRATA

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Winter 1998 Issue Vol. 56(1):

—p. 26. The correct address is: Glenmar Heather Nursery, Inc., PO Box 479, Bayside, CA 95524-0479. Tel.: (707) 268 -5560; e-mail: <glenmar@humboldt1.com.

—Pp. 41-49. Zdenek Zvolanek, not Josef Halda, was the constructor of the slab garden in the O'Byrne garden. Also, the O'Byrne nursery is not an alpine specialty nursery but rather carries only a few alpines.

—Pp. 67. The Southern Alpines '96 Conference Proceedings can be ordered from Southern Alpines Limited, P. O. Box 2984, Christchurch, New Zealand. Cost is $NZ48, probably a little over $US30. VISA is accepted.

Book Reviews

What Happens in My Garden, by Louise Beebe Wilder. 1997. Hartley & Marks Publishers: Vancouver, Canada. ISBN 0-88179-133-7. Paperback. $14.95.

The Gardener's Essential Gertrude Jekyll. 1964. Godine Press: Lincoln, MA. Paperback, 1993. ISBN 0-87923-599-3.

A Gardener's Encyclopedia of Wildflowers, by E. Colston Burrell. 1997. Rodale Press: Emmaus, PA. ISBN 0-87596-723-x. Hardback, $29.95

If there is still time on your hands after working in your garden late into the evening, when shadows have lengthened and colors faded, you may want to find a cool spot and slake your literary thirst with these recommended books.

Louise Beebe Wilder (1878–1938) gardened just north of New York City in Bronxville. When she wasn't in the garden, she penned, in a warm conversational style, ten books steeped in horticultural precision. *What Happens in My Garden* was written in 1935 and is available now in a fresh reprint, with nomenclature updates, from Hartley & Marks Publishers. The paperback is a collection of wide-ranging plant essays discussing little irises, hollyhocks, clematis, autumn colchicums, and snowdrops. But Ms. Wilder also writes knowledgeably on rock gardens, dovecotes, and "creeping plants." She describes a beguiling "white" garden in Wales on the river Ely, which she first saw at sunset—a garden of white flowers, variegated and gray foliage, even white stems—and noted, "It would always suggest harmony, yet there would be no lack of interest. Frayed nerves would find it remedial." *What Happens in My Garden* is a fine and highly recommended introduction to Ms. Wilder, who is recognized as one of the finest American garden writers.

Perhaps the greatest garden designer of the early Twentieth Century was Gertrude Jekyll (1843–1932). Much has been written of her "English" perennial borders and the attention to color she gave her designs. By the time she died, she had designed or co-designed with Edwin Lutyens some 300 gardens, and she herself had written thirteen books. *The Gardener's Essential Gertrude Jekyll* (Godine Press paperback reprint originally republished in 1964) is a collection of extracts of her writings from the legendary, albeit tersely titled books *Wood and Garden, Home and Garden, Annuals and Biennials*, and so forth. The opening paragraph of this anthology is a cajoling enticement to read on: "I lay no claim either to literary ability, or to botanical knowledge, or even to knowing the best practical methods of cultivation; but I have lived among outdoor flowers for many years, and have not spared myself in the way of actual labour, and have come to be on closely intimate and friendly terms with a great many growing things, and have acquired certain instincts which, though not clearly defined, are of the nature of useful knowledge."

Gardeners who feel the call of the wild will appreciate *A Gardener's Encyclopedia of Wildflowers* by garden designer and writer E. Colston ("Cole") Burrell. Though he currently lives and gardens in Minneapolis, Mr. Burrell has an obvious love and appreciation for native wildflowers that stretches far beyond the Upper Midwest. "Why grow wildflowers?" he asks. His simple response is that not only are they well suited to American gardens, whether located along beaches, in woods, or in mountain areas, but wildflowers are lovely components of the natural landscape and ought to be enjoyed. Burrell describes flowers adaptable for woodland gardens, sunny meadows and open areas, roadside plantings and prairies, to name a few, and suggests how to use them in a garden, and how to grow them and propagate them as well.

The book is illustrated with color photographs of the wildflowers about which he has lovingly written. For some of us it probably takes a leap of faith to realize that the garish, "steroid" hybrids, tetraploids, and various cultivars we may grow today in our gardens were derived from ancestors that were simple and wild, untamed by horticulturists and tissue-culture geneticists. Burrell's photographs show us wildflowers of understated beauty and simplicity.

