AMERICAN HORTICULTURIST

OCTOBER 1982

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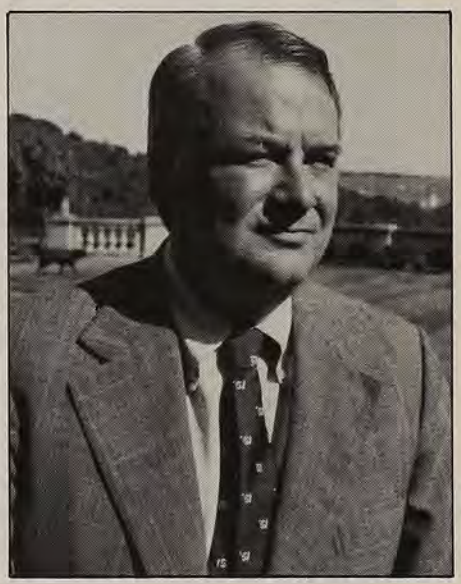
AMERICAN HORTICULTURIST

VOLUME 61 NUMBER 10

Design expertise is nowhere more self-evident than in the works of Nature herself. Here, the play of light and shadow emphasize the pleasing composition of *Agave*, commonly found in Baja, California and Mexico. Turn to page 22 and explore this region's fascinating landscape. Photograph by Pat O'Hara.

ON THE COVER: *Yucca* in flower. Photograph by Pat O'Hara.

PRESIDENT'S PAGE



My predecessors as Presidents of our Society have been noted for their expertise in various fields of horticulture. As your new President I will readily admit to being among the ranks of enthusiastic but amateur gardeners. I am not particularly troubled by this admission, however, because I have found that gardeners are always willing to share their knowledge, techniques, successes and failures, and hence I know that I can get plenty of help when I need it.

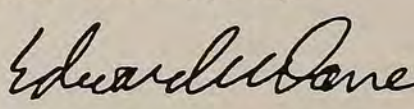
It is really because of the great personal satisfaction I derive from my association with the Society that I willingly undertake the responsibilities of President. Similarly, I will feel I have done my job if the Society achieves for others the many benefits I have enjoyed.

To add a small personal note for those of you I didn't meet at the Annual Meeting in Boston last year, I am a native New Englander and live on the coast north of Boston in Pride's Crossing. My wife and I are very fortunate to be living on a piece of land that belonged to her great-grandfather. It was originally landscaped by the Olmsted Brothers and retains some of the original, turn-of-the-century plants. We have three active children, a menagerie of animals and the beginnings of some good gardens. Every season brings a little better understanding of what we can accomplish, and the learning process is always fun and stimulating.

Arabella is an active judge for both the Garden Club of America and the Federated Garden Clubs so that between her activities and my Society association, we have met an incredible number of good gardeners, many of whom have helped us in more ways than we could relate. We both look forward to meeting as many of you as possible and seeing you at Society gatherings during the next three years.

My first year as President also marks the American Horticultural Society's 60th anniversary. In 1922 it was the intention of the founders "to develop a national organization devoted to horticulture in all its branches; to educate; and to disseminate horticultural information to all parts of the country." We try to fulfill that aim in many ways, not the least of which is by publishing this magazine. Happily, though not intentionally, the release of our newest publication, *North American Horticulture, A Reference Guide*, also coincides with our 60th anniversary celebration. In this volume we have brought together hundreds of organizations in North America relating to horticulture, thus fulfilling yet another goal of the Society's founders—to "bridge the broad area between the serious amateur gardener and professional horticulturist."

Uniting the interests of all American gardeners is no simple task, for it is an enormously varied field. Today our membership covers a broad spectrum—amateur and professional, nurseryman, backyard gardener, landscape designer, prize-winning orchid grower, rose fancier. In 60 years the Society has accomplished a great deal, but there is much more to be done. I look upon that challenge optimistically-surely these possibilities for the future are the nicest birthday present the Society could receive. We've only just begun!



Edward N. Dane
President

THE AMERICAN HORTICULTURAL SOCIETY'S

60TH ANNIVERSARY

Tall oaks from little acorns grow

1922 - 1982

THE BAMBOO ALTERNATIVE

Nandina's light, airy texture and form make it an excellent specimen plant. LEFT: Fruit of *Nandina domestica*. TOP RIGHT: Panicle of flowers of *N. domestica*. BOTTOM RIGHT: *Nandina*, growing at River Farm, displays its bamboo-like form.

