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Cover: *Sarracenia* hybrid "Queen of Hearts"

by Rob Proctor of Denver, Colorado

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Features

Departments

Sarracenia x catesbaei x Sarracenia alata

Hybrid Pitcher Plants

by Lawrence Mellichamp

I collected my first pitcher plant in 1968 in the coastal flat woods and pine savannas of southeastern North Carolina. Sarracenias grew commonly in these habitats characterized by moist, highly organic, nutrient-poor soils and frequent fires that kept dense vegetation from forming. Sundews, bladderworts, butterworts, and the world-famous Venus'-flytrap also grew in abundance, before the massive land-drainage activities of the 1970s which left much of the terrain dry pine plantations. North Carolina has more different genera of carnivorous plants than any other place in the world, and many of the species make interesting specimens for the home bog garden.

My favorites have been the pitcher plants. I still have growing a piece of the original one I collected over 20 years ago. The other carnivorous plants seem to come and go for me in cultivation, acting as annuals or short-lived perennials. Perhaps they are just more particular about their growing conditions. Nevertheless, I enjoy working with sarracenias and other bog species because they seem to represent a neglected area of gardening. Many people have water gardens, in shade or sun; but the bog garden, which requires full sun and just the right level of moisture, remains a challenge.

Possibly, too, bog gardening reminds me of my first encounter with the beautiful but fragile habitats that are so rich in species, without the pesky insects of the wild.

I can't deny, also, that a reason for growing bog plants is they *always* elicit a response of excitement, or awe, from visitors. Although different from the joy of seeing a lotus or waterlily in bloom, bog plants are very gratifying in their abnormal behavior.

The genus *Sarracenia* (named after 18th century Canadian botanist and physician Dr. Michel Sarrazin) contains 11 species, all but one of which are endemic to the southeastern United States. That one, *Sarracenia purpurea*, is remarkable in having spread during the 10,000 years since glaciation to the Gulf Coast and northward all the way west across Canada in peat bogs and on wet lake shores. It also seems to flourish as an introduced plant in northern European bogs. There is one close *Sarracenia* relative,

Darlingtonia californica, restricted to cool mountain streams and bogs in northwestern California and adjacent Oregon. *Darlingtonia* is difficult to grow in our hot southeastern summers and is not considered in this article. Some growers may keep it alive, but I have never seen plants grown well outside its native region. There are also distant relatives in southeastern Venezuela, in the genus *Heliamphora*, known as sun or marsh pitchers. Since they are not hardy, they will not be described here.

Most of the natural species of *Sarracenia* are well known as horticultural subjects, having been highly regarded in England and Europe since the Victorian era of the late 19th century. The often-cited treatment by John MacFarlane in L.H. Bailey's *Cyclopedia of Horticulture* (1914) is still required reading for anyone interested in pitcher plants.

I am especially proud of the fact that an ancestor of mine, a Dr. Joseph H. Mellichamp, who lived in the Bluffton area of southeastern South Carolina, collected and studied pitcher plants in the latter half of the 19th century. He published several scholarly papers describing his observations of *Sarracenia minor* (photo, p. 44), and he is attributed with proving that sarracenias catch and digest insects, i.e., that they are truly insectivorous. Even Charles Darwin, who wrote the first book on insectivorous plants, never realized that sarracenias were carnivorous!

One unusual trait of these species is that they hybridize freely among themselves, like tropical orchids, and the hybrids are fertile and capable of crossing with each other and back-crossing to the species, often resulting in fantastic natural hybrid swarms in disturbed habitats along the Gulf Coast. During the early 1950s, Ritchie Bell of North Carolina and Fred Case of Michigan studied and described most of the natural hybrids between pairs of species that grew together in the wild throughout the Southeast. The genus was monographed by Sidney McDaniel in 1971. ("The Genus *Sarracenia,*" *Bulletin of the Tall Timbers Research Station*, Tallahassee, 9:1-36.) In recent years, Fred and Roberta Case have recognized two new distinct taxa from Alabama, *Sarracenia alabamensis* (photo, p. 41) and *S. alabamensis* ssp. *wherryi*. In addition, distinct forms have long been known and cultivated, though not formally named, such as the giant form of *S. minor* from the Okefenokee Swamp in southeastern Georgia (photo, p. 43), a pink-flowered form of *S. purpurea* from Mobile, and various albino forms of most red-flowered species. Probably the most generally acknowledged natural hybrid is *S.* x *catesbaei* (photo, p. 43), a cross between *S. flava* and *S. purpurea*. Wherever they grow together, the hybrid may be found. Another common hybrid along the Gulf Coast is *S.* x *mitchelliana* (*S. leucophylla* x *S. purpurea*). Both can be robust growers. Our research efforts now are to acquire—from the wild or man-made—specimens of every possible cross between pairs of species.

Sarracenias produce large, bee-pollinated flowers in spring. There is one nodding flower per stalk, and usually one stalk per growing lead (or "toe"). Some smell sweet, others smell musty. A given individual plant blooms for about a week and the flowers are very showy, but it is the long-lasting pitchers that make these plants famous and that are mostly used to tell the different species apart. Lately, individual pitchers of wild-collected *S. leucophylla* (photo, p. 41) are being sold in florist shops as "cut flowers." All pitchers have hoods (mostly to keep out rain water), various hairs within the tubular pitcher leaves (to keep prey from

escaping), and no moving parts to catch insects. They are passive pitfall traps. As in all carnivorous plants, it is the leaf that is modified to catch prey. The pitchers will attract any number of bees, moths, ants, flies, and wasps by the sweet, sticky nectar secretions around the mouth of the pitcher. The insects slip into the tubes, can't get out, fall to the bottom and die, are digested by enzymes, and provide nutrients that are absorbed by the leaf to supplement their soil-based nutrition. We often use cotton balls to keep moths out of the pitchers in the fall as they tend to over-accumulate and "gum up" the pitchers —as if a person tried to eat an unplucked chicken.

The species of pitcher plants are described in Table 1, where brief distinguishing features are given. Flowers are either red or yellow; the pitchers are tall or short and of various colors (influenced by the amount of sunlight); and unless otherwise noted, the distributions refer to the coastal plain region of the various states. The seasonal production of pitchers can be distinctive: new pitchers may be produced starting in earliest spring and continuing until frost, or there may be periods of no apparent growth. For example, some species make new pitchers in spring only; others will have growing spurts in spring and then again in late summer or fall. Normally, fall pitchers are larger and more colorful. Three species [*S. flava* (photo, p. 44), *S. leucophylla* (photo, p. 41), and *S. oreophila*] produce distinctive, over-wintering, flat leaves that do not form tubes and are called phyllodia, in addition to their insect-trapping pitchers. These should not be cut off when grooming plants.

For a good discussion of all the species and many of the forms and hybrids, see *Carnivorous Plants of the United States and Canada*, by Donald E. Schnell (1976, Blair Publishing Co., Winston-Salem, NC), or consult back issues of the *Carnivorous Plant Newsletter*, an excellent quarterly guide to growing and understanding all carnivorous plants, now in its 19th year of publication (available from CPN, Biology Dept., California State University, Fullerton, CA 92634).

While the species are fairly easy to grow, I feel that often they do not make the best ornamental plants because of their seasonal pitcher production, their occasional dislike of all but the best conditions of sun, soil, and water, and the difficulty in obtaining propagated (as opposed to wild-collected) specimens. Hybrids are easier to maintain than species. All pitcher plants are very interesting and clearly intriguing to even the most casual observer. Only the famous Venus'-flytrap ranks higher in interest and that's because the trap moves. Yet pitcher plants are larger, more colorful, easier to grow, and more readily propagated by division, and thus should be more widely known. In response to an increasing interest in pitcher plants on the part of the general public and based on comments from visitors to the University of North Carolina at Charlotte Botanical Gardens, where we have hundreds of specimens on display, I decided to begin breeding man-made hybrids of *Sarracenia* for ultimate distribution to the horticulture trade. Only a few propagated species and hybrids are available now in the trade, and those only to a very limited degree.

I started in 1984 experimenting with making crosses and germinating seeds. Cross pollinations are done in April and May, as the potential parents come into bloom. There is much overlap of flowering periods. Pollen can also be kept refrigerated or frozen for some time, allowing crosses between widely divergent species even when there is no overlap in blooming times.

Seed pods mature in the late summer and fall and contain up to 500 seeds, depending on the degree of fertility of the cross. (In the wild, seeds are apparently dispersed by water during the fall hurricane season, according to reports by George Folkerts at Auburn University.) Seeds may be stored dry in the refrigerator for several years but must be stratified (given a cold and moist period) to germinate. I did experiments with stratification times to find the optimal germination rates. I found that placing the seeds on top of a moist, peat-based medium (1 part milled Canadian peat: 1 part perlite or vermiculite) and then refrigerating for four weeks at 40°F was acceptable for good germination. Under normal conditions the seeds sprout in about two weeks after refrigeration. I grow the seedlings in a peat and perlite medium, keeping them moist and in full sun, fertilizing twice a month with 1/4 teaspoon per gallon 18N-18P-18K (or 9-45-15) water-soluble fertilizer during the summer.

Even at that, the seedlings take about three years to reach flowering maturity, though they begin showing some adult characteristics during the second good growing season. (Do not fertilize adult plants.) Right now I have hundreds of one- and two-year-old seedlings waiting to be evaluated, of which only a small handful will be kept for further consideration for naming as cultivars or use as breeding stock. The majority will be sold at our spring plant sale. Breeding is a slow and tedious process, too much work to simply discard even the less spectacular plants. While everyone who buys may not get a named cultivar, every seedling is a potentially interesting plant. So you see, they are not as easy to grow as annuals, but rather present a challenge to the gardener as great as that of some of the choice alpines.

One of the most interesting aspects of my research has been obtaining the parental breeding stock. I collected typical specimens from the wild in North Carolina and especially the Mobile region of the Gulf Coast where most of the species are found. Rare species were obtained from long-time growers (before CITES permits were required). I was also most interested in finding and selecting unusually attractive natural hybrids from the wild, as well as from other collectors, including Fred Case of Michigan, Clyde Bramblett of Miami (photo of plant selection, p. 42), John Hummer of Arlington, Virginia, and Donald Schnell of Pulaski, Virginia. In this way, I was able to gather together some of the finest breeding stock in existence.

If there is need to justify my collecting from the wild, it is to say that I believe it is necessary for botanists to know their plants first-hand. It also ensures knowledge of the habitat and geographical origin of the material being utilized. Furthermore, it may have been the only way to obtain certain interesting and new breeding material from the wild. Pitcher plants are very prolific species and will colonize any suitable habitat. Selective collecting from the wild does no harm as long as the habitat is not destroyed. Some growers, in fact, have in cultivation specimens from now extinct populations of rare pitcher plants because they collected back before alteration. While I abhor mass collecting for profit, I see no problem with *knowledgeable* people taking horticulturally interesting material of plants from the wild for purposes of propagation and breeding. In fact, I encourage it, because that is how many new forms become available for general distribution.

I worked on hybridizing and selecting with Rob Gardner, curator of carnivorous plants at the North Carolina

Table 1 Scientific Name	flower color	pitcher color	pitcher height	pitcher season	Distribution
S. alabamensis	red	green to reddish; soft pubescence	tall	spring , weak robust fall	extremely rare, c. AL
S. alabamensis ssp. *wherryi*	red	green to reddish; soft pubescence	medium	all seasons	rare; sw AL, se MS
S. alata	yellow	green to reddish;	tall	spring, fall	AL to TX
S. flava	yellow	yellowish w/red veins	tall	spring only, robust	VA to AL
S. jonesii	red	reddish	medium/tall	all seasons	very rare, mtns. of NC, SC
S. leucophylla	red	green to reddish; showiest w/white hood	tall	spring, fall	FL, GA to MS
S. minor	yellow	green to reddish; hood w/spots covers mouth	medium	summer-fall	NC to FL
S. oreophila	yellow	yellowish	medium/tall	spring only	rare; ne AL, adj. GA, NC
S. psittacina	red	green or red; strongly hooked, flat on ground	very short	all summer	GA to MS
S. purpurea	red	green or dark red; sit on ground	very short	all seasons	e. US and Can
S. rubra	red	green or red	short/medium	all seasons	NC to FL

Botanical Garden in Chapel Hill, who also has an extensive collection. We began to realize that we were creating some exciting new hybrids that had real potential for the trade.

As we selected outstanding seedlings and made plans for new hybrid combinations, we decided to name some of our best plants as cultivars, realizing that some day they may become widely dispersed. We had fun coming up with such whimsical names as "Tattletale Delegation" and "Anxious Debate" (photos, p. 43) as we imagined the groups of pitcher leaves with mouths gaping rushing off to spread their gossip. (Double quotes around a name here indicate a proposed cultivar name that has not been published. Single quotes are an accepted designation for formally published cultivar names. We have published five names in 1987: see CPN, Vol. 16 for descriptions and color photos.) "Case's Resolve" (*S. minor* x *S. alabamensis* ssp. *wherryi*) is a particularly charming hybrid with subtle colors and form, named after its maker, Fred Case. 'Moore's Melody', with its flamboyant wavy hood, was named after J.C. Moore, Sr. of Mobile who helped in locating elusive interesting wild populations. 'Friar Tuck', "Flies Demise," and "Hobbit" are three diminutive hybrid siblings with impish features originating from a wild-collected seed pod resulting from a cross between *S. minor* and *S. purpurea*. 'Carolina Cooler' has a refreshing combination of greens and reds in the pitcher. 'Dark Ladies' is a captivating deep red dwarf form of *S. minor* from southeastern North Carolina. "Ladies-in-Waiting" and "Queen-of-Hearts" have delicate and robust feminine features, respectively, and are hybrids involving more than two species. Two of our most interesting specimens have come straight from the wild. One is called "Blackankle" (photos, p. 42) and is a richly veined natural hybrid between *S. flava* and *S. purpurea*. It was found in a small pocket of coastal plain vegetation in a seepage area surrounded by dry woods east of Charlotte, North Carolina, near the tiny crossroads settlement of Blackankle. The other, a striking, red-tubed form of *S. flava*, is unnamed and comes from northern Florida. Even now we have new hybrids so fascinating and delightful they defy descriptive names. We have a most unusual hybrid between *S. purpurea* and *S. alata* with short red pitchers that are so thickly pubescent you can actually see the fuzz. One of our finest is a stunning cross between the lofty *S. alabamensis* and the decumbent *S. psittacina*. It is as unlikely as a cross between a Chihuahua and a St. Bernard! And that makes it interesting.

We did look for certain characteristics in our hybrids and we rated them numerically in order to quantify superior selections. For example, we were interested in short, sturdy plants that would stand up under normal rainfall and wind out-of-doors. The taller forms tend to fall over under such circumstances. We also liked the rich colors of reds, yellows, and whites mixed with darker veins and patterns in the leaves. We gave points in our rating scale to those plants that produced pitchers continually throughout the growing season—in fact, that was a fairly important trait—and we gave extra points to those few that held their pitchers and color well throughout the winter in an unheated greenhouse.

The period of August through October is the prime time to enjoy *Sarracenia* hybrids because of the tendency of many parents to produce their best pitchers in the fall and because by then there has been a summer-long accumulation of showy pitchers. In an unheated greenhouse sometimes the pitchers

will last well into late spring of the year after they are formed. Normally, a given pitcher lasts a few weeks to a few months, with most dying down to the ground after a few hard frosts. In theory, the nutritive remains of the prey are naturally returned to the soil in the wild by this means. At the end of each season we just throw away old, dead pitchers when cleaning up the plants in our collection. Pitchers can be cut and removed anytime they begin to look unsightly. Division and repotting are best done April through October.

All Sarracenias are herbaceous perennials. Most are not evergreen, but a few are *(S. purpurea* for example), more or less depending on the severity of the winters in their native homes. As adults, they are perfectly hardy in most climates, having been successfully grown outside in central Michigan by Fred Case, where temperatures have been down to -24°F (with snow protection). At the McMillan Academic Greenhouse on the UNCC campus in Charlotte, I grow some outdoors year around in a 4' by 5', plastic-lined box filled with 6" of growing medium. They have experienced -8°F (in 1985) with no damage.

Most of my collection are grown in individual plastic pots (3" to 8" in diameter) staged in full sun on benches outdoors, and brought into an unheated glass greenhouse after January 1 each year. This gives them some hard freezes but protects them from the worst of winter where freezing and thawing tends to weaken the plastic pots. While freezing temperatures may not be absolutely necessary—I have seen them grown well for several years strictly in a cool greenhouse—the plants definitely benefit from a winter rest period of significantly cooler temperatures during the low-light months. Keeping them at 40°F for a few weeks or months seems to work well. There is no reason to try to force them to grow until good light returns in spring. The ones in our greenhouse froze down to 20°F suddenly one night back in 1985 with no ill effects. I would recommend you try them in the ground outside only if you can keep them constantly moist (they cannot dry out for more than a few hours without damage) AND give them full sun (they need at least 6 hours direct sun to bring out the colors). You could also grow them in a child's wading pool (sunk into the ground), a plastic wash tub or planter box, a half whiskey barrel, etc. They do prefer good drainage along with moist roots; they do not like to sit submerged under water for very long even though in the wild they may be found in seasonally wet areas. We keep most of our 4" pots sitting in small plastic saucers with about 1/2" of water to ensure that they do not dry out. We water them with city water every day in summer. Our city water is very low in soluble salts, even though the pH is about 8. The plants MUST have pure water. Try rainwater if you have trouble with city or well water sources. NEVER apply chemically softened water.