This past spring some friends and I participated in a native plant rescue at a site in southern Wake County, North Carolina, bulldozers turning earth behind us. The hepaticas, jacks, asarums, and other natives we moved are now enjoying an extension of life in various Raleigh and eastern North Carolina gardens. I think Burrell would have enjoyed such a weekend jaunt with us; his love of things wild, his concern for loss of natural areas, and his discovery of the native bloodroot at his mother's knee are clearly transmitted in his writings.

—Bobby J. Ward

Deer Proofing Your Yard and Garden, by Rhonda Massingham Hart. 1997. Storey Publishing: Pownal, VT 05261. ISBN: 0-88266-988-5. Price, $12.95.

Not so many years ago the sight of free-roaming deer grazing contentedly in an open field was a joy and a delight. Today the sight of deer happily munching our choice garden plants elicits shouts of anger, even profanity. In her new book on the problem of deer overpopulation, Rhonda Massingham Hart covers the situation and suggests possible ways of dealing with it.

More than an irritation to gardeners, deer overpopulation is a genuine threat to the environment: they destroy the understory, eliminating native plants and cover for small creatures; they browse young trees so the forest is unable to regenerate; they threaten themselves with starvation and disease; and they change the ecosystem in their range, allowing invasive exotics to come in. Highway collisions have caused many human fatalities and extensive automobile damage, certainly a very significant reason to diminish herd size. Several diseases, potentially fatal to humans and livestock, become more prevalent when deer populations are high. Lyme disease is, of course, the best known, but Ms. Hart mentions others as well.

Total control is almost impossible, but Ms. Hart has many useful suggestions for attempting it. She stresses that a solution that works for one person in one area may not work in another area. She also tells us that there are almost no deer-

proof plants—appetites depend on availability of food and how hungry the deer are. Among controls suggested are various types of fencing, which she feels offer the best chance of success; gardening with plants low on the food preference scale; foul-smelling and -tasting products; and products which make noises.

Deer are very much creatures of habit and will use the same trail for years—even for generations! A helpful technique therefore is to block their trails. The deer will go around the block, of course, but if they miss your garden on the new path, you have succeeded.

This book contains lists of plants deer prefer, lists of plants they don't like, landscape plans to discourage deer, plans for fences and physical deterrents, recipes for odoriferous and bad-tasting repellents and (as the real estate agents say), much, much more!! *Deer Proofing* is a fine book, written by a person who appears to have had ample experience with the deer problem. On two plants I disagree with her deer preference opinion, but that is perhaps because "our" deer have different tastes. Local deer do not seem to care for either Norway maple (*Acer platanoides*), which itself has become a threat to forests in Pennsylvania, or winged euonymous (*Euonymus alatus*), another invasive alien. The book's 145 pages are well illustrated, easy to read, and carefully indexed. At the back of the book are lists of sources for more information, complete with web sites. The light tone of *Deer Proofing* and the well-spaced layout make it a pleasure to read despite its rather gloomy topic.

—Dot Plyler

Cyclamen: A Guide for Gardeners, Horticulturists and Botanists, by Christopher Grey-Wilson. 1997. Timber Press: Portland, OR. 192 pp., 140 color photos, 40 line drawings, 12 maps, 7.5" x 10", hardcover. ISBN 0-88192-386-9. Price, $39.95.

Growing Bulbs: The Complete Practical Guide, by Brian Mathew. 1997. Timber Press: Portland, OR. 160 pp., 108 color photos, one line drawing, 6 x 9", hardcover. ISBN 0-88192-384-2. Price, $29.95.

We live at a good time. As more people become serious gardeners, interested enough to read books devoted entirely to one genus, more and better books appear to help develop and expand their knowledge and interest.

When *The Genus Cyclamen* appeared in 1988, cyclamen enthusiasts around the world rejoiced, for at last we had a monograph to help us classify, identify, and grow successfully these wonderful plants. Certainly I thought I would never need to buy another book on cyclamen. Shortly after publication an article appeared in *Cyclamen: The Journal of the Cylamen Society* announcing a new species and discussing the problems of subspecies. We now recognize 20 species instead of the 19 previously described. Expeditions to places where cyclamen grow in the wild brought more information on specific locations, forms, and environmental conditions.