Several years ago I was looking for a shrub that could be grown in a container and would provide a light and airy effect on my apartment's balcony. I had often admired screening hedges of bamboo grown in Pennsylvania and Maryland, and I had read that dwarf varieties of bamboo could be grown in pots or even as bonsai. Yet when I selected a small-leaved bamboo from a local nursery, planted it in a large pot and waited, I could only look on in dismay as its leaves browned in the sun and fell off. The plant was unable to live in the pot I had provided; bamboo needs lots of moisture and room for its underground rhizomes. For a time I abandoned hope of achieving an oriental mood of peace in my balcony garden.

Fortunately there is a shrub available in the nursery trade that can be used to create the light and airy effect of bamboo yet whose root system is well suited to both pot and garden culture—*Nandina domestica*. The Japanese *Nanten*, also commonly called heavenly or sacred bamboo, has small, angular leaflets that are borne on graceful, bamboo-like stems, which turn a brilliant scarlet in the fall.

I first discovered this shrub in the yard of my cousins' house in Alabama. *Nandina*, a member of the Berberidaceae or barberry family, grows well there under sun filtered through Spanish moss. The leaflets of these bushes are about 1¼ inches long, dark green and leathery. By July of each year the stems arch from the weight of foot-long panicles of pinkish-white flowers, which in October or November begin to form clusters of shiny red or orange berries. My cousins grow the popular standard-sized species (*N. domestica*) of this one-species genus, which grows into an open shrub six to eight feet tall.

Many cultivars of *N. domestica*, both standard-sized and dwarf, are grown in the South and in California as evergreen specimens, foundation plantings or hedges. 'Compacta' is a popular cultivar for garden and pot culture because at maturity it reaches a height of only four to five feet. The dwarf cultivar, 'Nana Purpurea', currently being recommended in some mail-order catalogues, is slightly coarser in leaf texture than the taller cultivars, but it is nicely mound-shaped and it grows only about one foot tall. This new dwarf plant is attractive as an edging plant for patios or under trees, and it adapts well to pot or porch culture.

Nandina will remain evergreen in winter temperatures to about 10° F (U.S.D.A. Zone 8). It is deciduous when exposed to temperatures of about 5° F, and the root systems will survive to 0° F. It can, therefore, be grown outdoors successfully in the very southeastern portions of Pennsylvania, in

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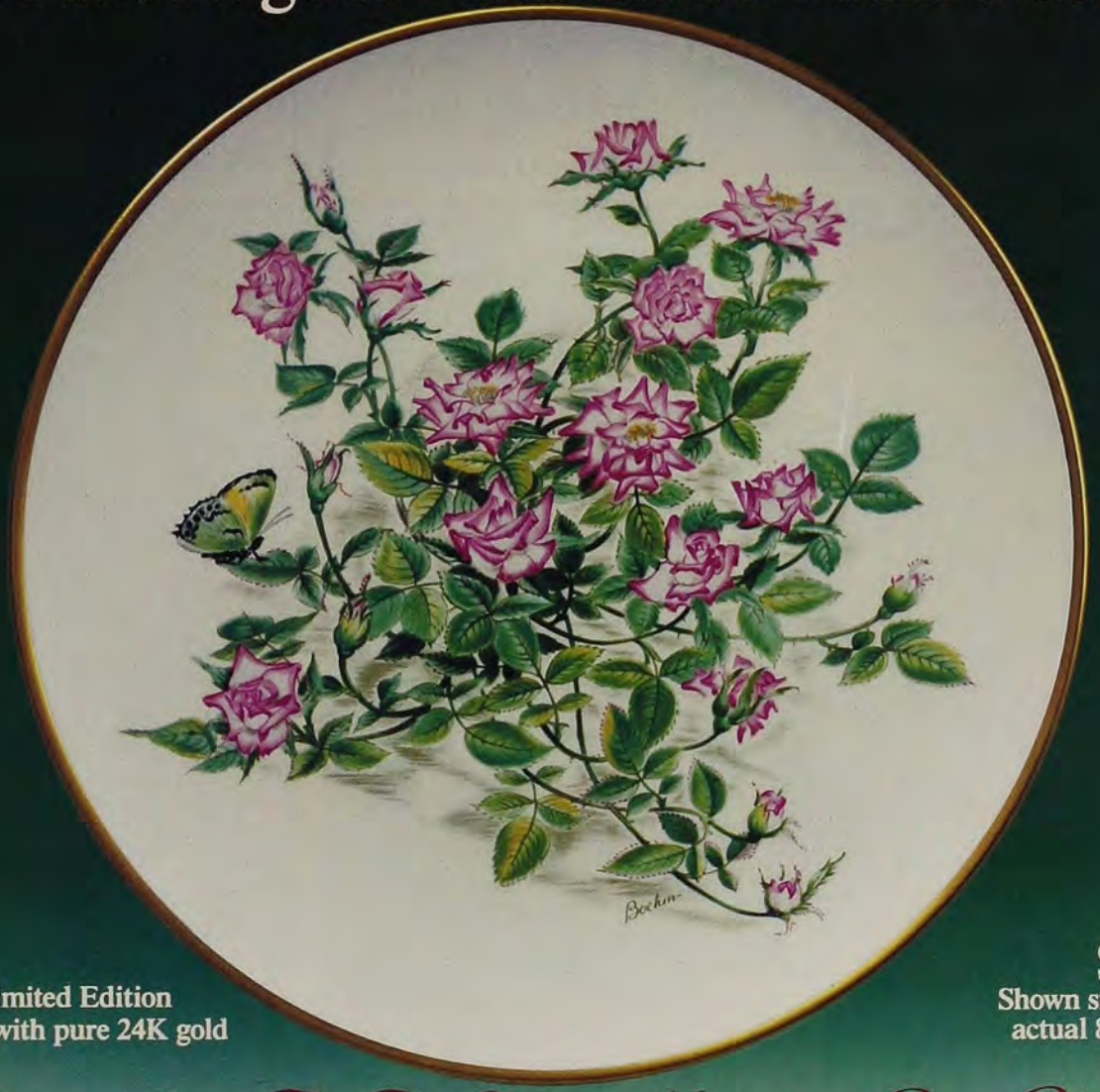