There is a variety of suitable growing media, including 1 part peat:1 part white quartz sand; 1 part peat:1 part perlite and/or vermiculite; or equal mixtures of leaf mold, sand, and potting soil. I am currently experimenting with potting in old, shredded sheet moss (new moss is too expensive!) with very good results—it provides perfect moisture retention and aeration. In the wild, we have found pitcher plants growing in almost pure clay on the one hand, and water-saturated sphagnum moss at the other extreme. Try to keep the rich soil to a minimum—they do not like high nitrogen content. I would not fertilize adult plants, those that are capable of catching insect prey.

It was hoped initially that the

modern techniques of tissue culture would allow us to mass-produce some of our cultivars and make them available widely, but difficulties with keeping the cultures sterile have proved beyond solution. Efforts continue in hopes of reaching a breakthrough. At present, we are able to multiply these selections only by dividing the most robust clumps several times a year, a painstakingly slow process for plants of such promise. And some of the hybrids multiply even more slowly than that. So far, for example, after five years, we have two plants of a *S. psittacina* x *S. purpurea* hybrid called "Snorkel" (photo, p. 42) which has a very dark red, 1" high rosette with prostrate, 4"-long pitchers turning up 90° at their tips.

Sarracenias are long-lived, always interesting, and most rewarding. I find it easy to spend hours tending the plants and admiring the myriad of delightful forms. They are very easy to maintain, if you just understand them and pay attention to their simple needs. Of course, these are famous words, easy to say. If we could all actually do that consistently for people as well as plants, we could change the world!

Sources of hybrid *Sarracenia* pitcher plants:

Orgel's Orchids, 18950 S.E. 136th. Street, Miami, FL 33196

Hummer's Acid-Wetland Flora, 1705 N. Quebec St., Arlington, VA 22207. Catalog, $1.50

Niche Gardens, 1111 Dawson Rd., Chapel Hill, NC 27516. Catalog, $3.

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Frontispiece drawing by Bonnie Arant Ertelt

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A Sphagnum Bog Garden

by Roberta Case

If you have ever been on a floating mat adjacent to a beautiful, clear northern lake, you have been struck by the beauty of the many sundews glistening in the sunshine, the pitcher plants, and perhaps orchids in bloom among the cranberry vines, sedges, and the shrubs of bog rosemary and leatherleaf. Beneath your feet, the ground cover is a mosaic of different species of *Sphagnum* that adds immeasurably to this beauty.

Sphagnum moss has tiny pores that hold a great deal of water. It produces a very acid environment that is rather sterile. Sphagnum grown as the basis for a bog garden thus provides a cultural medium especially suited to the more delicate and demanding ericaceous and insectivorous bog plants, as well as some orchids. More aggressive swamp plants like *Iris, Hibiscus, Peltandra*, and cardinal flower grow easily in ordinary soils and do not require any special substrate.

Cultivation of sphagnum is not easy under ordinary conditions. Sensitive to chemicals, including chlorinated water, metal ions, insecticides, and fertilizers, sphagnum grows best in full sun with a constant supply of nearly pure (even distilled) water. If the bog is allowed to become too dry, other mosses take over.

We have grown sphagnum mosses as ground covers in pots of pitcher plants using mineral-free well water or distilled water. But outdoors in a larger garden plot, distilled water becomes too expensive. Water from most wells contains harmful minerals. My discovery that water from a fish tank in the greenhouse worked as well as distilled water to grow sphagnum led to the idea of building a bog garden outside next to and watered by one of our waterlily ponds.

To construct the bog, I dug a hole about 6' long by about 3' wide and 1' deep and lined it with a heavy plastic sheet. Since many species of sphagnum grow readily on damp sand in nature, I filled in the hole with sand, in most places to about 2" above the water level of the adjacent pond. In each corner closest to the pond I sunk a deep plastic flower pot which had many small holes in its sides and bottom and a diameter big enough to accommodate my hand easily, for a siphon system. A short length of plastic garden hose serves as

the siphon in each pot, one end in the pot, the other in the pond. To start the siphon, fill the hose completely with water, removing all the air bubbles. Stopper both ends (a paper towel and a thumb work well as a stopper) and place the hose in position, each end below the level of the pond's surface, before removing the stoppers. This allows the water to flow into the pot and the water in the pot and the pond to stay at the same level. As long as the pond is at its proper water level, the bog will maintain its moisture. If the water in the pond drops, chlorinated or well water can be added to it and any detrimental substances will be sufficiently diluted that they will not harm the sphagnum.

If you have a good source of living sphagnum, pack the moss densely on the wet sand, keeping the heads of the moss even. If your source is limited, the live moss can be put through a coarse sieve or screen. Then scatter the pieces over the sand and pack them down. The fragments will grow and should eventually fill in and cover the surface. If the moss stays constantly moist but not soggy you have placed it at the right height above the water level. If not, raise or lower the sand and moss level. As the moss grows, it will wick moisture and grow higher around plants or other objects in the bog.

When the sphagnum is all in place or has grown to cover the sand, other plants can be planted. In one of my bogs, rose pogonias (*Pogonia ophioglossoides*) have multiplied from about a half dozen to well over a hundred blooming stems in just three years in the sphagnum. A tiny *Sarracenia purpurea* went from a half inch tall to a fully mature plant in two years. While not as spectacular in their growth, *Platanthera blephariglottis, P. clavalata,* and *Calopogon pulchellus* have bloomed well and maintained themselves. Pitcher plants do very well, *Sarracenia flava* becoming spectacular with its yellow flowers followed by the bright yellow trumpet leaves. All pitcher plants do very well, blooming and persisting for years, and proving winter hardy here in central Michigan. Some sundews and the Venus' flytraps prosper. Bog bean, *Menyanthes,* will run through the moss and become a pest but is easy to control. (Photos, p. 20)

While these desirable plants do well in the sphagnum, many undesirables do also! Cranberry vines will take over, as do most sedges, which often come in with the sphagnum. Grass, dandelion, sorrel, or just about any seed seems to germinate on the nice wet surface, so constant weeding is necessary.

I made the mistake of planting a small black spruce in the first bog. In three years it grew through the plastic liner at the bottom of the bog, which then would not retain sufficient moisture. The spruce is still in the bog, its roots so far contained in a heavy plastic pail. I had to replace the liner. If you are planning to put a tree in your bog, you may wish to have your liner deeper than 1'.

Animals also appreciate sphagnum. Robins will line their nest with it. Deer will paw it and sometimes in the winter will eat the pitcher plants. Skunks seem to like to dig in it. Hornets build their nests in it. It is attractive, and therefore needs a lot of attention to keep. However, if given good conditions, sphagnum is hard to kill. If the animals dig it out, just replant before it gets too dry, and it will continue to grow.

If you have a pond, construction of a sphagnum bog adjacent is not difficult and the results are very rewarding.

Roberta Case gardens near Saginaw, Michigan. She is a long-time member of ARGS and former president of the Great Lakes Chapter.

Miniature Waterlilies

by Stephen Doonan and Phil Pearson

The incorporation of aquatic plants in a bog or small pool will enhance a garden setting and allow several garden themes to be successfully tied together for greater interest and enjoyment.

Waterlilies belong to a family that is very old—the fossil evidence indicates more than 160 million years old. The multiple flower petals, numerous stamens, and design of the ovary indicate a floristically primitive group of plants. The family is found mostly in warm regions of the earth, but some members have adapted to colder climes. *Nymphaea tetragona* is found as far north as Alaska; *Nymphaea candida* in northern Europe; other genera that survive in ice-covered ponds are *Nelumbo* and *Nuphar*.

The most appealing waterlilies for the small home pool are the miniature hardy varieties. The smaller flowers and leaf size are not overbearing and a well grown specimen plant will merit special attention because of its uniqueness. The leaves are about 2.5" across with flowers ranging from 1-2.5" in diameter.

The variety of small waterlilies available is limited but a few very fine ones are to be found. One is *Nymphaea tetragona* var. *tetragona* from Japan (photo, p. 19). This variety includes especially nice forms of this variable species. The green leaves are 2.5-3" across, and the flowers are very small and pure white with a ring of golden anthers around the central stigma. *Nymphaea tetragona* has only a single crown per plant and does not produce lateral growth points, so that seeds are the usual means of propagation. *Nymphaea tetragona* 'Johann Pring' is another small-sized plant. Its flowers are deep pink with showy orange and pink stamens and the leaves are dark green with purple coloration on the underside. This clone is considered a mutation of *N. tetragona*, but the production of lateral growing points indicates that its parentage goes beyond the pure *N. tetragona*.

Nymphaea 'Pygmaea Helvola' has small, olive-green leaves with mottled purplish spots (photo, p. 18). The miniature, light yellow flowers have bright orange stamens and are produced throughout the summer. This tiny hybrid was supposedly produced from *N. tetragona* and another yellow

species, *N. mexicana* (photo, p. 18). *Nymphaea* 'Pygmaea Helvola' was originated by Joseph Latour-Marliac in 1879. A well grown plant will produce a hundred leaves and dozens of flowers: this is probably the best miniature. Marliac produced many of the currently popular hardy hybrids in the late 1800s, but kept his hybrid parents and methods secret.

Nymphaea 'Aurora' is a small plant with purplish, mottled leaves. The flowers are yellow the first day they open and then pass through orange to red before the flower expires. This hybrid cross was made by Marliac in 1895, and nurseries continue to offer it. Books specializing in waterlilies mention many more small varieties, but sources for plants are difficult to locate.

Most aquatic plants grow where they receive full sunlight. This is a factor for proper culture and must be considered when choosing the location for a pool or bog. Avoid building in the shadow of trees. The real joy of growing waterlilies is to see the bright, colorful flowers floating amongst their leaves and sparkling water. Without sufficient light, waterlilies bloom poorly and only during the brightest month of summer. Given a southern exposure, your pool will receive more light and the water will become warmer sooner, allowing spring growth to commence earlier.

The ideal growing medium for waterlilies is a rich garden loam soil—peat moss is not recommended. Miniature waterlilies can easily be grown in 4-12"-diameter pots for several years without transplanting or division. The soil surface in the pot can be covered with a dressing of gravel to prevent pool fish from stirring the roots out. Fertilizer especially formulated for waterlilies should be used in the early spring and again a month later to promote a robust plant producing a good show of flowers. Fertilizer pellets are pushed down to the pot bottom and will slowly dissolve for root uptake. Bone meal mixed in balls of clay can be placed in the bottom of the pot for slow-release nutriment.

The cold-hardy waterlilies can withstand solid ice on the water surface, but the resting rhizome of the plant must remain in unfrozen water. A pool constructed for waterlilies must be sufficiently deep to permit the water to remain unfrozen in your climate. Recessed pockets at the bottom of the pool, below the ice level of the coldest winter, assure that the water will not freeze. Each waterlily should be planted in a pot or small tub that can be shifted to various positions in the pool or removed completely. During the active growing months, the miniature waterlily should be about 6" below the surface; the level of the crown can be adjusted by elevating the planted pot on an empty, inverted pot at the bottom of the pool. Waterlilies should be returned to the deepest level just prior to freezing weather in autumn. Some growers with shallow pools store waterlilies in their basements or bury them in the ground below frost level through the winter; the roots must not be allowed to dehydrate while dormant.

A pool newly constructed from concrete must be allowed to age a short period of time because the release of harmful chemicals from the curing concrete can kill plants or fish. Change the water in the pool several times to flush toxic chemicals. Test the quality of the water with an inexpensive feeder goldfish: if the fish acts normal and lives for several days, the pool is safe for plants. A pool that incorporates rocks in the construction should use an exterior liner of either concrete or a pool-quality plastic made especially for the purpose. This water-holding pad will prevent loss of water through the seams between the rock and concrete;

it is nearly impossible to prevent water loss otherwise. Pools that have waterfalls flowing into them must be large enough to prevent the waterlily plant from being rocked about by turbulent water. Incorporate a drain in the bottom of your pool and it will be easier to clean. Placing a bench nearby allows you to relax and enjoy your water garden. Leave an easy approach to the water's edge for viewing and maintenance.

Despite the pleasure and enjoyment of a pool, it can have its drawbacks, too. Algae can grow profusely—unicellular algae cloud the water and filamentous algae will snarl any open space. Generally, algal growth occurs for a short period of time each season. It can be controlled by not over-feeding the plants and using algae-eating fish and snails. Fast-growing aquatic plants, such as *Anacharis* or *Myriophyllum*, use excess nitrogen and will help reduce algal problems. Chemicals are available to control algae, but need special attention to their prescribed application and should not be used in very warm water. Other problems are caused by animals. Ducks visiting your pool may eat the new leaves of waterlilies; raccoons may dig in the lily pots looking for food. Fish add interest to the pool and help control mosquito larvae in the summer; however, they must have cover under which to hide or herons, kingfishers, and raccoons will feed on them. Pools are magnets for small children and should be constructed to minimize the hazards of drowning.

Large jardinieres can be used to grow the miniature waterlilies; the expense, maintenance, and space requirements of a micro-aquatic garden are much less than those of a pool. The flowers of waterlilies are pleasantly fragrant and their intricate beauty and detail can be better enjoyed at eye and nose level. In Phil's large glazed stoneware containers (18" across and about 12" deep), lily plants are grown in small plastic pots placed in the bottom of the decorative pot. The water must be flushed periodically to maintain a fresh, appealing appearance. Removal of dead leaves and flowers is easy for the fastidiously neat among us. But dutiful attention must be paid in the fall. Freezing will certainly break a nice container and freeze the lily. The growing pot containing the lily can be managed as mentioned above. The glazed pot must be turned upside down for the winter.

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Perry, Frances. 1981. *The Water Garden*. Van Nostrand Reinhold Company: New York. 176 pp. ISBN 0-442-28259-1.

Aquatic Plant Sources in the USA

Slocum Water Gardens, 1101 Cypress Gardens Road, Winter Haven, Florida 33884-1932. $2 for catalog.

Van Ness Water Gardens, 2460 North Euclid Avenue, Upland, California 91786-1199. $2 for catalog.

William Tricker Inc, PO Box 7843, 7125 Tanglewood Drive, Independence, Ohio 44131. $2 for catalog.

Lilypons Water Garden, PO Box 10, 6800 Lilypons Road, Lilypons, Maryland 21717-0010. $2 for catalog.

Steve Doonan and Phil Pearson are joint owners of Grand Ridge Nursery.

Harbinger of Spring

by Judy Glattstein

It was William Shakespeare who wrote, "What's in a name? That which we call a rose by any other name would smell as sweet." Names carry connotations that influence our perceptions and encourage us to bring subjective opinions to bear on divers topics. Harbinger of Spring. Now there is a name full of promise, suggestive of early flowers before winter's icy grasp is loosed from the land. And indeed, this plant generates heat to melt its way through the frozen ground before the streams are free to rush downhill and birds begin to sing. Yet even its Japanese counterparts, with the cachet of foreign birth, are ignored in our gardens, even those with ideal damp conditions especially suited to their growth. For, cursed with the common name of skunk cabbage, *Symplocarpus foetidus* has all the smelly connotations of mephitic odors and poverty.

I like this plant. The gracefully tapered spathes, mottled rich magenta-brown or in simple green, are the first sign of growth in wintry swamps. Certainly few insects fly at this time of year, and so it does attract carrion beetles as pollinators. The same chill air that discourages insects suppresses the odor, which in any event is down around our ankles, hardly like a 6'-tall lily trying to attract a passing butterfly and spreading staining pollen on our noses when we stop to sniff. The fleshy, thong-like roots are well adapted to the mucky ooze of swamps. Paddle-like, large, green leaves make most hostas appear puny. This is a fit companion for large ferns and grass-like sedges likely to be found in wet areas.

We ignore this species from familiarity, I think, but this does not explain our disdain for its Asiatic relation, *Symplocarpus nipponicus*, with smaller leaves that have a long petiole. Occasionally a variegated form occurs. It flowers after the leaves appear and has a broadly elliptic spathe, tinted deep purple-brown.

Still not good enough? How about the western skunk cabbage, *Lysichiton* (*Lysichitum*) *americanum*? When I first made acquaintance with this handsome relative of *Symplocarpus* and *Arisaema* in 1976, I was enthralled with the glowing golden spathes which loosely wrapped the erect spadix. Graham Stuart Thomas has high praise for this, writing, "They are extraordinarily handsome and form a striking picture, and are followed by enormous paddle-shaped rich green leaves 1.2 m long and 300 mm wide or larger, which remain in beauty till the autumn."

Fine, yellow doesn't fit your garden scheme. You are out all day, slaving to earn sufficient to support the garden, and need flowers that look well as you stagger home at dusk. Just the plant for you, *Lysichiton camtschatcense* is smaller (about 3' x 3' rather than 4' x 6') and has a pure white spathe with pale green spadix, and, supposedly, is sweetly scented. It flowers from May to July on Kamtchatka, Sakhalin, and the Kurile Islands, still early in the year in those northern climes, but late enough for a wider variety of insects. It can hybridize with the preceding species and this cross produces offspring with beautiful, pale, creamy yellow spathes.