Christopher Grey-Wilson expanded his earlier treatment of the genus with this new information and with guidance on the care and treatment of these splendid plants. He gives tempting suggestions for combinations with other

plants in the garden. He hasn't abandoned his scholarly approach and includes both botanists' and gardeners' identification keys.

The pictures of plants in the wild, as well as of cultivars and named forms, should help resolve some of the disputes over names. In the chapter on modern "Florists'" cyclamen Grey-Wilson gives details of past breeding, lists of cultivars, and instructions on growing these plants in quantity.

I found the chapter on inter-specific hybrids especially interesting, because Grey-Wilson not only tells of the hybrids one might produce but also gives precise directions for doing so. As with most advice on hardiness, that given in this volume is best taken as an intelligent suggestion. We all have pockets of microclimates. Indeed, part of the joy and challenge of gardening comes from understanding every variation of climate and soil in one's garden. I advise all gardeners to grow many plants from seed and test them in a variety of locations. All of the species listed in Groups I through III survived temperatures near 0°F and have endured prolonged freezing temperatures in my Zone 7a garden.

We have made progress in slowing the flow of wild-collected cyclamen. Grey-Wilson states: "There is no reason to buy cyclamen collected from the wild..." Furthermore, he reminds us that it is illegal to import wild-collected seeds of those cyclamen on Appendix I of CITES. Three cyclamens, *C. balearicum*, *C. creticum*, and *C. graecum*, receive this, the greatest possible protection to their existence in the wild. All other species are on Appendix II, where seed collection is permitted, but the importation of tubers requires CITES certification to ensure that the numbers collected will not threaten the existence of the species.

If asked whether one who has the earlier monograph, *The Genus Cyclamen*, needs this expanded revision, *Cyclamen*, I respond with an unqualified "Yes." I hope Mr. Grey-Wilson will direct his attention to other genera in the near future.

Brian Mathew's *Growing Bulbs: The Complete Practical Guide* differs from his scholarly monographs on hellebores, bulbs, crocuses, and irises. It should be viewed as what its title suggests it is—a practical guide. This is not an encyclopedia of bulbs, but an excellent guide to the cultivation and propagation of bulbs in the garden and greenhouse. It is written for enthusiastic gardeners more than for specialists, though it will be useful to both.

The first chapter gives a clear explanation of the differences between bulbs, corms, tubers, and rhizomes. He deals succinctly with growing conditions, inside and out, with questions of hardiness, and finally with pests and diseases. Although his chapter on propagation is aimed at the amateur, he includes advice on techniques preferred by many professionals, from seed sowing to artificial means, such as scaling, scoring, and leaf cuttings. He omits tissue culture, a method requiring special equipment and skills beyond the needs of most gardeners.

Mathew's cultivation guide is easy to use with plants arranged in alphabetical order. Concise advice is given for each genus, including qualifications for species that need special treatment. This is an excellent basic guide to tempt gardeners into growing bulbs and to expand the range of plants grown by those already so tempted. If you find yourself attracted to some genera more than others, you can find more detailed information on species and forms in his earlier books, *The Larger Bulbs* and *The Smaller Bulbs*. Any book by Brian Mathew is not to be missed. Buy it. You will use it!

—Nancy Goodwin

NARGS Coming Events

Annual Meeting: Skyrockets and Shooting Stars
July 1–5, Eugene, Oregon
Registrar, Jane Nelson (541)–683–4863

The Piedmont Chapter of NARGS invites you to

Midwinter Musings: A Garden of Pleasant Flowers

Eastern Study Weekend
January 29-31, 1999

Sheraton Imperial Hotel and Convention Center
Research Triangle Park, North Carolina
near Raleigh-Durham (RDU) Airport

Plan now to travel south to North Carolina for a study weekend featuring speakers from Great Britain, Missouri, Washington, and the host state. Jack Elliott, Nancy Goodwin, John Grimshaw, Dan Hinkley, Will McLewin, Milo Pyne, and Nick Turland are slated to speak on a wide range of topics, from little bulbs to hellebores. Plant sales will provide a look at what's offered by area nurseries, and the weekend also will include book and art sales. You can visit local gardens and nurseries before and after the weekend. Look for a brochure in the summer issue of the *Quarterly*, and please plan to register early—registration will be limited.