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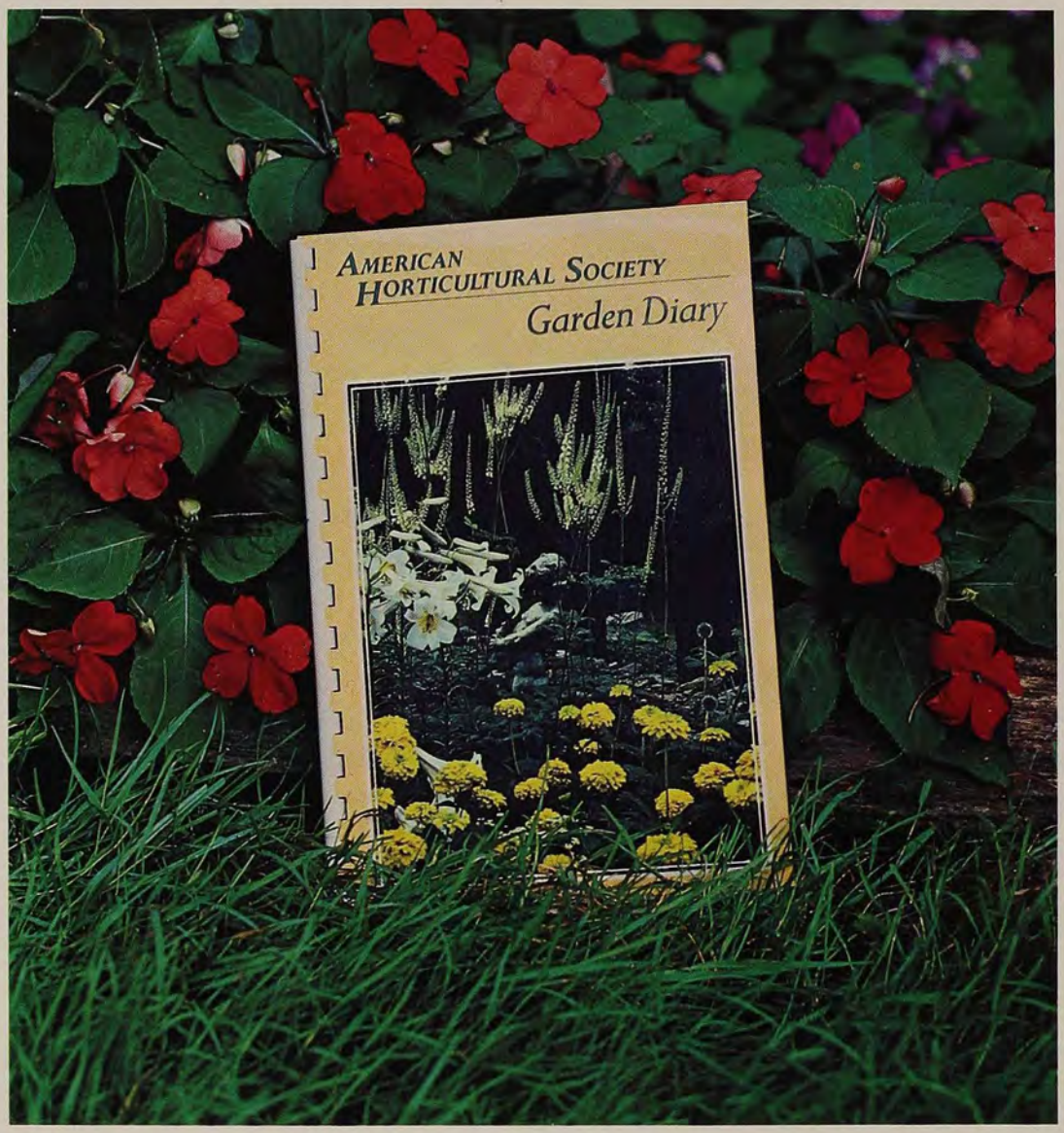
THE AHS GARDEN DIARY