All of these species are suitable for those difficult damp places. And if you don't have a damp place, then make one. For these wonderful natives and their foreign cousins deserve a respected place in our gardens. "Rose is a rose is a rose is a rose," said Gertrude Stein. But I say harbinger of spring is a gentler, kinder name than skunk cabbage.

Symplocarpus foetidus J. Glattstein

Calla palustris Fred Case

Lysichiton americanum Fred Case

Nymphaea 'Froebeli' photos by Phil Pearson

Nymphaea 'Pygmaea Helvola' (p.13), and *N. x laydekeri*

Nymphaea mexicana (p. 14)

Nymphaea tetragona v. *tetragona* (p. 13)

Nymphaea tetragona v. *leibergii*

Nymphaea tetragona v. *tetragona*, leaves (p. 13)

Fred and Roberta Case Sphagnum Bog, with *Sarracenia flava* (pp. 11-12)

With *Pogonia* and *Calopogon*

photos by Fred Case

Building a Waterfall

by Ray Radebaugh

An alpine lake with a waterfall is always a popular destination for mountain hikers. A climb to a high peak is exhilarating—the panoramic views at the top give one the feeling of conquering nature—but on the other hand, pausing at an alpine lake and waterfall immediately refreshes and relaxes. Here one feels in tune with nature. The sight and sound of cascading water immediately provide a psychological cooling effect on a hot summer day. A relaxing lunch in such a setting may be the highlight of any vacation. I have many pleasant memories of sitting next to a high mountain stream, listening to the flow of water over rapids or falls. It is this focal point, with its delightful cooling and relaxing qualities, that we as rock gardeners would like to bring to our gardens. Recreating such a pleasing and natural-looking scene in the rock garden, however, may be the the ultimate challenge.

The construction of waterfalls and the associated streams and pools can be fraught with problems and frustrations that can leave the gardener in a state of mind quite opposite to the relaxation conveyed by nature's handiwork. People who have waterfalls in the garden have often been frustrated by having the system leak and by not being able to find or repair the leak. In addition, what begins as a vision of your own crystal clear mountain stream and pool often ends up as a pond choked with greenish brown algal scum. Proper construction techniques and materials can go a long way toward eliminating these problems and making the end result very enjoyable.

About two years ago I built a small pool and series of waterfalls. It serves as a focal point in one part of a shade garden, but the primary reason I built it was to get practice and experience before tackling the much harder task of constructing a pool approximately 10' in diameter that is to be fed by a series of streams, waterfalls, and smaller pools. I strongly recommend that any beginner start with something small—something easy to tear up if it does not work out as desired. From that experience, I learned first hand the frustration of looking for leaks, but I also discovered how to narrow down their location and how some leaks can develop from unexpected causes. I learned what not

to do in the larger pool. One of my most pleasant surprises was how delightful and peaceful a small waterfall can be. The lower pool is only 3' x 2' and a few inches deep. It holds about 10 US gallons (38 L) of water. The upper pool is about 1' diameter and is situated about 3' higher than the lower pool. A small cascading stream connects the two. The primary waterfall into the lower pool drops only 3", but it provides an unmistakeable sound of trickling water that can be heard 50' away in the garden. Its sound is very peaceful. A larger waterfall is not so peaceful, but it is more dramatic.

For many gardeners a small pool and waterfall will be the final goal. Such a feature can be built in a few days and is simple to maintain. My 10-gallon pool can be drained in about two minutes for cleaning purposes. The effort necessary to construct a natural-looking pool and waterfall increases rapidly with increasing size. A pool with 1000 gallons or more can become a major undertaking, but a very satisfying one if done correctly. A pool of this size should be considered a permanent part of the garden and be constructed to last. Costs for materials and equipment can run well over $1000.

Interest in water features in the home garden has grown dramatically in the last ten years, partly because of the availability of new materials that can eliminate many of the associated problems. There is very little published about construction details for natural-looking waterfalls and pools. *The Stapeley Book of Water Gardens* by Stanley Russell is useful reading. There are several construction techniques and materials to choose from. One is not necessarily better than another, each having its own advantages and disadvantages. This field is an evolving science and art, and I would like to hear from anyone who has new ideas and experiences to share. Before anyone can seriously deal with the art of arranging rocks, plants, and moving water in the garden, it is necessary to understand some of the science and engineering that underlie this art. All the engineering details that go into making pools, waterfalls, and streams functional must remain hidden from sight and sound in any system that is to look natural.

Water leaks appear to be the most serious problem with the use of water in a garden. A very small leak can be tolerated, but because it goes on 24 hours a day, a steady stream of a few drops can amount to a lot of water. This water can lead to muddy areas in the garden and it is a waste of a precious resource. If leaking water becomes greater than 2-5% of the water used for irrigation of the garden, then repairs are needed. Yet finding and repairing leaks can be very difficult. Any garden pool should be constructed with the best materials and techniques to prevent all leaks right from the start and to remain leak-free for many years. The new materials that are now available make this job much easier. The three types of pool and stream liners available are: (1) concrete, (2) flexible membrane liners, and (3) molded liners. For many years concrete was the only material used for pools. The results were far from satisfactory unless construction was very carefully done according to rigid specifications. The availability of flexible membrane liners in the last 10 to 20 years has made leak-free construction easier. Concrete is still very useful, but only if used *with* the flexible sheet liners. Using the two together creates a double barrier, decreasing the chance of any leak. If the concrete cracks (and it usually does at some time), the flexible membrane keeps the water from leaking past the crack.

Flexible membrane liners fall into two categories: thermosets and thermoplastics. Without going into a discourse on chemistry, I will simply mention that the thermoset membranes of interest here are vulcanized rubber. They cannot be molded or welded by heat, thus, they are called thermosets. Thermoplastics can be molded and welded by the use of heat. Both types of flexible membranes have been used in lining entire reservoirs. The two types of rubber membranes readily available for use as pool liners are isobutylene isoprene (butyl rubber) and ethylene propylene diene monomer (EPDM rubber). (And we think some botanical names are long!) Butyl rubber is readily available in Europe but more difficult to find in the US. Russell discusses this material in much detail. In the US, EPDM rubber is more readily available. In fact, EPDM rubber is the most widely used single-ply roofing membrane in the US and is available from many roofing contractors. It was developed 30 years ago, by Carlisle SynTec Systems, Carlisle, Pennsylvania. Weathering tests begun at that time indicate a lifetime of at least 30 years. Butyl rubber, also manufactured by Carlisle SynTec Systems, begins to show signs of deteriotation after a few years' exposure to the sun.

Both EPDM and butyl rubber are noted for their high elasticity. They can stretch over 300% before breaking. Tensile strengths of these two membranes are at least 1305 psi (9.0 MPa) for EPDM and 1200 psi (8.3 MPa) for butyl. EPDM and butyl can be purchased in single pieces as large as 50' x 100'. Larger sheets can be made up by splicing pieces together with a rubber contact adhesive made specifically for this purpose. The glue joint must be made very carefully be obtain of sufficient strength.The rubber must be cleaned with lead-free gasoline or a special cleanser made by the manufacturer before applying the adhesive to both surfaces. When the adhesive becomes tack-free (a few minutes) the surfaces are mated together and pressed with a roller to make a good bond. An overlap of about 6" is recommended. The edges of the splice are then protected by covering them with a lap sealant. EPDM rubber is available in thicknesses of 45 mils (0.045" or 1.1 mm) and 60 mils (1.5 mm). Butyl rubber is available only in 60 mils and thicker. A 45 mil sheet should be satisfactory for lining a pool, especially if it is to be covered with either concrete or gravel. In my opinion, the rubber liner should be covered to give the pool a natural look, even though the liner color is black. In clear water the slight wrinkles in the liner are a sure giveaway to man's (or woman's) intervention. If the liner is not to be covered, then the 60 mil grade may be worth the extra investment to insure that no sharp object can accidently puncture it. One should always plan for the unexpected. A pool and waterfall are big attractions to kids. I know from experience that kids can quickly turn to such mischief as throwing stones in the pool or even poking in it with sticks. Because butyl rubber is somewhat more expensive and harder to obtain in the US compared with EPDM rubber, I would not recommend it for use in this country except in special cases. It has no advantages over EPDM for most garden pools. Current prices for roofing-grade EPDM and butyl membrane are listed in Table 1 where they can be compared with prices for other membranes. Carlisle SynTec Systems makes a 45 mil Fish Care EPDM membrane that does not contain a flame-retardent and other toxic chemicals that could leach into the water and kill fish, if the pool is stocked with fish. These chemicals would not be a concern if the membrane is to be covered with gravel

or concrete. Carlisle SynTec Systems should be contacted for the location of the nearest distributor of Fish Care EPDM. Its cost is about 15% higher than roofing grade EPDM. If roofing grade EPDM is to be used uncovered with fish, it should be thoroughly washed and aired out for at least a week before filling the pool with water. For the maximum tear resistance in very special cases, EPDM can also be obtained in a mesh-reinforced grade, known as EPDM R, at considerably higher prices. Such material has little elasticity.

Table 1.
Approximate retail prices for flexible membranes. ($ per square foot)

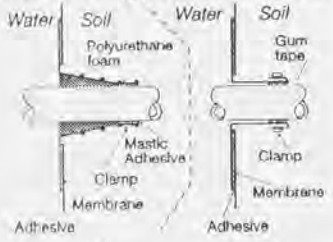
PVC	20 mils	$0.35
PVC	30 mils	$0.45
Hypalon	36 mils	$0.73
EPDM	45 mils	$0.43
Hypalon	45 mils	$0.85
EPDM	60 mils	$0.61
Butyl	60 mils	$0.86

There are two thermoplastic membrane materials suitable for use as pool liners, polyvinyl chloride (PVC), and chlorosulfonated polyethylene (Hypalon). They have greater tensile and tear strengths than do the rubber membranes, so a thinner material may be used to give the same total strength. PVC membrane has a tensile strength of at least 2300 psi (15.9 MPa) and is available in thicknesses of about 20 mils and 30 mils. I would recommend the thicker grade for increased tear and puncture resistance. Like rubber, it will stretch more than 300% before breaking, although recovery to its original length can take several minutes. The color is usually black, but a dark green 32 mil grade, known as Tetra Pond Liner, is available from many local garden supply shops. Because it is a thermoplastic, PVC can be welded together by the use of heat; however, that can be done only at the factory with special equipment. The other bonding method, which can be done in the field as well as in the factory, is by chemical or solvent welding. A special solvent is applied from a squirt bottle to the top of one surface and the other surface is quickly laid on top. The joint is then pressed together with a roller. This solvent-welded joint is as strong as the membrane itself, but the disadvantage is that the joint should not be moved until the solvent completely dries, about 24 hours later. A flat surface, such as a piece of plywood or a concrete driveway, is needed on which to lay the two PVC sheets. PVC membrane is slightly less expensive than rubber membranes. Its one disadvantage is that it will begin to breakdown after a few years' exposure to sunlight. For that reason, PVC should only be used as a pool liner if it is to be covered with gravel or concrete. PVC membrane begins to lose its flexibility at low temperatures. It will become brittle at -20°F (-29°C) and should be worked with only at temperatures above 60°F (16°C). The other thermoplastic membrane material, Hypalon, is trademarked by DuPont and is available only with a polyester scrim reinforcement. As a result, it is very resistant to tearing and it will not stretch. It is black or blue in color and is made in thicknesses of 36 mils and 45 mils. Because of the reinforcement, the 36 mil grade is perfectly satisfactory for nearly all garden pools. Unlike PVC, Hypalon has excellent resistance to weathering and need not be covered, although it will not look very natural. Like PVC, Hypalon is also bonded by solvent welding and by heat welding. A grade suitable for potable water is available and is used uncovered by the US Fish and Wildlife Service for fish hatcheries. The price of Hypalon is higher than that of EPDM rubber or PVC. Both PVC and Hypalon

membranes may be purchased from the Watersaver Company, headquartered in Denver and with regional offices around the country.

The best plumbing arrangement requires pipe penetrations below water level. The penetration of the membrane must be done in a way that is reliably leak-tight. Fortunately, manufacturers of the flexible membranes discussed here make special pipe boots or flashings for just this purpose. For the rubber membranes, either premolded or uncured pipe boots are available The premolded pipe boot has a conical tube attached to a flat disk at one end, as shown in Fig. 1(a). The conical tube is cut off at the proper location to fit over the pipe, but with a rib left at the end for added strength. A single pipe boot may cover the range from 1" (25 mm) up to 2.5" (64 mm). Larger sizes are available. Costs are about $10-15, depending on size. A hole is first cut in the rubber membrane where the pipe is to pass through. The base of the pipe boot is then glued to the membrane on the inside surface with the conical portion projecting toward the soil side, as shown in Fig. 1(a). The pipe is passed through the conical tube which is stretched slightly. The end of the conical tube is rolled back about an inch and a special adhesive or water cut-off mastic is applied to that portion, which is rolled back over the tube. A stainless steel hose clamp is placed around the outside of the glued joint. Because there is a void inside the conical portion, it is advisable to fill it with an expanding polyurethane foam sealant to support the rubber cone from collapsing due to soil pressure on the outside, which in turn would put pressure on the adhesive joint between the boot and the membrane. Soil must be tamped around the outside of the cone to provide a backing before the pool is filled with water. If the pipe boot were to face in the other direction, it might be difficult to gain access to the inside of the cone to fill it with the foam sealant. The other type of rubber pipe boot is an uncured type which can be molded around the pipe after coating it with splicing cement. No clamp is used on that type and there is no void to fill. The PVC and the Hypalon pipe boots are similar to those for EPDM, except the conical tube is replaced with a straight tube as shown in Fig. 1(b). These are made to order by the Watersaver Co. to fit a specified pipe size and cost about $40 for a 90° boot and $50 for a 45° boot. The end of the tubular portion of the boot should be cut to the desired length and then rolled back a little to form a cuff before inserting the pipe. Gum tape is wrapped around the pipe before sliding the pipe into final position with the tape under the area of the cuff. A stainless steel hose clamp makes the final seal as shown in Fig. 1(b). Be sure to back fill with soil to support against the water pressure inside the pipe boot. In some cases it may be desirable to have the pipe boot face in the direction of the water, still with the adhesive joint on the water side. The boot can be covered with gravel or concrete.

Figure 1 Pipe Boots for (a) EPDM & (b) PVC and Hypalon membrane



Although concrete has been used for many years as a waterproof liner for pools and streams, it has two problems: its susceptibility to cracking and its unnatural look. Unless highly reinforced

and properly cured, concrete may eventually crack, especially if the soil base is not fully compacted. Expansive soils, like bentonite clay, would certainly be a problem. The rigid nature of concrete means that expansion joints are needed for long stream runs to compensate for a difference in thermal expansion between concrete and the soil base. Because of these problems, concrete should not be considered a leak-free liner unless the design and construction is supervised by a professional concrete expert. *Fountains and Pools*, by C. Douglas Aurand, presents a comprehensive set of construction guidelines and specifications for using concrete as a pool liner. However, his emphasis is on formal pools.

I recommend the use of concrete only in conjunction with one of the flexible membrane liners. The concrete forms a protective layer over the membrane to prevent any puncture from sharp objects. Large rocks of several tons can be placed on top of this concrete liner. Unlike a gravel protective layer, concrete can be used on vertical surfaces and can be cleaned easily by a periodic water-vacuum. However, it is just as unnatural looking as a membrane liner with wrinkles. But concrete can be made to look much like natural rock or soil by the use of special concrete dyes and some artistic shaping. Some or all of the concrete can also be covered by natural rock or gravel. A concrete liner in a large pool becomes a permanent structure that can only be removed with jack hammers, so the design of the pool and stream must be well thought out before the concrete is poured.

For a very small pool and stream, I prefer to use a high-strength stucco or plaster reinforced with glass-fiber. Its composition by volume is: 1 part Portland cement, 1 part masonary cement, 4 parts masonary sand, and 1/2 part chopped glass-fiber. Instead of adding water, a latex masonary additive can be used full strength or diluted 1:1 with water. The glass fiber used in this mix should be an alkali-resistant grade that can be purchased from most concrete suppliers. The glass fiber and the latex additive improve the tensile strength to the point where a thickness of 1-2" is sufficient for a pool less than about 3' in diameter or a stream a few inches wide. This thinner covering makes it easier to work with and to fit into small areas. The surface of this stucco has a 'hairy' texture because of the glass fibers. It can be left this way or covered with a layer of the same stucco that does not have the glass fiber. Concrete colors can be mixed in to give a natural look. The cost of the glass fiber and the latex additive makes the high strength stucco described here too expensive for large pools. However, the cost can be reduced, with some sacrifice in strength, by diluting the additive to 1:4 with water and reducing the amount of glass fiber to 1 lb per 90 lb of Portland cement. For larger structures, a true concrete should be used that has the following mix: 1 part Portland cement, 2 parts sand, and 3 parts coarse aggregate (crushed stone, 3/4" maximum size). Glass fiber can be added to the mix to increase its resistance to cracking, if desired. After thoroughly mixing the dry ingredients, clean water is added to give a maximum water/cement ratio of 0.5 by weight (5.5 gal per 90 lb bag). As the water content of the mix increases, the permeability of the concrete increases and the compressive strength decreases. With these conditions, the probable compressive strength after 28 days is 4000 psi (28 MPa). To improve tensile strength and to reduce the likelihood of cracking due to temperature changes, reinforcement in the form of rebar or welded wire fabric (WWF) is recommended. The concrete should be at least

6" (152 mm) thick with the metal reinforcement covered by at least 2" to protect it from corrosion. Extreme caution needs to be exercised when placing the steel reinforcement on top of the flexible membrane liner to prevent puncturing it. As a safety precaution a 1-2" plaster coating could be applied to the liner first. Dry concrete colors can be mixed in with the dry concrete ingredients before adding water if a uniform color is desired. Blending of various colors is best done by mixing up several batches of colored plaster or stucco and applying these as a 1-2" coating on the damp concrete about 24 hours later. Some practice batches should be done first to achieve the desired color, which is lighter after drying. Darker colors hide the concrete look better than light colors do. The color should be similar to that of the stone used in and near the pool. Colors such as black, brown, red, and orange are most useful and can be mixed together. Unless one becomes very good at this concrete coloring and texturing, it is best to have this exposed concrete covered by several inches of water to partially obscure the results.