Registrar: Bob Wilder (wilder@pagesz.net) or (919) 781-2255
Chair: Bobby J. Ward (biblio@pagesz.net) or (919) 781-3291

N·A·R·G·S BOOKSTORE

MORE BOOKS BY NARGS MEMBERS

The following is an additional listing of some of the books in the NARGS Bookstore written or edited by current members of NARGS. See the Bookstore ad in the Winter 98 *Quarterly* for the previous listing. (Any members who have written or edited books appropriate for the Bookstore and wish them to be considered for inclusion, please contact the Bookstore Manager.)

NEW TO THE BOOKSTORE:

Dwarf and Unusual Conifers Coming of Age, by Sandra Cutler.....32.00
*The Gardener's Encyclopedia of Wild Flowers**, by C. Colston Burrell.....24.00
*Northwest Penstemons: 80 Species of Penstemon Native to the Pacific Northwest**, D. Strickler24.00
*Rock Garden in the South, by Elizabeth Lawrence**, ed. by Nancy Goodwin.....18.50
The Serious Gardener: Rock Gardens, by Bob Bartolomei.....18.50
*The Undaunted Garden: Planting for Weather-Resilient Beauty**, by Lauren Springer26.50
*Winter Garden: Planning and Planting for the Southeast**, by P. Loewer.....32.00
Winter Ornamentals, by Dan Hinkley.....8.00

NEW FROM TIMBER PRESS:

*Gardener's Guide to Growing Clematis**, by Raymond J. Evison.....24.00
*Gardener's Guide to Growing Penstemons**, by David Way and Peter James.....24.00
*Gardening with Grasses**, by Michael King and Piet Oudolf.....28.00
*The Well-Tended Perennial Garden: Planting and Pruning Techniques**, T. DiSabato-Aust24.00

TIMBER PRESS'S TOP 5 BESTSELLING TITLES FOR THE YEAR 1997:

1. *Book of Salvias**, by Betsy Clebsch.....24.00
2. *Botany for Gardeners*, by Brian Capon.....13.00
3. *Hosta Book*, by Paul Aden.....16.00
4. *Dirr's Hardy Trees and Shrubs**, by Michael Dirr.....56.00
5. *Moss Gardening**, by George Schenk.....28.00

CLOSE-OUT SPECIAL 30% OFF: ONLY A FEW LEFT):

*Daffodils for Home, Garden and Show**, by Don Barnes.....9.50
*Hebes and Parahebes**, by Douglas Chalk.....11.00
*Modern Miniature Daffodils: Species and Hybrids**, by James S. Wells.....13.00
*Trees of Georgia and Adjacent States**, by Claud Brown and Katherine Kirkman....23.00

* denotes hard cover

Prices listed above are approximately 20% off the list prices (some privately printed and/or non-US published titles may be somewhat less.) The complete list of all titles stocked is published in the Summer *Quarterly*. The most up-to-date listing may be found on the NARGS website (www.nargs.org) from which orders may also be made. Also, copies may be requested from the Bookstore.

OUT-OF-PRINT NOTICE:

The title *Jewels of the Plains*, by Claude Barr, is unfortunately completely sold out and is out-of-print. No addditional copies are available.

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SPECIAL NOTE:
Any titles published by Timber Press, whether on the Bookstore list or not, are available to NARGS members through the Bookstore at 20% off list price. If you wish to receive one of their catalogs, contact them at : 133 S.W. Second Avenue, Portland, OR 97204; 1-800-327-5680; 503-227-3070 fax; orders@timber-press.com.

BACK ISSUES OF THE *ROCK GARDEN QUARTERLY* (ALL POSTPAID):

50–Year Index to the *Bulletin of the American Rock Garden Society*, Vols. 1-50 (1943-1992) $2.00
1943–1989 issues .....$1.50 each
1990–1996 issues .....$5.00 each
1997–1998 issues .....$7.00 each
some issues sold out completely—inquiries welcome

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While they last: FREE with any order: the old ARGS cloth patches and window decals (two kinds: outside and inside the glass placement.) Ask for any or all when you order.

North American Rock Garden Society Bookstore
930 Wimbleton Drive, Raleigh, NC 27609 USA
919/781-3291, voice; 919/783-0654, fax; nargs@pagesz.net, email.
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