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Best of all, AHS members are entitled to a discount off the retail price. In bookstores our Diary will sell for $14.95, but the discounted price to members is just $11.95 including postage and handling. Order several today in plenty of time for Christmas giving.

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protected locations to southern coastal New England and in very sheltered locations into the southern parts of U.S.D.A. Zone 6. When frost touches any *Nandina* its dark-green leaves turn pinkish-bronze to scarlet. This striking color, the display of summer flowers and the quarter-inch berries have assured continuing popularity for this attractive shrub.

Nandina grows best and produces its clusters of berries most prolifically in the sun, but it will also grow and flower well in light shade if the soil is rich, peaty (slightly acid) and moist. Maintaining a proper balance of moisture for the roots is very important. Dry soil during the summer will cause incomplete flower set, and fall drought will cause the berries to drop. Conversely, too much moisture in the form of heavy rain during the summer will wash away pollen from the flowers, preventing pollination and berry production.

To keep moisture near the roots it is important to mulch these plants. An acid material such as half-rotted oak or maple leaves, peat moss, fine wood chips or pine bark is ideal. Since the organisms that help decompose these mulches may tie up the nitrogen in the soil, apply a fertilizer rich in this element in the spring when new growth begins. Apply subsequent light applications of a balanced fertilizer from April to August to ensure good flower and fruit set.

In full sun nandinas will grow into pleasing, open, rounded-shaped shrubs. With their informal texture and form these plants make an excellent and colorful hedge in warm climates. *Nandina* is more often grown as a specimen plant, and for this purpose it usually is carefully pruned to accentuate the light, airy effects of the graceful stems and leaves. Because the flower panicles develop at the ends of the stems on new growth, shape plants in late winter when the stems are still dormant or in the summer after the flowers have developed. At either time it is best to remove all the dead stems and some of the older ones at the center of the clump, so cut them off at the base of the plant. Use this method to achieve an open-textured plant, and enhance the feeling by cutting a few stems back by one-third or one-half. This additional pruning fills out the base of the plant and opens the clump to both light and air. Whenever *Nandina* is cut or sheared from the top, new growth develops very slowly. To encourage eventual leafing out, position cuts just above a leaf node.

In Japan *Nandina* is also known as the "Symbol of Clear Air" or the "Gift of Purification." It is often planted there as a carefully shaped specimen in front of a house, a shrine or a gate. One Japanese pond-side garden featured a standard, thinned, but mound-shaped *Nandina* planted near a boulder of gray stone. The contrast of textures and wispy leaves cascading over the massive rock effectively accentuated the lightness of the nandina's form and the interesting color of its leaves. This effect was complemented by nearby plantings of long-needled pine and a bergenia-like plant with bold, round leaves. Japanese gardens often highlight the special form and texture of plants by using contrast. For example, dense and deeply

NANDINA CONT'D

colored evergreens are often planted near shrubs with light and airy leaf patterns like those so evident in *Nandina.*

In this country *Nandina* is effectively grown in front of evergreen windbreaks, close to the warmth of buildings or under the protective canopy provided by trees. Such locations will protect plants from killing frosts and frozen soil. Standard-sized, thinned nandinas look particularly oriental in mood when they are planted in pots or in the ground in front of panelled screens of translucent white fiberglass. The screens define the lacy texture of the leaves both in pattern and silhouette, and they also help to protect the plants from sun and wind.

Nandinas can also be displayed effectively as house plants or as garden specimens when grown in pots against a trellis. Carefully prune shrubs grown for this purpose, and loosely wire the stems to the wooden supports of the trellis. When these plants produce flowers and berries they will be displayed to advantage held upright on the tips of the wired stems.

In the North or in the South when *Nandina* is grown in a pot or porch box it must not be crowded. Each shrub—standard or dwarf—needs about 18 inches of soil in which to grow (growth will occur at the sides of the plant). The same acid, peaty loam and adequate moisture that support garden-grown nandinas will satisfy those grown in pots. Repot each plant once a year. A fine mulch of sphagnum moss will help to keep the soil cool and moist. In the Japanese tradition, nandinas grown in pots as house plants are often set in a basin filled with stones in sand. If the air in the house is dry, the leaflet tips will begin to brown, and many berries will drop. These basins filled with water raise the humidity near the leaves. Although *Nandina* is seldom bothered by insect pests, good ventilation and high humidity are as important as adequate moisture and sunlight in keeping the plant healthy.