The pouring of concrete can either be done by mixing up small batches at a time with a portable concrete mixer or ordering premixed concrete. When an entire truckload is delivered at one time, finishing must be done quickly and extra help is required. For high vertical walls the use of gunite (a sprayed, stiff concrete mix) is often advisable. However, be prepared to pay at least $3000 for bringing in the equipment and personnel to do this job after the site is already prepared. For pools significantly larger than 10' in diameter the cost will increase. By comparison, the cost of premixed concrete for the same size pool about 2' deep would be about $165 at a price of $63 per cubic yard. A 30 mil PVC liner for the pool would be about 15' x 15' and cost about $100. Proper curing of concrete or stucco is important to reduce the liklihood of cracking. Concrete generates a lot of heat when it cures, so all concrete pouring should be done during cool weather. The concrete needs to be kept moist for at least a week by covering it with burlap that is periodically sprayed with water.

Gravel is a common covering for the flexible membrane liners. It should not contain any sharp stones in the part next to the liner. It should be well washed and not contain any fine sand or soil. If a sandy beach is desired at one end of the pool, be sure the sand is well washed before it is put in the pool. It may be difficult to maintain a beach clean and free of algae without periodically changing the sand. If soil is desired for water plants, it is best to cover it with several inches of stone chips to keep it from dispersing into the water. Often soil is confined to pots to help keep the pool bottom clean. Rather steep side walls can be covered by including some large stones in the gravel or building a retaining wall a few inches or more away from the liner and backfilling with gravel. In essence, an underwater rock garden is constructed on top of the liner material. Pots containing water plants can then be plunged into the gravel and taken out without getting much soil into the water. For large pools, a gravel depth of about 6" should be used. That extra depth needs to be considered when excavating for the pool. Gravel in the stream bed may be redistributed by the flowing water and waterfalls. Sand or small stone chips are easily carried away by moving water. Gravel cannot be used as a base to build up a waterfall with various rocks since the water would flow through the gravel underneath the rocks. Only concrete, or

rocks and mortar can be used in these locations where a nearly leak-free seal to the liner is required.

Rigid liners premolded at the factory into an informal pool and a series of waterfalls are readily available at garden supply stores. They are usually made of high density polyethylene or a fiberglass/polyester resin composite. The ground must be dug out to fit these liners quite well since they do not have much give in them. Any gap between the hole and the liner should be backfilled with sand to provide good support. These molded liners make the task of installing a pool and waterfall quite simple, but the end result is very artificial-looking unless rocks and plants are used to hide the liner surface. There is not much room for creativity with this approach.

The growth of algae in garden pools is as serious a problem as leak-free construction. For large pools where the water depth is greater than 3' the problem is diminished considerably. However, most pools in private gardens will not be that large. Many gardeners try to simulate a pool and stream from an alpine setting where the water runs crystal clear, but after a few months of hot summer weather the pool turns into a dismal swamp. Why does that happen in the garden and not in nature? The higher temperatures encountered in the garden speed up the process of algal reproduction. In the mountains, the water begins as melting snow. As it flows down from the mountains, it begins to warm up, but if we assume the water flows at an average speed of 5 mph (8 km/hr), then after one week, the water will have traveled 840 miles (1352 km). At that time the water is probably in the ocean or in a very large river where algae are slow to grow. After one week and even several months in a garden pool, the water is still there and being warmed by the sun (assuming that a garden pool and waterfall use recirculating water since very few of us are blessed with a natural stream in our backyards). Algae prefer to grow in still water with a low oxygen content. Recirculating the water over waterfalls and rapids keeps the water moving and enriches it with oxygen. Thus, the waterfalls help to reduce the algae growth—but they will not stop it.

There are three control methods for inhibiting algae growth in a garden pool. Biological control relies on the use of water plants to create more dissolved oxygen in the water and the use of algae-eating fish. A delicate ecological balance exists in such a system, which is not easy to maintain. The end result may include a certain amount of algae, so crystal-clear water is rarely achieved, which may be perfectly satisfactory for many, especially if a lower elevation pond is being modeled. Crystal-clear water can only be obtained by using a chemical control. Swimming pool chemicals, such as chlorine, do keep the water clear, but also make the water unfit for growing either fish or plants. Less potent algicides vary in strength; some harm only fish, some harm neither plants nor fish. Swimming pool supply stores often carry several types. If fish are not put in the pool, stronger algicides can be used.

Filtration is of debatable effectiveness in reducing algae. I have not experimented enough with it myself to be able to draw any conclusions at this time nor have I heard of definitive experiments by others. In principle, if algae begin to form in the water, they can be filtered out, as long as the algae pass through the pump and into the filter. Whether this actually occurs in practice is open to question.

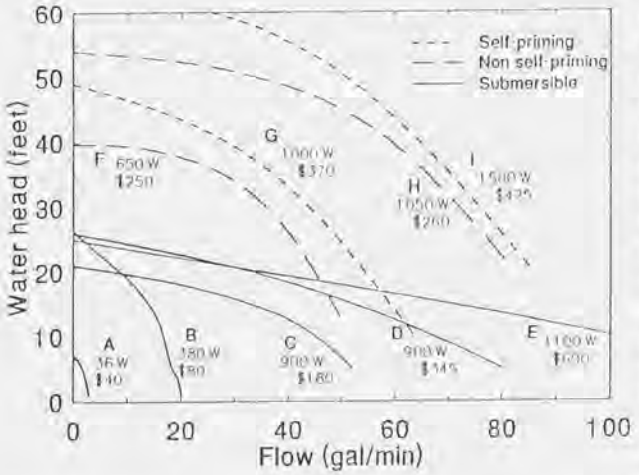
Our goal is to effectively move water from the lower pool up to the starting point of the waterfalls in a way that is

competely hidden, so that the water course looks entirely natural and becomes an integral part of the garden.

There are three types of pumps that can be used for recirculating water: (1) submersible, (2) non-self-priming, and (3) self-priming. As the name implies the submersible pumps can be completed submerged in the water. The electric motor and the power cord are sealed to keep water out. A hose or pipe is attached to the outlet and directed to the start of the waterfalls. The intake on these pumps is usually on the bottom, protected by a screen. The largest US manufacturer of submersible pumps is the Little Giant Pump Co. in Oklahoma City. The smaller models are readily available in garden centers and hardware stores. Larger size submersible pumps, available from pump distributors, are made in three different versions: sump pumps, effluent pumps, and sewage pumps. The main difference is in the size of solids they can handle. The screen on the sump pumps limits the size of solid to about 1/8" diameter. This screen also reduces the flow rate somewhat in large sizes of pumps. The effluent and sewage pumps can handle larger solids and have somewhat higher flow rates for the same size pump compared to the sump pumps. The non-self-priming and the self-priming pumps are centrifugal pumps, like the others, but they cannot be submersed in water. They must have an intake pipe leading from the pool to the pump inlet. The non-self-priming pumps must have the pump inlet lower than the water level in order to maintain water in the pump and to begin pumping. The self-priming pumps can be placed higher than the water level since they are able to suck the water up to the pump even when they are dry. These latter two types of pumps are used as swimming pool and spa pumps.

Figure 2 shows representative pump performance curves for the three types of pumps. For the smaller submersible pumps there are many sizes between those shown in the figure. The lower set of curves for the non-self-priming and the self-priming pumps represents the smallest size pump of these types generally available. Pumps larger than those indicated here are available, but for flows greater than about 100 gal/min (379 L/min), professional contractors should be consulted. The electrical power input required to operate each of these pumps is indicated. For power less than about 1500 W, a 115 V line can be used, whereas for power greater than about 1500 W a 230 V line should be used. These power inputs are useful for determining the operating cost of the pump. In the Denver area, where the cost of residential electric power is about $0.083/kWh, a 1000 W pump will cost about $60 per month to operate 24 hours a day. For economic reasons, it may be desirable to have the pump connected to a timer so that it operates for only part of each day. Another option is to have a smaller pump operating continuously to provide filtration and some waterfall action. The larger pump can be turned on for special occasions to provide for a more dramatic waterfall. Pump B in Fig. 2 would be excellent for the smaller pump in a large pool because of its relatively high head needed for filtration. In order to gauge the effect created by various flow rates, it is best to observe existing waterfalls and to do some experimenting. Flow rates up to about 10 gal/min can be achieved from a garden hose. The recently reconstructed rock garden at the New York Botanical Garden has a waterfall pictured in a recent issue of the Bulletin of the ARGS (Vol. 49(2):117, 1991). The pump for this waterfall is 4 horsepower, which can handle about 250

Figure 2 Pump Performance Curves



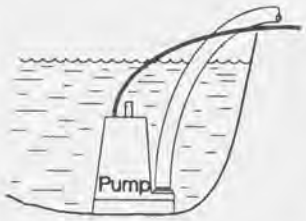
gal/min. The flow rate of the waterfall in the Rock Alpine Garden of the Denver Botanic Gardens is about 165 gal/min. The large waterfall in the Perennial Garden of the Vail Alpine Gardens has a flow rate of 250 gal/min, whereas the spring in the Woodland Garden has a flow rate of about 15 gal/min. For large flow rates, it would be best to rent a pump to determine the best size before purchasing one. For my small pool and waterfall discussed earlier I use the pump A indicated in Fig. 2 which has a flow rate of 2.5 gal/min with a 2' head.

Submersible pumps are designed to handle large flow rates but with low heads. Except for very small sizes, they are able to pump up to about 20', which is usually satisfactory for residential waterfalls. For higher heads, swimming pool pumps, either non-self-priming or self-priming, must be used. One advantage of submersible pumps is that they cannot be heard while running. Swimming pool pumps produce a whining or humming sound that becomes particularly loud when the bearings and seals begin to wear. I am able to hear my neighbor's swimming pool pump quite easily when it is operating. Such pumps should be placed in a pit below ground level with a heavy cover to muffle the sound. Another advantage of submersible pumps is that they require a little less power to operate at a given flow rate for heads less than about 10'. The advantage of self-priming pumps is that they can completely pump out a pool even with the pump located above the pool level, and they have rather high heads. Both submersible pumps and the two types of swimming pool pumps should last several years with continous summer operation. When they fail, submersible pumps must be replaced entirely, whereas swimming pool pumps can be rebuilt.

A swimming pool pump can be placed anywhere outside the pool in a location where it may be hidden. It is best to keep the inlet pipe as short as possible, but lengths of 10-20' are not unreasonable. The outlet pipe can be somewhat longer, but still it is best to minimize the length of pipe because the pressure drop in the pipe reduces the flow rate of the pump. For submersible pumps there are several options for location. The simplest method is to place the pump in the bottom of the pool as shown by Fig. 3. The electric cord plugs into a nearby outlet and the outlet tube or pipe runs up to the head end of the waterfall. One disadvantage with this placement is that the pump is visible

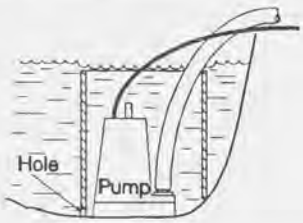
unless hidden by rocks. These rocks need to be moved when the pump is taken out in the winter. The color of most of these pumps is light blue, very visible even when in a deep crevice. Some of the smaller pumps are now available in black, which is not so visible. Another disadvantage with this placement is that all the intake to the pump comes from the bottom of the pool. As a result, floating objects, such as leaves, seeds, small insects, mosquito larvae, etc., remain on the surface of the pool and give it a rather unsightly look. What is needed is a means to intake some of the surface water to the pump. This is known as skimming. Figure 4 shows an easy method for incorporating skimming. Here the pump is placed inside a sump made from a bucket or a tube with the top edge of the sump just below the level of the water. As the pump removes the water within the sump, more flows in over the edge. The water level inside the sump is slightly lower than that in the rest of the pool, so floating debris collects in the sump and should be removed periodically. There should also be a small hole at the bottom of the sump to allow the pump to intake some water from the bottom of the pool where the amount of dissolved oxygen may be less. Approximately 25-50% of the water intake should come from the bottom of the pool. The bottom intake is also needed for more reliable operation. If leaves partially block the skimming action and reduce the flow over the lip, the entire contents of the sump are quickly emptied and the pump runs dry, causing damage to the pump. The result is the same if the water level in the pool happens to be reduced slightly. The lower intake hole stabilizes the water level in the sump and prevents it from emptying unless that intake plugs at the same time. If the upper intake becomes blocked by leaves, the water level in the sump begins to lower, but as it does so the increased head difference causes an increased flow rate through the lower intake hole. The water level in the sump will not decrease any further in this case. As an added safety measure, it is advisable to use a pump with an automatic shutoff in case the water level gets too low.

Figure 3
Pump location in pool



The arrangement shown in Fig. 4 still has the problem of an unsightly sump filled with a pump, an electrical cord, and an outlet tube. Figure 5 shows a somewhat better arrangement where the sump was created in one corner of the pool by a concrete liner. The concrete can even be extended above the water line and a cover placed over the sump as shown by the dashed lines in Fig. 5. The upper intake to the sump is through a slot at water level. Needless to say, the concrete facing the pool needs to be colored and textured or hidden with rocks. Unfortunately,

Figure 4 Simple Skimmer with Pump

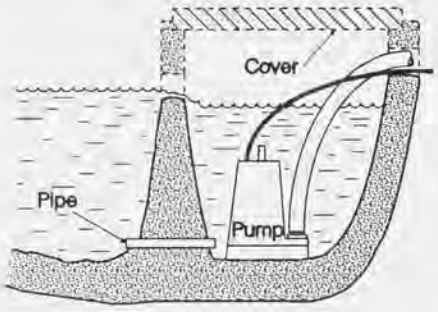


the arrangement in Fig. 5 requires a cover right at the edge of the pool, in an area which is valuable real estate in terms of aesthetics. The cover could be hidden with an artificial rock made from

expanding polyurethane foam covered with a plaster layer textured and colored to look like rock.

For a small pool of 10-100 gal, a simple arrangement shown in Fig. 6 is satisfactory. Here 1.5" black ABS plastic pipe and a tee fitting form the skimmer and the lower intake. The upright tube that forms the skimmer need not be glued into the tee. A strainer for the two

Figure 5 Built-in Concrete Skimmer & Sump with Cover



inlets is made by cutting a disk with scissors from the soft plastic strainer material made by the Little Giant Pump Co. These disks are made to be a snug fit inside the tee and seat against stops inside the tee. A few well-placed rocks hide this relatively small skimmer and lower intake. I have used this arrangement in my small pool and have found it to work very well. The intake from the pool leads to a small sump, which can be made from 6-8" PVC pipe, depending on the size of pump used. This sump can be placed several feet from the pool and the cover hidden by rocks or plants.

Evaporation on a hot summer day can lower the water level in the pool fast enough that it bcomes necessary to add water at least every few days. The action of the skimmer depends upon a water level that must remain constant to within about 1/2". Maintaining this level manually would be a tedious chore. In addition, provision must be made to prevent the water level from getting too high after a hard rain, because with too high a water level the skimmer does not perform as well. Figure 6 shows one method for controlling the water level that works especially well for a small pool. Here water slowly drips from a copper water supply line and runs into the pool. This water can be run through a moraine, if desired, with the excess water running into the pool. For a discussion of moraines, see the *Bulletin of the ARGS*, Vol. 48(4):285-296, 1990). The flow rate is adjusted by a stainless steel (not brass) needle valve such that there is slightly more water coming in than is lost by evaporation on a hot day. The excess water then runs into the overflow pipe and into the drain line. An inspection port above the drain line is useful for observing and minimizing the rate of water flow.

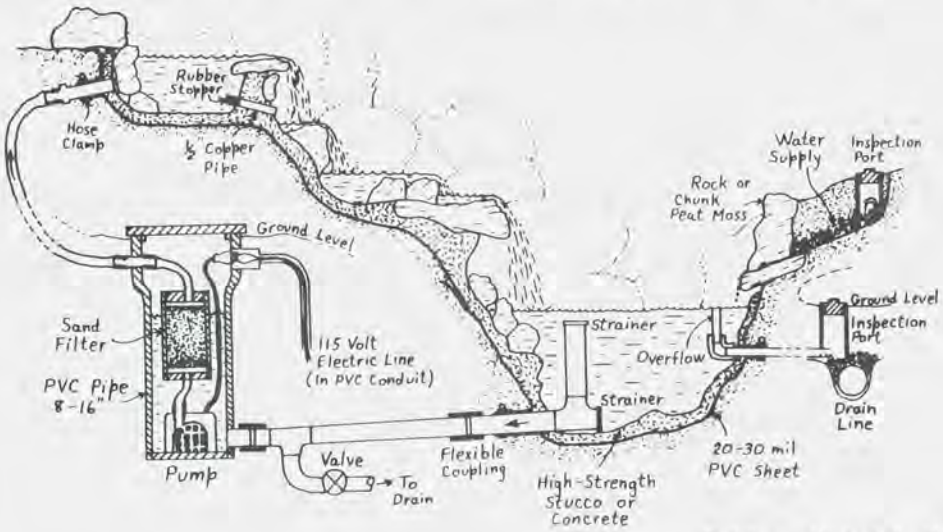
For larger pools, where the change in evaporation rate from day to day will be greater, a float valve may be used to control the water level.

In moving water from the pool to the pump and from the pump to the start of the waterfall, it is necessary to use sufficiently large pipes to be able to handle the flow without excessive pressure drops or head loss.

The first step in constructing a water garden is to spend time planning it well. To look natural, the main pool should be located in a low spot in the garden. The main focal point will be a view across the pool to a stream and waterfall entering the pool from the opposite side. That view needs to be chosen carefully to look natural and have no distracting objects. In nature, streams enter a pool or lake through a valley. For that reason a garden stream should appear to be coming down a valley or canyon. Even the origin of a mountain

stream, such as an alpine lake, is at a relative low point compared with the surrounding mountains. Thus the garden stream should not be originating from the high point behind the pool. It is not uncommon to see water gardens made by digging out dirt for the main pool and then forming a mound with this dirt next to the pool. Next a volcano is formed by carving out a small crater in the center of this mound. The crater is filled with water. The stream coming down the side of the mound would look better if it were lava instead of water! This artificial look can be avoided by remembering to develop a valley. As in nature, this valley should have curves and bends. A second waterfall near the origin of the stream adds further interest and depth to the main vantage point across the main pool. From that main vantage point, the two waterfalls should not be lined up with each other, but rather they should be offset somewhat and be at different angles. Interesting rocks from the field or from a local supplier of garden rocks should be gathered, to be placed alongside and in the stream and pool. These rocks should look like they have been water eroded for millions of years. Avoid using rocks all of the same size and don't be afraid to use some rather large ones that require much help from friends or even a crane to move them into place. The sight of a large rock partially submerged by water in a stream can be very appealing and ensure a natural look. However, such a large rock in the stream bed must be planned for when constructing the stream bed. That is why these rocks should be gathered before constructing the water garden. Also a waterfall may be formed as a stream flows between two large rocks and has its path partially blocked by these and other smaller rocks, as indicated in Fig. 7. These two large rocks present the image of a valley or ravine where water woud naturally flow. Again, because they are part of the stream bed, its construction must take them into account by making the channel formed with the flexible membrane liner and a concrete liner wide enough and deep enough to

Figure 6 Cross-section of entire waterflow system for small pools



accommodate these large rocks. Once the overall plan is finalized, construction can begin. Fine details of the stream bed and waterfalls can only be dealt with during the construction phase.

In excavating for the pool and the stream bed it is useful to stop temporarily at the point where the water level is planned. Various views can be checked, with some good imagination, to get an idea of how the finished product will appear. Some adjustments to the planned water level may be done at this time. Excavation then continues down to the bottom of the stream and pool. Be sure that there are steps on the pool sides for holding rocks or plants. When satisfied with those, more digging is neccessary to provide for the thickness of the concrete or gravel liner and for a 1-2" sand bed below the flexible liner. Holes and trenches for the sump and pipes are dug at this time also. The sand bed is then put in, with moist sand being used for steep walls. Wet newspapers can be built up to about 1/2" along the steep side walls to hold the sand. Panels of the flexible membrane liner and all pipe boots shoud be glued at this same time and the corresponding pipe pieces inserted and clamped. Rubber pipe caps are temporarily clamped onto the inside end of the pipes. Next, the liner is moved into position and lowered into the excavation with pipes being supported by soil. The hole should be filled with the liner in a relaxed state to prevent undue stretching with a resultant loss in strength. The liner is then filled with water and the pressure of the water forces the liner into position against the sand and soil backing. Be sure the pipes are located properly in their trenches. If not, the trench can be altered or the water pumped out and the liner moved appropriately. Once the proper position is obtained and the liner is filled with water, it should be allowed to sit for a day or more so that any leaks may be observed. Water can be pumped up to the start of the stream and allowed to run down the liner and back into the pool to check that for leaks also. It is difficult to check the complete stream bed at this time since the dams for the waterfalls are not in place. Some temporary dams made of clay could be used if there is any doubt about the integrity of the liner, particularly at any seams. At this point the liner should be extending beyond its desired location in all directions. It is tempting to remove most of that excess at this time, but it should be left on for now unless absurdly in excess. It is easy to get into problems in the stream bed with not enough liner to go above the water level after the dams and waterfalls are put in place. The pipes extending through the liner can now be attached to the skimmer, sump, and overflow line. These components are filled with water and checked for leaks. Temporary caps can be taken off the pipes, and with a pump in the sump the entire system can be operated in a recirculating mode. If the water level remains constant with the water supply turned off (except for a slow loss due to evaporation), then it is time to proceed.

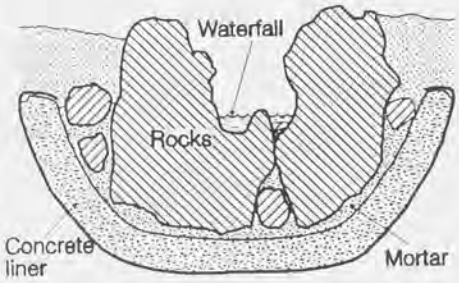
Either a gravel or a concrete liner is now placed in the pool. Rocks can be used as a retaining wall, and backfilled with gravel or concrete, by placing them on the gravel floor or a partially cured concrete floor. The concrete lining need of the streambed need only follow the average grade of the stream at this time with consideration for the large rocks that will be sitting on top of this base. The concrete walls must always extend above the water line. Some preliminary water dams can be incorporated into this base as shown by the cross section in Fig. 6. Rocks that are to be in the stream bed are put in place on the concrete using mortar to block the flow of water underneath the

rock and around the outsides. Figure 8 shows a cross-section of rock placement for the waterfalls shown in Fig. 7.

The next step in building small pools and waterfalls along the stream bed is one of the most challenging and interesting tasks in waterfall construction. Up until this time, we have only had an approximate idea of how we want the waterfall to look. When water actually starts to flow over the rock, we may end up with a somewhat different waterfall than what we had planned. The hope is that it will be something that we want. We begin by placing various rocks in the path of the flowing water to further dam it. At this point most of the water will flow underneath and between the rocks. These bypass channels need to be filled up to force the water to go over the top. A colored mortar is used for this sealing, but nevertheless, it should be placed where it is not easily seen. Other rocks can be placed in front of the mortar to hide it. Drain tubes as shown in Fig. 6 should be incorporated at the base of these dams and plugged with rubber stoppers. Once the mortar has dried but has not fully set, the pump is turned on to produce water flow over the falls. If the result is not satisfactory, the mortar joints can still be broken apart and the construction altered. It would be very useful to have a clay-like material that could be used to temporarily seal gaps between the rocks while trying out different arrangements. This material should mold to the rocks but not stick very well, so that the rocks can be easily pulled apart and moved around. The problem with using clay soil for this is that it quickly muddies the water, requiring that the pool be thoroughly cleaned afterward. Any suggestions for a good temporary seal material? When building a small waterfall the underside of the lip should slope back up to force the water to break loose from the lip which otherwise will cling to the rock because of surface tension. Alternatively, a groove can be cut below the lip or a sharp ridge of plaster placed below the lip to break the water flow along the rock surface. While in the process of building the waterfalls, one could also put in a small island along the stream with gravel below the water level and soil above.

Fig. 7 Split Style with bi-level right fall

Figure 8 Cross section of above, showing tight seal required



When all the stream bed and the waterfalls are completed and there still are no leaks, it is then time to trim off most of the excess liner material. Do not cut it flush with the concrete liner! If the concrete cracks and develops a leak, there will be a layer of water between the concrete and the flexible liner that can wick into any soil that might cover the edge of the liner. In

addition, even though the liner may be above the level of water flowing past it, the water level upstream may be higher than the edge of the liner and be able to create a miniature artesian well with water slowly seeping out of the joint between the concrete and the liner. The best way to treat the edge is to have a groove formed in the concrete next to the liner while the concrete is still wet. The liner is then folded over the top of the concrete and trimmed off at the inside edge of the concrete. When rocks or soil are placed over the liner to hide it, there will be a small channel under the liner to carry away the water. Making a natural-looking boundary to the pool and covering the end of the liner is always a difficult job. An edging all around the pool made with flagstone looks very artificial, as does an edging made with irregular shaped rocks all of the same size. Large rocks are used along the edges to hide both the inside of the concrete lining and the top edge. An alternate technique would be to replace the top rock with a backfilling of gravel covered by good rock garden soil. Because of the capillary action of gravel and sand, the liner needs to be extended some distance above the pool edge.

One of the easiest types of waterfall to construct is the weir type, in which water flows from a stream over a flat rock to give a wide and uniform fall. Usually this type of waterfall is aligned with the flow direction of the stream. To add more interest, the waterfall could be turned at a slightly different angle. By using an unevenly shaped rock for the spillway, the waterfall can be split into separate falls. By varying the shape of the edge, a concave or horseshoe fall can be created, which is always interesting. Instead of having a single fall from top to bottom, one can break the height into two falls, especially attractive when the water flows in different directions for each set of falls as in the photograph on page 39. These types can be combined for even more interest. In Fig. 7 and in the photograph on page 40 a single fall is combined with a double fall that has direction change. In the split falls, the island created between them can be planted with ferns or other moisture-loving plants to create a more natural look. The waterfall shown on page 38 provides an excellent model for the construction of attractive waterfalls and the incorporation of plants close to the water. The construction of waterfalls is very rewarding, and I see it as a new art form for artistic creativity.

Acknowledgements

I wish to thank the following people for valuable discussions and useful information: Marty Jones of Colorado Alpines and Vail Alpine Gardens; Dave Vader of Watersaver Company, Inc.; and Tim Eorgan of Carlisle SynTec Systems.

Sources

Carlisle SynTec Systems, PO Box 7000, Carlisle, PA 17013 (717)245-7000
Hayward Pool Products, Inc., 900 Fairmont Ave., Elizabeth, NJ 07207 (201)351-5400.
Little Giant Pump Company, 3810 N. Tulsa, Oklahoma City, OK 73112 (405)947-2511.
Watersaver Company, Inc., PO Box 16465, Denver, CO 80216 (303)289-1818

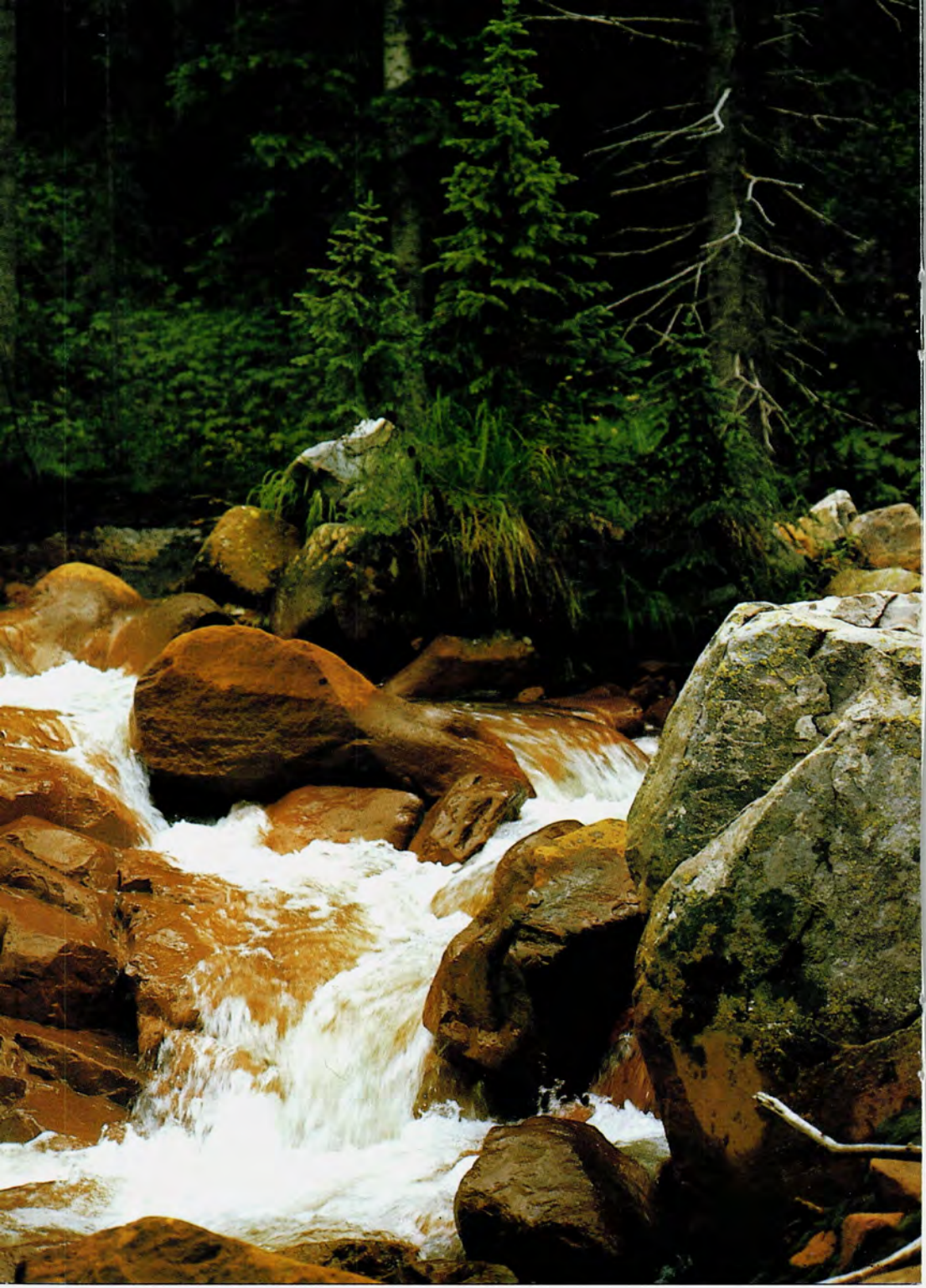
Ray Radebaugh has been rock gardening for about 20 years and enjoys incorporating his scientific and engineering training into the garden. He is in the process of constructing a large rock garden at his home in Louisville, Colorado, including several moraines, pools, and waterfalls. He is a founding member of the Rocky Mountain Chapter of the ARGS. Figures by the author.

Mimulus cardinalis, Deer Creek Falls,
Grand Canyon National Park, Arizona

Waterfall on Deer Creek, with *Adiantum capillaris-veneris*

photos by Loraine Yeatts

Waterfall at Forest Lake



Falls at Rock Creek, just above Vallecito Creek,
San Juan Mountains, Colorado

Loraine Yeatts

Sarracenia jonesii (p. 4)

Sarracenia alabamensis (p. 4)

photos by L. Mellichamp

Sarracenia leucophylla (pp. 4, 5)

Sarracenia leucophylla

Sarracenia "Blackankle" (p. 8)

Sarracenia "Blackankle"

Sarracenia "Snorkel" (p. 10)

Sarracenia flava,
selection and photo by C. Bramblett (p. 6)

Sarracenia "Tattletale Delegation" (p. 8)

Sarracenia "Anxious Debate" (p. 8)

photos by L. Mellichamp

Sarracenia "Oke Giant" at Case's (p. 4)

Sarracenia x catesbaei (p. 4)

Sarracenia minor (p. 4)

Sarracenia alata flower

photos by L. Mellichamp

Sarracenia flava (p. 5)

Sarracenia flava in habitat

Bog Gardens and Bog Plants

by Frederick W. Case, Jr.

Bog gardens form a natural adjunct to an alpine rock garden. Alpine lake shores frequently harbor boggy, mossy, peaty sites filled with interesting plants. On the west side of the Beartooth Highway just above timberline is a series of such small ponds and lakes ringed with huge boulders and outcroppings and filled with wondrous natural gardens. Bogs also occur in boreal lowlands, among the mountains of the East, on the coastal plains, and in the non-arid interior of America. Rocks, bogs, pools, and wildflowers, in Nature, all blend together into an harmonious whole. Why not also in the garden?

If you desire to grow bog plants, some decisions become necessary. First, how much work do you want to do? Many of the commoner and less specialized bog plants will grow quite easily in merely moist soil with little time invested. More specialized (and sometimes the most spectacular or unusual) bog plants require rather exacting soils. Some demand full sun, others much shade. Growing them can be a lot of work, but the results can be absolutely breathtakingly beautiful.