Nandinas need less moisture during the winter months, but they do need light and cool to cold (frost-free) temperatures to remain healthy. I winter my own pot-grown, standard *Nandina* in the the garage or inside in a northwest window during particularly cold winters. My plant was raised from seed, which is one satisfactory way to raise nandina. Sow the seed any time after the berries harden from frost. I removed the fleshy pulp from several berries and planted the seeds (two per berry) one-

quarter-inch deep in a sterile seed-starting mixture at 70° F. I covered the three-inch pot containing this tamped down mixture with polyethylene film and placed it in a bright but not sunny window. Germination was slow, but in a little over a month I noticed the first seedling. Even though many books recommend stratifying the seeds in alternating layers of seed and sand outdoors in a cold frame, I did not find this technique necessary for successful germination.

Nandina will remain evergreen in winter temperatures to about 10°F (U.S.D.A. Zone 8). It is deciduous when exposed to temperatures of about 5°F, and the root systems will survive to 0°F.

A better and more usual method of propagating *Nandina* is by division of the side shoots that appear at the base of the plant. This is best done in the spring before vigorous growth begins. Combine division with pruning to maintain an attractive shape in the shrub. Cuttings, which can be taken from stem tips in August, will be very slow to root.

I have never tried growing my *Nandina* as a bonsai specimen, but a grouping of several dwarfed and thinned plants would be effective displayed for the color of their foliage. Because the root systems need room, it would be best to choose a medium-sized pot in which to grow the *Nandina* (in an upright or a cascading attitude). Keep the bonsai plant mulched with moss or stones. Also water once a day and shelter the plant from strong sun and high temperatures.

Nandinas will fail to set fruit if they are planted singly, so it is best to plan groupings of plants in pots or in the garden to ensure cross pollination. Fall berries make an attractive display on the bushes, and they are beautiful and long-lasting when cut for holiday and Christmas decorations. I obtained my first clusters of berries several years ago, and at that time I arranged them with glossy camellia leaves. When the leaves had withered the red nandina berries still remained secure on their stems. I dried the clusters and later rearranged

Continued on page 36

PROPER PLANTING OF ORNAMENTALS

Establishing trees and shrubs in a harsh environment can be difficult, especially when they're not planted or cared for properly. To avoid such problems and increase tree and shrub survival, special attention to location, soil conditions, quality of plant selected, proper planting techniques and proper post-transplant care are needed. Making the right choice of plants to site and soil conditions could be the subject of an article in itself. [Editor's note: see "Ornamental Trees," October 1981.] This column will be restricted to a discussion of what to do with the plant once it's bought.

Plants are commonly sold as "bare-root," "balled and burlapped," "container grown," "balled and potted," or "packaged stock." Because they have no soil around the roots, bare-root plants will die unless they're planted immediately. If for some reason this is not possible, pack peat moss or other moisture-holding materials around the roots to keep them moist, then water them and keep them in a cool place. If they need to be stored for several days or weeks prior to planting, put them in a shallow trench by covering the roots with soil. Bare-root plants are usually available in early spring, before the bud break, or in the fall after the leaf fall. Be wary about bare-root stock with bud or leaf breaks.

A balled and burlapped (b & b) plant retains around its roots a ball of field soil wrapped in burlap to prevent root disturbance, which makes it easier to establish. Container-grown, potted and packaged plants are desirable for the same reason.

PLANTING TIME

Balled and burlapped stock can be planted in the spring or fall or even during warmer periods if the plants are properly mulched and watered. Plant container-grown stock with an undisturbed root system any time of year, except when the soil is frozen or high temperatures coupled with dry winds would increase the chance for excessive desiccation. Otherwise, plant most deciduous stock, particularly bare-root nursery stock, during the dormant period (after leaf-drop in the fall and before bud-break in the spring).

Illustration by Elizabeth Ayella

Some plants—such as birch, magnolia, sweet gum, beech, flowering dogwood, rhododendron and Japanese maple—with thick, fleshy root systems, are best planted in the spring. This allows ample time for roots to develop before the onset of low temperatures in the fall.

In summer the rate of transpiration and water loss from the foliage is less for needle-leaf evergreens than for deciduous species. Therefore, needle-leaf evergreens are less subject to transplanting shock and can be moved earlier in the fall and later in the spring than can most deciduous species. In

the fall, transplant evergreens early enough to allow for root development before the onset of winter.