Secondly, where will the bog garden go? Proper placement of a bog garden in relation to other garden features greatly enhances the garden's effectiveness. In my opinion, placement of bogs, ponds, and rock outcrops should look geologically authentic. Ponds and bogs typically occur in the lowest part of the landscape or in locations obviously dammed in some way by rocks or soil. In the small home garden, watercourses or waterfalls should not erupt from a volcano-like hump near the pond, but should emerge from a pile of rocks or from behind foliage in a natural way. Plants used in these gardens need not be restricted to species that grow together in the wild, but all should be natural bog or waterside vegetation at least somewhere in their natural ranges.

Plants require proper light for adequate food production if they are to prosper and flower. The amount required depends upon the species, its native latitude, and length of season, and whether the climate is predominantly sunny or cloudy. In the northern United States and Canada, most of the bog plants discussed here will need a

minimum of four hours of full sunlight per day. Placement of the bog garden must take available light into account as it occurs during the entire growing season.

Once committed to an in-depth bog garden planting, soil preparation becomes a major project. Many of the most spectacular bog plants require a nutritionally sterile, acid substrate free from the competition of surrounding plants. Current studies suggest that many of these bog plants are poisoned by the presence of free metal ions, particularly those of phosphorus, boron, copper, and zinc. These components become most available to plants at soil pHs in the circumneutral range. Many orchids, pitcher plants, droseras, Venus'-flytraps, and heathers and other ericaceous plants do not grow in neutral soils naturally. To grow them in the garden first requires that you prepare a suitable acid soil bed.

If you visit a bog, with its quaking, sodden soils, and see heaths, orchids, sundews, and pitcher plants in abundance, you might conclude that water is a major requirement of these plants. Surprisingly, although some water is required, many bog plants show biological adaptations for near-desert dryness! Furthermore, many of these plants, farther north in their ranges or on high mountains, emerge from bogs onto drier upland peaty soils. It is the cool soil temperature provided by constant evaporation of water and low groundwater temperatures, coupled with freedom from competition with other more aggressive plants, that limits successful establishment of their seedlings to bogs in the more southern parts of their ranges. Therefore, if you provide the correct type of soil, you can usually grow these plants with considerably less water. This is desirable, for peat and leaf-mold in confined, unnatural situations can rot too rapidly, badly sour the soil, and smell foul. In the ensuing conditions, prized plants will die.

For carnivorous plants, hardy bog orchids, and the smaller ericaceous plants, either a sand-peat bed or a bed of living sphagnum moss provides ideal conditions. A healthy sphagnum bed cannot be beat, not only because certain highly desirable plants thrive and proliferate, but because the beauty of the sphagnum adds charm to the garden. (See pp. 11-12 for details.) A sand-peat bed is easier to construct, and wet or dry, it grows many choice plants as well. After selecting the area for the bog, excavate the existing soil to a depth of at least 10", more if you will be growing larger woody plants. Line the excavation with a heavy plastic sheet—I prefer to use black plastic if possible, at least 6-8 mil for lasting quality. An alternative would be to sink a child's plastic wading pool into the ground. A bog liner needs to have some drainage holes in it, or it will stay too wet and the soil will sour. Punch a few holes around the sides of the liner about 4" below ground level. This will aerate the upper layers while the impervious lower portion will act as a moisture reservoir. Fill the bog with a 50:50 mixture of silica sand (available as sandblaster's sand at a building supply store) and Canadian sphagnum peat. If you have a very large project, fill the lower portion of the hole with ordinary sand, and use the more expensive purchased silica sand and peat mixture only in the top 4-5". Unless the surface of the soil is covered with living sphagnum moss, we use coarse pine needle straw as a mulch both to protect the plants and to discourage weed seedlings. Never use fertilizers on the roots of carnivorous plants or terrestrial orchids.

Ed. Note: For recommended plants and references, look for the continuation of this article in the next issue.

A Woodland Waterfall and Pool

by Judith Jones

Over the years I have often set up displays for flower shows or educational exhibits. To captivate attendees into lingering long enough to absorb the elements in a display, the overall picture must first capture their attention. The fresh burbling sound of water falling into a pool surrounded by luxurious greenery draws everyone within sight of the display. The same hypnotic effect holds true in the garden.

While learning to erect waterfalls on flat concrete or carpeted surfaces from step-stools, upended buckets, and other props, I have garnered a certain number of basic yet effective ideas that can be used when building a permanent garden waterfall. The most valuable lesson I ever learned was a simple technique demonstrated by my beloved nursery associate and friend, Torben Barfod. I was building my first flower show waterfall in a 10' by 10' space. The sides of the falls were bounded by stair-step risers shaped like those on which athletes receive their medals. A rigid, plastic, pie-shaped liner formed the pool. Heavy plastic was draped up the sheer front of the riser to contain the water (hopefully) that was to spill down built-up tufa. After an hour or so of carefully stacking endless bucketloads of tufa up to the top of the riser, I worked several suitable chunks into what looked like a good spill angle over the pool. The small pump was activated to test-run a short while to see if all was watertight. Puddles appeared from beneath the pool out onto the floor. A quick rearrangement of the top layers of tufa did nothing to halt the leakage. I was in despair—there was not time to take the whole structure apart to rebuild before the show opened. I would not be able to run the falls. What a waste of energy for just a pool!

Then Torben stepped in and wedged a long piece of cedar into the tufa at a downward angle over the pool. The plastic tube carrying the water to the top of the falls was secured to the wood with light wire and then disguised with a mat of fresh woodland moss. The water followed the wood and fell freely to the pool. Ferns and moss were tucked in the pockets between the tufa and all around the pool edges already camouflaged with cedar logs. Instant gratifying success! The water trickled out from under its mossy cap and

bounced musically off the submerged tufa below. People flocked to stand by this small oasis of tranquility. A waterfall fiend was created—me!

Torben and I have gone on to build many more display waterfalls, both temporary and permanent, and we are constantly asked to translate the process into do-it-yourself terms. Without breaking your back or your bank account you, too, can install a modest waterfall feature.

We are fortunate in that we live in an area where the "found" materials we use are available from friends, customers, or colleagues. These essential "found" items include some rock, decorative pieces of wood (we prefer to use western red cedar as it is the most water resistant), and fresh woodland moss. The most costly "hardscape" items include a pump, plastic tubing, and a pool.

For a small scale pool, a small submersible pump will deliver plenty of action. My favorite is the 1.1 amps Little Giant, model 1-A, which comes hard-wired to plug in and accepts 1/4" plastic tubing. It is 4.5" tall by 3.5" in diameter, so it can be easily camouflaged by a rock or a piece of wood when nestled up to the pool's edge. The base has a plastic screen to keep debris out of the intake, and even with bits sucked up to the screen, this pump performs admirably. I have a smaller, 0.67 amp pump from the M/M Pump Co., Model M/M101, which I use for displays. Its filter readily clogs, however, and clogging almost halts the pump action unless the pool is kept free of debris. These small pumps range in price from $40 to $50.

Larger pumps can run more than one fall in a watercourse. Just join the tubing with T junctions and run it to the top of two or more falls. If you use more than four T junctions, it may be necessary to have valves in the lines to regulate the amount of water going to each line.

The pool itself can be any tough rubber or heavy plastic container which is deep enough that the pump can be completely submerged. A container depth of 10-12" would be ideal so that you can incorporate potted or free-floating aquatic plants into your pool.

Our favorite display pool is a round, black rubber stock-watering basin, purchased from a feedstore for around $15. This tub is approximately 3' across and 12" deep. It will last indefinitely sunk in the ground away from the stomping of the heavy-hooved critters for whom it was designed. Another item we've used is a rectangular tub made for restaurants to gather up dirty dishes. It is a light gray and not as attractive as the black rubber tub, especially when algae begins to decorate the sides. Feel free to use your imagination and utilize whatever bargain container crosses your path from the local junk store or garage sale. Just remember, you want your pool to have the same gardening longevity that you do, so that you are not forced to replace it just as your plants are settling into established maturity.

Now that you have your found and bought items all assembled, it is time for the real joy—and occasional frustration—to begin. Even though building a small pool and waterfall is a simple task compared to laborious heavy-rock construction, vast excavating, and messy concrete mixing and pouring, the same basic principles regarding the site choice still apply. Geysers that spring out of the ground are wondrous and exhilarating in Yellowstone Park but highly suspect and somewhat alien in the midst of your lawn. If this is to be an informal, naturalistic waterfall, it must appear as if its source lies beyond view. The design feat of making the waterfall believable, while blending it

into your garden scheme, is the most difficult and crucial part of the project.

This type of waterfall may be constructed on a level site, with the decorative wood overhanging the pool contributing the only real height. However, such a site does benefit by mounding the soil upward by strategically placed rocks. The wood that is to carry the water to the pool is cantilevered out from this mound. The pockets resulting in the mound of soil and rocks should be planted with taller plants than are used around the base and forefront to give scale to the fall (see photos, pp. 62, 63). The apparent shape of the pool basin can be altered by laying wood or rock across the edges. Moss is the great disguiser for temporary displays, and it can serve the same function in permanent plantings until other plants mature.

Polypodium ferns form wonderful mats of interlaced rhizomes overlaid with mosses, and these excel as a cover for the plastic tubing laying on the jutting wood. The water stream can be fine-tuned by adjusting the mossy mat. Both fern and moss will thrive indefinitely from water wicked from the fall. If you live in an area where the winters are dry, you may have to replace this covering every couple of seasons. On the West Coast, we use *Polypodium glycyrrhiza* as our mossy cover, as Mother Nature fabricates wonderful, large, flat mats of rhizome and moss that can be allowed to drape quite naturally. East Coast gardeners may find it more challenging to transform their *Polypodium virginianum* and *P. appalachianum* into suitable coverings. It may be necessary to secure the rhizomes to the wood with fishing line and to lash in some woodland moss to keep the rhizomes moist and cool.

Now that the waterfall is in and you're idly surveying your handiwork, let the fluting strains of cascading water stimulate your planting scheme. Being a fern grower, I am very aware of the shapes, textures, hues, and the tapestry-like effect of foliar associations. I would like to encourage you to use ferns as a foil and adjunct to your flowering plant choices. I mix astilbes, silenes, phlox, geraniums, gentians, grasses, penstemons, and whatever else strikes my fancy among the ferns and dwarf conifers adorning my own woodland waterfall.

Once you've built your waterfall, try your hand at mixing ferns in with your other indispensable garden subjects; you'll find that they, too, will become irrefutably indispensable to the integral garden portrait. I am fed up with articles which regale the reader with glowing descriptions of fine garden combinations in which all the higher vascular plants have proper names, but the pteridophytes are dismissed as just "and ferns." In my companion article to this in the next issue of the *Bulletin*, I shall come to you with a very different viewpoint, in which all the ferns contributing to the composition of the garden picture shall be meticulously named and all accessory angiosperms shall be deemed "and plants."

Judith Jones gardens in Seattle, Washington and is proprietor of Fancy Fronds, a mail-order nursery.

Miniature Water Gardens

by Joseph V. Tomocik

Intimidated by the engineering details of a large waterfall? Boggled by bogs and their special soil and water requirements? Nonplussed by plumbing and pumps? Don't despair! Small-space water gardens are an enticing alternative to more ambitious schemes and can be enjoyed by any rock gardener. A multitude of charming aquatics can be exquisitely displayed in any container that will hold water—clay pots, plastic containers, half barrels, or many others.

Waterlilies are among the loveliest of all flowers and are easy to grow in small pots as long as they receive sufficient sun. They thrive on the warm water of small containers and are very easy to attend to. Thanks to the special efforts of hybridizers Dr. Kirk Strawn, Perry D. Slocum, and England's Reg Henley, it is just a matter of time before additional charming, dwarf waterlilies will find their way into commerce. Several promising varieties are now being grown and evaluated at Denver Botanic Gardens and other botanic gardens throughout the country.

The imaginative and curious gardener will seek out and incorporate some other exciting water plants that likewise adapt well to small containers. From the margins of wild lakes and wetlands come the following, among many others. Sweet flag (*Acorus calamus*) has dramatic, iris-like leaves and an invigorating scent. At 2', it adds height to the miniature garden picture as well. Prairie cordgrass (*Spartina pectinata*) will grow to 3' in a summer season and lends a special grace, swaying gently in any breeze and providing a bit of shade. Common arrowhead (*Sagittaria latifolia*) has wide, arrowhead-shaped leaves and tiny, airy white flowers held well above the water level. *Houttuynia cordata* 'Variegata', from East Asia, has vibrant multi-colored foliage. All of these can be grown in ordinary garden loam in 2-gallon pots and placed with the pot rims just below the water surface. Mulch the soil with gravel to help keep the water free of murkiness. Maintenance of any of these plants is slight to none.

Finally, floating plants can be added. You will be amazed at how quickly these reproduce. Duckweed (*Lemna minor*) is among the world's smallest flowering plants—what could be more appropriate for a rock gardener to grow? Water fern (*Azolla*) assumes a reddish tint with age. Water lettuce (*Pistia stratiotes*), in the Araceae, has velvety, pale green leaves and reproduces by stolons. If any of these become too abundant for your taste, simply discard the excess, or share with fellow gardeners. DO NOT introduce these into wild water systems.

The plants listed are just a few of the many possibilities that exist. The only limits are our imaginations. Small-space water gardening and its incorporation as part of the rock garden is in its infancy. The best times are ahead.

Rock Gardening in Ontario

by Barrie Porteous

Contrary to popular belief, the weather in southern Ontario is surprisingly pleasant. This is partly due to the fact that this area of the country lies at the same degree of latitude as northern California and partly due to the close proximity of the Great Lakes, collectively the largest body of fresh water in the world. It is therefore with good reason that southern Ontario is known as the Banana Belt of Canada, and those attending the May 1992, conference will likely find this fruit in great abundance, primarily, however, in grocery stores. Perhaps "Banana Belt" is something of an exaggeration. While it is true that summers are hot and humid, winters can be above freezing, below freezing, snowy or wet. Considering the climatic conditions, it is not surprising that alpines don't grow especially well in Toronto.

Temperatures change dramatically as one travels north away from the moderating effects of the Great Lakes, and it is here, high on the Canadian Shield, that alpines really come into their own. Our cottage is located 5 miles north of the 45th Parallel and 50 miles east of Georgian Bay, in the Muskoka region of Ontario. Even in summer temperatures rarely climb above 80°F. There are none of the problems associated with the humid, tropical air which bedevils growers in Toronto. Autumn is long and often quite wet, and frosts begin in September, with daytime temperatures slowly dropping below the freezing point by late November. Unfortunately, we are too far east of Lake Huron to benefit from snow squalls that blow in on northwest winds. Nevertheless, snow generally coats the ground from early December on, accumulating up to 18" deep, until early April when there is a rapid thaw and very often flooding of low lying areas. Under such conditions, a great variety of plants—although regrettably no bananas—can be grown with little effort or skill.

Much of the vegetation over the southern part of the Canadian Shield consists of a mixed forest zone with hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), white birch (*Betula papyrifera*), and assorted maples predominating. In early spring, before the trees have leafed out, the woods are filled with a variety of wild-

flowers. *Trillium grandiflorum* grows in the woods, but also seems quite at home in open areas exposed to the sun. *Trillium erectum* is only found in the forest. *Trillium undulatum*, though common, has more particular requirements in that it is usually to be found in damp, heavily shaded cedar woods (*Thuja occidentalis*) or in north-facing areas of high shade, but only if there is a great deal of humus in the soil.

Dutchman's breeches (*Dicentra cucullaria*), trout lily (*Erythronium americanum*), and spring beauty (*Claytonia virginica*) are common, and as soon as these plants have finished blooming, the trees leaf out and the black flies arrive. There are over 100 species of black flies in Ontario. Some only attack birds, some attack large animals, such as moose and deer, and virtually all attack humans with a great deal of enthusiasm. These flies, with characteristic humps on their backs, take a large chunk out of any unprotected areas of flesh and at the same time inject a substance into the skin which causes intense itching. In some instances arms and legs can swell up like balloons, and the only cure is to rush off to hospital for an injection. In addition, these airborne beasts will crawl into ears and eyes or up the nose if given half a chance. It is understandable that Native Americans coated themselves from head to toe in bear grease. There is, of course, a bonus for residents of the region: guests and in-laws are rarely seen at this time of year. But visitors to Toronto need not worry, as the only insect they are likely to encounter is the Mediterranean fruit fly.

We are fortunate to have a sphagnum bog at the end of the lake only a few hundred feet from our property. Pitcher plants (*Sarracenia purpurea*), sundews (*Drosera rotundifolia*), and Labrador tea (*Ledum groenlandicum*), plus a whole host of kalmias and andromedas abound, but, sadly, no orchids.

At the time of purchase, the cottage lot was heavily wooded, and I had very little interest in gardening. In subsequent years I went through my back-to-nature phase, followed by a fascination with vegetables, annuals, perennials, and rhododendrons. It was only in the early 1980s that I experienced a metamorphosis and emerged upon the world as that most magnificent of all creatures, an alpine gardener. The hundreds, if not thousands, of plants that have perished over the years bear testimony to the fact that there is a great deal to learn, but learning is perhaps half the fun. Over the years the one-acre lot has gradually been tamed, and sand beds, limestone beds, acid beds, wet beds, and woodland gardens, together with a number of troughs, have all been constructed, the purpose being to grow as many of my favorite plants as possible.

On a trip to Scotland about ten years ago, I happened to visit Jake Drake's nursery. Many superb plants were available, but the ones which really took my fancy were the famous Sunset Strain of *Lewisia cotyledon*. At the time I remember thinking that I could die and go happily to heaven—or more likely the other place—if only I could grow a few of these exciting plants. They became my first passion. Ten years later, with *Lewisia tweedyi* being used in place of petunias to line paths, the bloom, so to speak, is off the rose.

There were, and still are, very few nurseries in Ontario that offer good rock garden plants. Lewisias, in particular, were impossible to find. It was only with the help of friends in Vancouver that I was able to get my hands on some. To my surprise, a few survived and bloomed very well, only adding to my desire to grow more. Being a Scot, and therefore having a reputation for

frugality to uphold, the next logical move was to learn how to grow the plants from seed. To my surprise, this turned out to be fairly easy.

Lewisia seed, collected in summer and fall, is planted in 3" pots in a mixture of 2 parts Promix to 1 part perlite. After watering, the pots are placed in a zip-lock bag and left in the refrigerator to stratify for four to six weeks. They are then removed from the bag, put in 1' x 2' trays, covered with a plastic lid, and placed under cool white lights. Germination is usually rapid and even, and many hundreds of plants can be obtained in this manner. Planting the seeds outdoors in pots doesn't seem to give anywhere near the same germination rate, and the few plants that do grow are slow to develop even though the soil mix stays fairly open. While it is true that lewisias prefer open, airy sites in the garden, seedlings, including those of *L. tweedyi*, will grow happily under plastic beneath lights. It is helpful to sow the seed thinly and allow the seedlings to reach the size of a 50-cent piece before moving them on. Smaller plants seem to sit and sulk for a long time, and in some cases, they refuse to grow at all and simply end up dying. The *Lewisia cotyledon* and *L. tweedyi* seedlings are hardened off and moved into the garden in late May, and by fall, they will be close to the size of dinner plates, given the proper soil and siting. It is also relatively easy to break off the rosettes from larger plants and root them up in damp coarse sand in a shady position outdoors. Cuttings do not respond well to being put under lights. They root easily enough, but then tend to go downhill quickly unless moved into the garden.

Generally speaking *Lewisia cotyledon* and L. *tweedyi* prefer well-drained, peaty soil in a location shaded from the noon sun. *Lewisia cotyledon* will tolerate a great deal of sun and tends to be less prone to rotting if given an open, rather than shady position. *Lewisia tweedyi* can be planted in full sun, but will totally collapse into a pathetic pile of limp leaves by midafternoon each day in summer. They do recover by nightfall, but it's not hard to tell that the plants don't appreciate this sort of treatment. On the other hand, lewisias pushed to their limits of sun tolerance seem to flower prolifically, and it is not unusual to see a plant of *Lewisia tweedyi* with well over 50 blooms.

As the garden is still being constructed, there is very little time to worry about whether or not plants are properly fertilized. In spite of erratic attention to nutrients, these two species tend to bloom freely, prolifically in the spring and sporadically in the fall.

Cold, dry winters offer little opportunity for rot to set in. As a result, lewisias can be planted in any position except upside down. The key is to stop water gathering around the crown of the plant. If necessary, this can be accomplished either by leaving one inch of crown above the soil and back filling with stone chips, or by positioning the plant vertically in a crevice or wall.

Lewisia rediviva flowers early June, but it is certainly more demanding in that it needs to be dry, if not baked, during its summer dormant period. The temperature here never gets hot enough to bake the plants, and frequent summer rains ensure that they never dry out. In spite of this, some are five years old and relatively happy. Michael Stone pointed out that many western plants may be drought tolerant rather than drought demanding, and perhaps that is the case for this plant. Certainly *Lewisia rediviva* is common throughout the western states and must grow in many places that receive late evening thunderstorms at elevations sufficiently high that they don't "bake."

Wherever populations occur, the common feature seems to be excellent drainage, a condition ensured in the garden by planting in 12" of coarse sand.

I have failed dismally with *Lewisia longipetala* and *L. pygmaea* due to the fact that squirrels love them and will go to any lengths to dig them out of the ground. A friend recently reported that the liberal application of moth repellent flakes had caused even a family of ground hogs to leave the garden, but it seems likely that this exodus was caused more by the poor quality of the plants in the garden than by a distaste for moth balls. Nevertheless, it is worth a try next year. *Lewisia brachycalyx* has come and gone several times, and I don't know why. Perhaps it isn't hardy, or perhaps it, too, gets eaten.

In my youth I used to search the hills of northern Scotland for white heather. It didn't matter that I never found any, for it was fun just exploring, but the interest in these plants never left me. Now I have thoroughly indulged myself and acquired over 1,000 assorted heathers, all more or less happily surviving through -35°F winters. Very often there are only 3-6" of snow on the ground. In spite of this, all *Erica carnea*, most *Calluna vulgaris*, and some *Erica vagans*, *Erica cinerea*, as well as *Daboecia* hybrids will bloom and double in size every year. Plants of *Daboecia* x 'William Buchanan' survived a horrible, almost snowless winter in 1990, bloomed prolifically the following summer, and then died after the winter of 1991, which was the mildest in 20 years. None of the dwarf bun-forming *Calluna vulgaris* hybrids seem to be hardy, with the exception of *C. vulgaris* 'Foxii Nana'. In the right spot the plant is long-lived, and one specimen has even been growing for the last five years in a bed composed of limestone chips and sand.

The Canadian Shield was stripped of any decent topsoil during the last ice age, and attempts at farming were abandoned in many places due to the frustrating nature of farming on rock. Any soil that is left is sandy and porous and makes an excellent growing medium for heathers especially when liberal quantities of peat moss are added. New beds have been constructed in the fall for the last 5 years by digging in a four-cubic-foot bale of peat moss for each 4' by 4' area of garden. Late fall rains and melting snow in spring help wet the mixture, and the bed is ready for planting by early May. Soil pH is obviously an important consideration when growing ericaceous plants, and here there is no problem for, courtesy of our friends south of the border, the average pH of the rainfall is between 3.7 and 4.0. While the heathers seem to like this regime, the effect on the natural environment is disastrous, for the land is not able to buffer itself, and the lakes receive a deluge, every spring, of melting snow with a pH not much higher than that of vinegar. While there are no noticeable effects in the garden, the native maple and birch trees in the forests are dying off. The problem is exacerbated by onslaughts of gypsy moths and tent caterpillars. Fortunately, neither appears to be adding heathers to its menu.

Once the heathers are in the ground, the beds are mulched with pine needles, partly to keep the soil moist, partly to raise the snow level and partly to provide nourishment. The mulch breaks down very quickly, and fresh needles have to be added every couple of years. The native white pine (*Pinus strobus*) is not much use, as the needles are soft and don't trap air or moisture. However, the needles of red pine (*Pinus resinosa*), planted years ago by farmers looking for a cash crop, are very stiff and perfect for mulching

heathers, cassiopes, phyllodoces, and rhododendrons. When I remember to, I throw a 0-15-10, slow-release fertilizer on the beds, but even plants that don't get any seem to bloom well and quickly increase in size.

One of the important tasks each year is to ensure that the heathers are properly trimmed. This is especially true for some *Calluna* hybrids which will get very leggy unless decisive action is taken. Ericas can be pruned with garden shears in midsummer, leaving plenty of time for flower buds to set. Plants of *Erica carnea* 'Springwood White' are now over 3' in diameter and tend to get wacked back by the lawnmower every time the grass is cut. In spite of this they appear to suffer little damage; the plants are all very healthy. *Calluna* hybrids must be pruned in late fall or early spring if they are to spread outward rather than upward although some varieties will keep going up no matter what is done. The important thing is to cut out any woody stems as the plants flower best on new growth.

While heathers can be planted out using one of this variety and one of that, it is far more effective to group them in bunches of three to six. It is likely that the heights and spreads of hybrids given in most books could only be achieved under ideal growing conditions found perhaps on the West Coast or in Europe. Elsewhere it would be safer to subtract one-third from the width given, so that a spread of 24" would in reality be closer to 16". Attempts have been made in my garden to display the heathers according to leaf, flower color, height, and blooming season. It is possible to achieve a tapestry of color, as the leaves come in shades of yellow, gold, orange, gray, and all hues of green. Regrettably, some of the plants with the best foliage color have insignificant flowers. The varieties with double flowers in shades of white, pink, and lavender are especially nice. The flowers of *Erica carnea* hybrids are mostly pink, pinky-red, or white. *Erica cinerea* and *Daboecia* hybrids don't flower as prolifically, but do have attractive bells. Care has been taken not to experiment with too many potentially tender plants, as that often results in large holes come spring, particularly after a nasty winter.

Over the last 15 years most of the maple and birch trees have been cut down and pine and oak planted in their place. In spite of the fact that temperatures drop below -30°F for weeks on end and below -35° for several days at a time, a surprising number of rhododendrons and azaleas do quite well. A few, such as *Rhododendron roseum, R. vaseyi,* and *R. brachycarpum* ssp. *tigerstedtii* are now over 6' in height, and many of Dr. Paim's species selections show great promise. Dr. Paim, from Fredericton, New Brunswick, has spent years selecting hardy plants from seed lots, and many will bloom after exposure to -35°. The Northern Lights azaleas, from Minnesota, are also extremely hardy, and while they don't have the tight trusses of the Exbury hybrids, they are reliable and free flowering. Most of the Iron Clads don't bloom above the snow line and any plant with a hardiness rating of -15°F or less will not survive the first winter.

Through trial, error, and a few deaths, a variety of other plants have ended up in a north-facing acid bed. Amongst these are many cassiopes, phyllodoces, fall-blooming gentians, and the odd *Glaucidium palmatum, G. palmatum,* white form, *Leiophyllum buxifolium* 'Nanum', *Calceolaria* sp., *Rubus arcticus, Meconopsis* sp., and *Callianthemum kernerianum.* The gentians are especially valuable, as few plants, other than heather, bloom in the fall. Many hybrids are available and offer every shade of blue. My

personal favorites are those which have the palest colors, namely *Gentiana* 'Caroli', *Gentiana* 'Strathmore', and *Gentiana* 'Inverleith'. Quite a few have less attractive bluish-purple bells, and some are white. White fall gentians are, in my opinion, rather like white meconopsis—not the sort of thing which can be recommended.

Cassiopes probably grow best in full sun in a cool damp climate. Since we cannot provide the latter, they have to be planted in the shady bed, which inhibits flower production. *Cassiope* 'Muirhead', *C. lycopodioides*, *C.* 'Edinburgh', *C.* 'Badenoch', 'Bea Lily', and *C.* 'Bearsden' all bloom well enough, but don't compare to those grown in the gardens of northern England, for example, at Inverewe on the West Coast or Branklyn on the East. Phyllodoces also flourish in our shady bed, but are even more frugal with their blooms. Clearly something different has to be tried.

Contrary to popular opinion, meconopsis are not especially difficult to grow. Perhaps most failures are a result of encounters with excessive heat. This explains why visitors to Toronto will not see any growing alongside bougainvilleas by the shores of Lake Ontario. Those who venture north might be luckier, as the peak blooming season is mid to late June.

Seeds of *Meconopsis* either seem to sprout like watercress or not come up at all. The temptation is to sow them thickly, hoping a few may sprout. If this is done, I usually end with a pot full of seedlings that can't be separated. Promix or Promix with a little perlite appear to be good growing media, and stratification doesn't hurt. I plant the seeds, as soon as they arrive from the various exchanges, into 3" pots in plastic bags. If they are placed in the lower part of the refrigerator, they will sprout quickly, which is fine if they are to be grown under lights, but not good if the pots are to be held until spring. In the latter case, the pots should be placed under the freezer compartment or put outside where the seed will remain inactive until the weather warms up. After that seeds germinate readily and can be transplanted by end of May. It is perfectly easy to grow meconopsis under lights, and 3"-diameter plants are possible by March. At that time, within a 24-hour period, every one will die. Temperature is the culprit, for once the mercury hits 75°F, there are likely to be many mortalities. This doesn't happen outdoors, perhaps because there is air movement or more likely because night temperatures drop substantially outdoors, but only drop a few degrees in the basement. Turning the air conditioner on each evening may be a solution, but as my wife has pointed out many times, divorce is another. I now grow all my meconopsis outdoors.

The primary reason for growing meconopsis is to fill the early summer garden with gentian-blue poppies, and any of the seeds listed under *Meconopsis grandis* or *M. betonicifolia* fit the bill. *Meconopsis aculeata* and *M. horridula* are relatively easy, but not worth the trouble, partly because they are monocarpic and partly because the flowers don't compare well to those of their larger relatives. Once they have settled in, clumps of the perennial varieties are very hardy; new plantings are established by division in early spring.

Rock gardeners are perhaps the only denizens of the plant world who can drool over hairy, flowerless buns. For this reason I haven't ignored the monocarpic species. By fall, *Meconopsis paniculata* and *M. nepalensis* have formed very attractive rosettes, and the plants bloom over a long period before dying.

As a director of the American Penstemon Society, I am obliged not only to grow as many varieties as possible but also to say nice things about the genus. Well, most come in various shades of purple, some are blue, some yellow, and quite a few are white, pink, or red. There are many good ones but also quite a few that are somewhat scruffy. Almost all of mine are grown on a sand bed in the part of the garden that receives the most sun. In former days this was a lawn, a place where the more sedentary member of the family would read, sleep, and drink wine. The moment the first piece of turf was turned over, divorce lawyers sprang into action. A settlement was reached, however, when a novel and permanent area for the aforementioned activities was designated. Back in the newly conquered territories, some 12-15" of very coarse sand was placed on top of the overturned turf and large stones positioned every 4' or so to provide areas from which planting, admiring, and sometimes weeding could be carried out. The sand gets very hot and is so porous that it never allows water to stand on the surface. In fact, it is so coarse that it never moves, even during prolonged thunderstorms. As a result, a great many western plants grow well. *Lesquerella, Physaria, Gilia, Phacelia, Townsendia, Lewisia rediviva, Tanacetum douglasii, Zauschneria garrettii, Artemisia*, dwarf yuccas, *Sphaeralcea*, assorted cacti, *Calochortus, Dianthus, Phlox, Eriogonum*, and of course, *Penstemon* all thrive. In a belated, and probably vain attempt to save myself from being thrown out of the Penstemon Society, I must say that there are many good plants within the genus. *Penstemon oliganthus, P. cobaea, P. montanus, P. whippleanus, P. glaber, P. humilis, P. procerus, P. richardsonii, P. newberryi, P. rupicola*, as well as all the shrubby species and hybrids, including *P. fruticosus* and *P. davidsonii*, grow like weeds. However, I want to succeed with *P. eatonii, P. utahensis* and some of the southern gems with tubby, red bells, none of which make it through the first winter for me. At great expense I twice raised *P. acaulis* from seed and twice killed it long before it bloomed. I have succeeded with *P. caespitosus* var. *desertipicti* and *P. teucrioides*. *Penstemon humilis* "Mackay Form" from Patty Slayton hasn't yet bloomed but creates wonderful, groundhugging mats. It is true to say that the penstemons are the backbone of the summer garden when little else is in bloom, but I suspect that I have by now burned my bridges.

No doubt many of the visitors to the 1991 Annual Meeting will want to spend at least some time lying on the beach under a palm tree on the sunny shores of Lake Ontario. For those hardy souls willing to risk encounters with black flies, mosquitoes, moose, bear, and the odd rattlesnake, the area around Georgian Bay, from the Bruce Trail to Parry Sound and on inland, offers a wonderful opportunity to study a wide variety of unique and interesting plants, both in the wild and in the garden.

Barrie Porteous had no interest in gardening in his youth, except in lawn-mowing, which gained him privileges with the family auto. He says he took up gardening to escape his wife, but in recent years has gotten more enthusiastic about both marriage and gardening.

Plant Portrait

In Praise of *Lilium pumilum*

by A.B. Borkovec

Lilies, with their stately blossoms and frequently tall stature, are seldom seen in rock gardens. Somehow they don't seem to fit in, the surrounding vegetation being too low or incompatible with the straight, up-reaching stems and radiating, strap-like leaves. However, there are exceptions, and *Lilium pumilum* is an outstanding one.

In 1986 I obtained seed collected in the Lake Baikal region of the USSR by the Czech botanist Josef Halda. I planted it in December in a flat using my regular, unsterilized medium (2 parts leaf mold: 1 part sand: 1 part perlite). The flat was kept outside during the winter, and in April a good portion of the seed germinated. In about a month, the seedlings were thinned, then moved to a partly sunny location, and watered when dry. Each seedling bore a single grass-like leaf that persisted until frost. Next March, vigorous growth started, and in May the sturdy seedlings, still with only one leaf each, were transplanted, some directly to the rock garden and some to pots. The following year, 1989, one of the plants in the garden developed a wiry stem 20 cm tall, and in May produced a nodding, 5-cm-wide, strongly fragrant blossom of the Turk's-cap type. The curved petals, dark orange and spotted black, lasted for a week. The other plants, whether in pots or the garden, required another year before they started to bloom but then had more blossoms per plant. In 1991 the lilies were 25-40 cm tall and bore up to ten blossoms per plant.