PRUNING AT PLANTING TIME

Improper pruning creates more problems than solutions and can ruin a plant's form for life. One popular recommendation is to remove about 30 percent of the top growth at planting time to compensate for root loss. Some studies, however, have revealed that pruning more than 15 percent of top growth may reduce the plant's visual quality for a season or two. Probably only corrective pruning should be done at planting. The evaporative demand of a plant, its root size and the soil-water supply should also be considered when pruning. If the plant will lose more water than it will be able to take up, then it should be pruned severely. As a general rule, fast growing trees with large leaves will need more water than small-leaved, slow growing plants because they transpire at a greater rate. On the other hand, a plant with little or no water loss should be pruned lightly or not at all. For example, a cottonwood or a tulip tree would need more water and would dry out more quickly than a yew or a small-needled evergreen.

PREPARING THE SOIL AND PLANTING

Dig the planting hole wide enough and deep enough to allow the roots to spread without crowding. For container-grown and b & b stock, the hole should usually be about two feet wider than the soil ball to allow adequate backfill. Amend the backfill with no more than 20 percent organic materials, such as peat moss or compost. Loosen the soil in the bottom of the hole to a depth of four to six inches.

If the hole is dug by an auger, loosen the hard, smooth surface created by the equipment. This hard layer often prevents penetration by young roots, confining the root system to the auger hole. Remove plastic packaging prior to planting. Burlap may be left on b & b rootballs, but it should be loosened and pushed a third of the way down on the soil ball. Also remove so-called "plantable pots" to hasten establishment and root growth. Cut roots of container-grown plants lengthwise two to three times with a sharp knife to stop roots from circling around the pot and to stimulate lateral root growth. Place bare-root stock over a mound of prepared backfill, and spread out the roots to create a plant-

ing situation similar to that of the original one in the field.

If a tree or shrub is planted too deeply or not deeply enough, its growth will be stunted, and eventually it may die from root diseases or other problems. Plant trees at the same depth they were growing in the nursery. Generally the root collar, where the roots join the stem of the plant, should be three to four inches below the level of the soil. It is better to err in the direction of a slightly shallow planting than to plant too deeply, because too much dirt on the roots will smother the plant. Also, newly planted trees may settle a bit after planting. When using bare-root material, make sure the roots are not exposed to the sun during planting. If a number of plants are to be planted, place them in a container filled with water until they are planted. Once planted, fashion a watering basin or a saucer-shaped depression around the plant to allow water to flow in the root area.

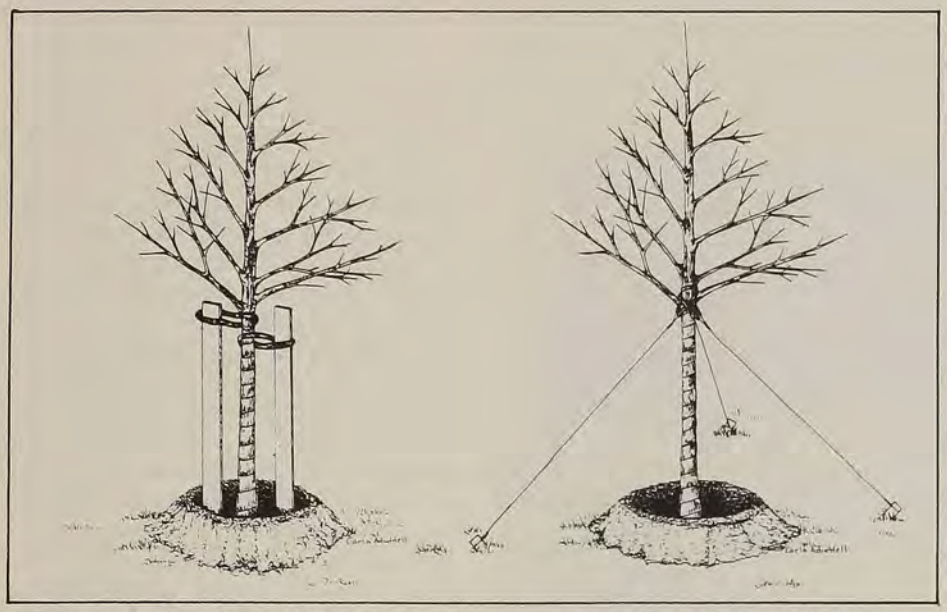
FERTILIZING

No one can dispute the beneficial effects of fertilizing trees and shrubs. Timing of applications and the type of fertilizer used affect the outcome. Recent research reveals several advantages of applying fertilizers at planting time, particularly phosphorus (P), which enhances the formation of new roots needed for the quick establishment of the newly planted trees.