One of the reasons this lily fits well into the rock garden is its small size. Also, because the numerous, grassy leaves are only 10-15 cm long and 3 mm wide and they radiate horizontally from the slender stem, the overall impression is of an airy cylinder with flowers emanating from the upper third. Since only two to four blossoms open at a time, the flowering period extends for several weeks. The stem and leaves persist until fall, probably because the stem develops its own roots in addition to those produced by the bulb. I plant my bulbs about 15 cm deep in regular, good garden soil with the top 3-cm layer composed of crushed stone. Although these lilies tolerate some shade rather well, they seem to prefer full sun.

Lilium pumilum is not a new plant to cultivation. Nevertheless, I have never seen it being offered. Because of its great beauty and relative ease of propagation, I recommend it greatly as one of the show pieces of the late spring rock garden.

Drawing by Don Leake

Books

A Southern Garden. Elizabeth Lawrence. 1991. The University of North Carolina Press: Chapel Hill, NC and London. [Special 50th anniversary edition of the original 1942 publication with 19 watercolors by Shirley Felts], 5.5 x 9.25", 251 pp. $16.95 paperbound; $24.95 clothbound. ISBN 0-8078-4355-5 (paper), 0-8078-1962-X (cloth).

Although first published in the spring of 1942, this fiftieth anniversary celebration of Elizabeth Lawrence's first volume remains contemporary and fresh and suitably complements the current regional gardening renaissance. Her lucid narrative was the heart of the first gardening book published for the mid-South (roughly Zone 8 from Richmond to San Antonio and the West Coast to Seattle). It is filled with modest and personal, yet keen observations (she often wrote how a flower smelled—and occasionally tasted!). While regional in scope, her prose extends significantly beyond the borders of the South. It contains inspirational observations, strong opinions, and most of all endearing writing.

Among the plants discussed—and still desired by southern gardeners—are *Iris unguicularis* and *Clematis cirrhosa*. In urging the planting of such winter bloomers, Miss Lawrence writes that "The chance that tender blossoms will escape the rigors of winter is...a chance well worth taking." She says she pictures herself in winter living in a "Hesperides of perpetual spring, perfumed with sweet olive and gay with camellias..." These thoughts presaged her subsequent *Gardens in Winter*, published in 1961.

Shirley Felts has provided 19 handsome watercolors. This edition includes botanical and nomenclatural changes in the text and index. The book contains her still highly useful tables of blooming dates for annuals, perennials, bulbs and shrubs. Edith R. Eddleman, designer and curator of the Elizabeth Lawrence Memorial Border at the North Carolina State University Arboretum, provides a new foreword and notes that "No one...has ever written so well or so warmly about gardening." I agree.

Bobby J. Ward

Through the Garden Gate. Elizabeth Lawrence, edited by Bill Neal. 1990. The University of North Carolina Press: Chapel Hill and London. 6 x 9", 256 pp., hardbound. Price, $19.95. ISBN 0-8078-1907-7.

Through the Garden Gate is a collection from the Charlotte Observer of 144 of the 720 columns originally written by North Carolina gardener Elizabeth

Lawrence. Miss Lawrence (1904-1985) was the first woman to receive a degree in landscape architecture from the then North Carolina State College. It is lovingly edited by Chapel Hill's Bill Neal, who notes that "...when Elizabeth Lawrence pronounced the botanical name of a plant, it echoed with an authority that we are unlikely to hear ever again." His collection of her prose ranges widely from Oberon to *Oxalis*, Hezekiah the King to winter-blooming hellebores, and alphabetically from Aaron to *Zizyphus*. It includes her first column (she was then 53 years old), which invites the reader to enter the gate to her garden: "I invite you to enter in, not only in my garden, but into the world of gardens; a world of mystery, adventure and romance; a world of poetry and philosophy; a world of beauty and work." She quotes, among others, Thoreau, Shakespeare, the classic English herbalists, and Sackville-West. Her purpose was to inform, acquaint, and gently cajole her readers.

The columns are arranged by month, thereby providing a year's coverage for seasonal and topical garden subjects. Elizabeth Lawrence gardened first in Raleigh, NC, and then in Charlotte, NC. Both gardens provided material for her garden columns for the Observer as well as for her books. This volume makes her "voice" accessible for the first time to a contemporary generation of gardeners and is an appropriate memorial to both Miss Lawrence and Mr. Neal. This is a fine—and highly recommended—companion book to *A Southern Garden* for Laurentian devotees.

Bobby J. Ward

Seed Germination Theory and Practice. Norman C. Deno. 1991. Self published: State College, PA. 8.5 x 11". Paperback; 150 pp., Price, $ 15.50. See advertisement in this issue.

Norman Deno's book is an encyclopedic canon of germination data on some 2,000 species of temperate zone plants representing 123 families and 605 genera. It includes specific directions for optimum germination and contains germination rates data (charting the number of seed germinated over time) under various conditions rather than the traditional method of percent germination.

Dr. Deno, professor emeritus of chemistry at Pennsylvania State University, discusses seed dormancy and the associated metabolic and chemical aspects of preconditioning treatments, especially the effects of temperature. He invites the reader on a "voyage of discovery in the world of seed germination" and through a discussion of the biological basis for seed dormancy.

He adequately covers seed collecting and storage, photoeffects, outdoor exposure, oscillating temperatures, and related topics. For many species covered in the book, he examines effects of washing of seed and puncturing the seed coat. The data are contained in a listing by genera starting with *Abeliophyllum* (Oleaceae) and finishing 100 pages later with *Zigadenus* (Liliaceae).

The seed for his studies came from botanic gardens in Europe, Asia, and the US, as well as from seed exchanges such as that of the American Rock Garden Society. *Seed Germination Theory and Practice* was inspired by the Bernard Harkness *Seedlist Handbook*, and serves as a companion. Dr. Deno's publication is a "must" reference guide.

Bobby J. Ward

Lewisia cotyledon hybrid in Porteous Garden
For description of garden, see pp. 51-57

Ericas

photos by Barrie Porteous

Ericas

Trillium undulatum

Demonstration garden at Barfod's Hardy Ferns
see pp. 47-50 for construction of woodland waterfall and pool

photos by Judith Jones

Judith Jones garden waterfall and pool (pp. 47-50)

Adiantum aleuticum, serpentine ecotype

Dryopteris affinis 'Congesta Crispa'

First flower on plant grown from seed

White-flowered variety

Glaucidium palmatum

photos by Armen Gevjan

Propagation

Growing *Glaucidium palmatum* from Seed
by Roxie Gevjan

The adage "There's more than one way to skin a cat" can certainly be applied to the germination and treatment of seeds. I do not know anything about skinning cats, but I have been sowing seed for 30 years and have learned some interesting things. There are countless ways to sow seed successfully. In the early years of my trials with seed sowing I was easily intimidated by plants presented as difficult. That intimidation began to disappear after a trip to the late Henry Fuller's garden where I observed *Lewisia cotyledon* growing on a flat surface and producing an abundance of seedlings. No lewisias were in perpendicular rock crevices or heavily stone-mulched areas, but just on flat, well-drained surfaces. Seeing those choice plants growing in contradiction to the accepted cultural concepts of the day gave me the courage to diversify my own techniques in the garden and especially in seed sowing procedures.

Enter *Glaucidium palmatum*. In 1972 I knew only that *Glaucidium palmatum* was a Japanese woodland plant and worth adding to our garden. I requested seed from the ARGS exchange. Knowing nothing is sometimes a bonus. A person so gifted is totally unconditioned and free to explore. My lack of knowledge of *Glaucidium* has often been a plus. Not having read about any of the supposedly necessary procedures on how to germinate this seed, I simply planted it in January in my usual medium of one part sand, one part top soil, and one part loam. It was placed outdoors in a screened, unheated patio with many other seed pans. They were covered with newspaper and a sheet of glass to keep them moist. When a seed pan showed germination, it was removed and placed in the cold frame, which is also screened but is not covered with glass. I do not recall how long the pan of *Glaucidium* seeds remained in the cold frame, but within three years the seedling had been planted in the woods and glorified itself with three beautiful blossoms. The blooms were so lovely that I began watching the plant more carefully. Each year the number of flowers increased remarkably. I finally stopped counting the year the plant produced more than 40 blossoms.

At that point I began ordering seed from all the exchanges. I tried using different sowing procedures and soil mixes—all without success. For two years I had no success. I decided that my first success had been just a fluke. Perhaps seed must be fresh to produce a good crop of seedlings. I harvested my own seeds in late September and sowed them in my original manner. Two months later it was suggested to me that the seed should be frozen for three months. I sowed the remaining seed and placed the pot in the freezer. The pan on the patio germinated in mid-April and the pan from the freezer about a week later, although the latter had fewer seedlings. Both pans were relegated to the cold frame.

Now what was I to do with my treasures? There were enough seedlings that I could dare to experiment. I made the momentous decision to transplant a few

seedlings in the cotyledon stage. I had always read and been told that this was a forbidden procedure. Seeds were to be transplanted only when true leaves appeared. I took the chance of losing some seedlings and transplanted a few into pots in mid-May. All survived! I transplanted the remainder of the seedlings about three weeks later and of nineteen I lost only three. The following year, 16 survivors produced their true leaves. The third year a few were planted into the woodland and the rest were moved to larger pots. Once in a permanent spot in the garden, the plants really grew quickly. Most bloomed in their third year. *Glaucidium palmatum* is not the touchy plant that I once thought.

My first plant, described as white-flowered, turned out to have blossoms delicately tinged lavender-pink, a beautiful color. For the past several years it has produced three to five pure white flowers. I also have plants from seed which produce pure white flowers, strikingly beautiful. Throughout my woodland now are many self-sown seedlings, all doing well. *Glaucidium palmatum* appears to have no diseases and seems unattractive to deer, squirrels, rabbits, skunks, moles, voles, chipmunks, and groundhogs. To grow it is to know it. To know it is to love it.

Errata

#@!☆@#☆@!!!

Bulletin of the American Rock Garden Society 49(4): Fall 1991.
"Jovibarbas, I Presume," pp. 295-6, is by Karen Matthews, not Karen Harris. The Editor apologizes sincerely.

Alyssum handelii is described on p. 264 and pictured on p. 260.

ARGS Coming Events

1992 Western Winter Study Weekend

From the Carpathians to the Caucasus:

Alpines for the Connoisseur
Portland, Oregon
February 28—March 1, 1992

The Columbia-Willamette Chapter invites you to a weekend focusing on the rich flora of the mountains at the heart of the Old World, with an international roster of speakers on topics from ecology to propagation.

Speakers: Christopher Grey-Wilson, Fritz Kummert, Zdenek Zvolanek, Jane Bock, Panayoti Kelaidis, Josef Halda, Norman Singer, Geoffrey Charlesworth, Faith Campbell, David Hale, Steve Doonan, Phil Pearson, Jan Palmer, David Palmer

Site: Monarch Motor Hotel, Southeast Portland
Fee: $80.00; meals additional
Registrars: Jan and Dave Dobak, 2584 N.W. Savier St., Portland, OR 97210-2412; write for brochure

1992 Eastern Winter Study Weekend

24th Annual Eastern Winter Study Weekend
A Weekend of Eclectic Excitement

January 24—January 26, 1992

Speakers: Norman Deno, on seed germination; Fred McGourty, on small perennials suited to the rock garden; Verna Pratt, on Alaskan wildflowers; Ian and Carole Bainbridge, on western European alpines of the Dolomites and Pyrenees; Fred and Joann Knapp, on plant hunting by amateurs; Reynold Welch on destructing a rock garden

Site: Marriott Wind Watch, Hauppauge, New York
Fee: $75 before Jan. 6, 1992
Registrar: Ruth Recca, 98 Stony Hollow Rd., Centerport, NY 11721

IV International Symposium on Bulbous & Cormous Plants

Organized by the

International Bulb Society in collaboration with the ISHS

Noordwijkerhout, The Netherlands 17–20 May 1992

This Symposium will consist of invited presentations, contributed papers, posters and discussions. It will cover various aspects of taxonomy, ecology, conservation of wild species and the breeding and culture of "new" bulbous plant crops. It is intended for bulb lovers of all professions and tastes.

During the symposia there will be trips to the Bulb Research Centre, Lisse, the Aalsmeer Flower Auction, Keukenhof Show Gardens and Floriade World Horticultural Exhibition; also social events will be organized.

The symposium is scheduled so that you can attend the world famous Chelsea Flower Show 19–22 May, 1992.

Partial List of Speakers:

Dr. B. Mathew, UK, *Iris 'Juno' & Allium* • **Dr. N. Aliechina**, USSR, *Tulipa* • **Dr. Peter Goldblatt**, USA, *The Family **Iridaceae*** • **Dr. Alan Meerow**, USA, *The Family **Amaryllidaceae** & Eucrosia Breeding* • **Dr. M. Roh**, USA, *Eucrosia* • **Dr. J. Dutilh**, USA, *Hippeastrum* • **Dr. Graham Duncan**, South Africa, *Lachenalia & South African Bulb* • **Dr. J. Grau**, Germany, *Chilean **Amaryllidaceae*** • **J. Bryan**, USA, *Bulbous Plants* • **Dr. T. Takeda**, Japan, *Lycoris* • **Sir Peter Smithers**, Switzerland, *Nerine* • **Dr. E. Bayer**, Germany, *Chilean Bulbs & **Tecophilaceae*** • **Dr. D. Lehmiller**, USA, *Crinum* • **Dr. N.M. Du Plessis**, South Africa, *Gladiolus of South Africa* • **B. Heath**, USA, *Daffodils* • **Dr. G. Littlejohn**, South Africa, *Gladiolus & Ornithogalum* • **Dr. K. Dixon**, Australia, *Propagation of Australian Geophytes* • **Dr. A. Coertze**, South Africa, ***Amaryllidaceae** Breeding* • **Dr. G. Ising**, Sweden, *Hippeastrum & Cyrtanthus* • **J.A. Castillo**, Argentina, *South American Bulbs* • **Dr. P. Ravenna**, Chile, ***Iridaceae** of the New World* • **R. Goemans**, UK, *History of Freesia & Alstroemeria* • **Dr. M. Fay**, UK, *Bulb Conservation* • **Dr. M. Boussard**, France, *Rare **Iridaceae*** • **Dr. P. Eckersley**, UK, *Conservation* • **Dr. M.G.M. van Creij**, Holland, *Lilium & Tulipa Breeding* • **Dr. A. Seisums**, Latvia, *Allium for the Garden* • **Dr. P.J. van Leeuwen**, Holland, *Leucocoryne* • **Dr. A. Balode**, Latvia, *Lilium* • **Dr. H. Koopowitz**, USA, *Conservation* • **Dr. A. Zobova**, Latvia, *Lilium* • **Dr. T. Howard**, USA, *Bulbs of Mexico* • **Dr. J. Conran**, Australia, *Australian Geophytes* • **Dr. J. Fernandes Casas**, Spain, *Wild Daffodils* • **Dr. W. van Essen**, South Africa, *Cultivation of South African Bulbs* • **Dr. J. van Staden**, South Africa, *Rhodohypoxis* • **Dr. A. Hoffmann**, Chile, *Bulbs of Chilean Andes & **Tropeolaceae*** • **Dr. A. Halevy**, Israel, *Flowering of Bulbs* • **Dr. P. Perry**, South Africa, *Bulbinella* • **Dr. T. Tsuchiya**, USA, *Alstroemeria* • **Dr. R. Bogers**, Holland, *Galanthus* • **Dr. A. de Hertogh**, USA, *Leucojum* • **Dr. P.J. van Vuuren**, South Africa, *Ornithogalum* • **Dr. S. Verryn**, South Africa, *Gladiolus Breeding* • **T. Hatch**, New Zealand, *Nerine & Lachenalia Hybrids* • **Dr. J.P. O'Farrell**, Argentina, *Bulbs of Uruguay* • **Dr. A. Dafni**, UK, *Mediterranean Geophytes* • **Dr. K. Sato**, Japan, *Lilium Breeding* • **Dr. P. Winski**, USA, *Alstroemeria for Pot Plants* • **Dr. K. Funnell**, New Zealand, *Callas* • **Dr. J. van Tuyl**, Holland, *Nerine* • **Dr. D. Shahak**, Israel, *Oncocyclus Iris* • **Dr. P. Hanelt**, Germany, *Allium* • **Dr. W. Eikelboom**, Holland, *Iris Breeding* • **Dr. K. Mynett**, Poland, *Lilium* • **Dr. A. Shmida**, Israel, *Mediterranean Bulbs* • **Dr. J. Doordun**, Holland, *Hippeastrum* • **Dr. R. Fritsch**, Germany, *Allium* • **Dr. S. Han**, USA, *Triteleia* • **Dr. M. Bridgen**, USA, *Alstroemeria* • **Dr. E. McRae**, USA, *Lilium Breeding* • **Dr. H. Okubo**, Japan, *Hippeastrum* •

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Back issues of the ARGS Bulletin are available. Following items are postage paid: Decal—ARGS Dodedcatheon, $1.25; "Seeds-3 methods," $2.50; "Troughs-construction and plants," $3.50; Library Binders, $6.00, $7.00 overseas. This is only a partial listing; most titles listed in the last issue are still available, as are many additional books.

Please mail inquiries and orders to:

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American Rock Garden Society Bookstore
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