Apply nitrogen (N) fertilizer cautiously at planting time; it should not come in direct contact with roots. Mix the fertilizer into the backfill or with the soil in the bottom of the planting hole.

Any all-purpose, complete fertilizer (10-10-10, 10-6-4 or 12-12-12) will provide the nutritional needs of the plant. Some fertilizers will supply only nitrogen, phosphorus or potassium. For example, such phosphorus materials as superphosphate or bone meal are effective in producing a good root system and can be added directly to the planting hole.

Some slow-release or time-release fertilizers, which are safer and more labor saving to use but also are more expensive than the conventional types, are Nitroform and ureaform (both 38 percent nitrogen), sulfur-coated urea (36 percent nitrogen plus sulfur), MagAmp® (magnesium ammonium phosphate), Osmocote® (several formulations are available) and the Agriform tablets. In addition to granular types, there are liquid fertilizers, such as the 20-20-20, 10-52-17 and other formulations, all of



Support newly planted trees with stakes placed near the tree trunk or with three or four guy wires fastened to the ground. Generally, trees more than one inch in trunk diameter should be supported in this fashion for one to two years after planting. Illustrations by Carla Aduddell

which are soluble and should be ideal for deep-root feeding.

Apply granular fertilizers at about one-tenth to one-fifth pound nitrogen or one to two pounds of a 10 percent fertilizer (10-10-10) for every inch of tree-trunk diameter. A three-inch tree would need three to six pounds of 10-10-10 mixed in the backfill at planting.

MULCHING

Cover the ground above the roots with four to six inches of mulch such as peat moss, ground bark, straw or compost after you've planted. A mulch greatly reduces weed growth and water loss from the soil surface; it prevents surface crusting; it improves water penetration; and, most important, it helps maintain a uniform temperature, which will promote greater root growth. Applying heavy mulch is especially important when planting in the fall, because it helps protect roots from drying out and temperature fluctuations.

STAKING AND GUYING

Generally, trees more than one inch in trunk diameter should be supported by a stake or guy wire for one to two years after planting. After roots have penetrated firmly in the soil and the plant becomes established, no further external support will be needed.

For trees of up to two inches in diamter, a stake (2-inch x 2-inch) driven into the ground close to the trunk will be adequate. Tie the tree to the stake by pieces of wire attached to garden hose, rope or plastic string. The ties should be low on the trunk. If two stakes are used instead of one, tie the tree to both stakes. For large trees several stakes or guy wires may be needed. Hold the tree in place by three to four guy wires looped to the trunk or lower branches and perhaps tightened by turnbuckles. Another method is to drive a stake in the ground away from the trunk at a 45° angle and tie it to the tree.

Do not stake trees for more than two to three years. Research shows that trees staked and supported over a long period do not develop strong trunks or root systems and are more prone to wind movement. In contrast, trees grown with little support develop a flexible stem that can bend without breaking.

To avoid damage on a tree trunk caused by sun, winter weather extremes, borers and animals, wrap newly planted trees up to the first limb with burlap, paper tree wrap or strips of material known as "tree guard" (available at any nursery or garden center). Remove the wrapping after 12 to 18 months.

By following these simple recommendations, any well chosen tree or large shrub should survive transplanting and grow into a healthy, vigorous addition to the garden.

—Houchang Khatamian

Houchang Khatamian is an assistant Professor of Ornamental Horticulture at Kansas State University.

BOOK REVIEWS

ORNAMENTAL SHRUBS.
C. E. Lucas Phillips and Peter N. Barber. Van Nostrand Reinhold Co. New York, New York. 1981. 320 pages; hardcover, $29.95. AHS discount price $22.20 including postage and handling.

This English shrub book, although intended for the American market as well, will be of use to the advanced gardener in the United States but not the beginner. Many of the cultivars discussed will be difficult, if not impossible, to find. Hardiness zones for the United States and Canada, and for Europe, have been reduced to a common system that is useful. The general text of the first 60 pages is definitely for the English reader, but the "Register of Shrubs," which makes up the rest of the book, covers many species and cultivars that may be new to the American reader. The black and white line drawings and photographs scattered through the text are too few in number to be of much help, but the 32 color plates are superb.

TWO FOR THE WEST COAST

FLOWERING PLANTS IN THE LANDSCAPE.
Mildred E. Mathias (editor). University of California Press. Berkeley. 1982. 254 pages; hardbound, $16.95. AHS discount price, $14.80 including postage and handling.

GARDENING WITH NATIVE PLANTS OF THE PACIFIC NORTHWEST.
Arthur R. Kruckeberg. University of Washington Press, Seattle, 1982. 252 pages, hardbound; $24.95. AHS discount price, $23.70 including postage and handling.

Originally published as a series of booklets on flowering trees, shrubs and other plants, this latest effort of Los Angeles Beautiful is a new version of the earlier *Color for the Landscape*, re-edited and expanded. If you garden in a Mediterranean climate (this means in much of southern California), this beautifully illustrated guide will show you what to expect from the choicest plants from a world-wide selection. Trees, shrubs, vines, groundcovers and natives

are included. The selection is varied and even more choices are listed in a series of appendices.

Gardening with Native Plants, although dealing with more than 250 plants from the Pacific Northwest, is intended to be used as an introduction for gardeners throughout the country as well. In addition to recommendations on use in the garden, propagating and cultural instructions are also included. This is a well written and well illustrated guide to the rich flora of a region that has much to offer to our gardens.

THE GREAT PUBLIC GARDENS OF THE EASTERN UNITED STATES.
Doris M. Stone. Pantheon Books. New York, New York. 1982. 302 pages; paperbound, $12.95. AHS discount price, $12.25 including postage and handling.

Starting with Fairchild Tropical Garden in Miami, Florida and progressing north to the Arnold Arboretum in Jamaica Plain, Massachusetts, the author guides us through 34 outstanding public gardens of the eastern United States. All the vital statistics—location, admission hours and fees and such details as provisions for the handicapped—are included. The author also describes each garden and calls attention to any special plant collections within it. A historical sketch provides further background for each establishment, and a series of "boxes" throughout the book provide interesting vignettes about special plant groups, people and garden features. If you like to visit gardens, this guidebook is a must.

BROMELIADS.
Jack Kramer. Harper & Row. New York, New York. 1981. 179 pages; hardcover, $27.50. AHS discount price, $23.50 includingpostage and handling.

With the increasing popularity of bromeliads as house plants, this excellent treatment should answer any question that might occur to the beginning grower. Lots of photographs (both color and black and white), descriptions and cultural instructions for more than 200 species clearly show the great variety to be found in this fascinating plant family. Chapters on buying, collecting and displaying your plants in the garden and around the house complete the story for the beginning grower and might even give the more advanced collector a few new ideas.

ROCK GARDEN AND ALPINE PLANTS.
Raymond Foster. David and Charles. North Pomfret, Vermont. 1982. 256 pages; hardcover, $31.50. AHS discount price, $26.45 including postage and handling.

This book is true to its title. It is about plants rather than gardening (a few pages of the book *do* touch on this subject). If you are a rock garden enthusiast you will enjoy learning where your plants come from and how they grow in nature. The arrangement is geographical, and the plants, their natural growth habit and their wild associations are discussed by regions. The entire world is covered. The last 50 pages are devoted to a cultural table covering more than 1,000 plants.

GERANIUMS FOR HOME AND GARDEN.
Alan Shellard. David and Charles. North Pomfret, Vermont. 1981. 232 pages; hardcover, $22.50. AHS discount price, $19.00 including postage and handling.

Covering all aspects of selecting and growing the popular cultivars of *Pelargonium* (which we call "geraniums"), this book is good for the beginner. Since geraniums are mostly grown as house plants, the cultural instructions are applicable even though this is a British book. Unfortunately, as is usually the case, American readers will have a difficult time locating the European cultivars that are described. ❶

—Gilbert S. Daniels

Gilbert S. Daniels is the Immediate Past President of the American Horticultural Society.

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CHATSWORTH GARDEN

BY WENDY J. SHEPPARD

Strolling through a constant drizzle, one can still enjoy the beauty and romance of the Cascade, the Emperor Fountain and the Azalea Dell in the garden surrounding Chatsworth House—a fine example of an English country house. This 17th-century garden, located in Derbyshire at Bakewell, is considered to be the most extraordinary and varied of the landscape gardens in England. Presently owned by the Duke and Duchess of Devonshire, Chatsworth House and Garden have passed through the hands of many owners and undergone numerous alterations.

The original garden was laid out around the main block of the house for the 1st Duke of Devonshire (1641-1707). It was transformed during the ownerships of the 3rd Duke (1698-1755) and his son, the 4th Duke (1720-1764). Launcelot "Capability" Brown was responsible for the "natural" style of landscaping, which, by 1760, obliterated the formal garden.

Besides enlarging the house, further changes were made after the 6th Duke inherited Chatsworth in 1811. He hired Joseph Paxton, noted for his application of scientific and engineering techniques to landscape design, to assist in redesigning the garden. Paxton's exceptional engineering skill was evidenced by construction of the Great Conservatory, or Great Stove, begun in 1836 and completed in three years. It flourished with plant specimens obtained from all over the world. In fact, the first banana to ripen in England was grown there. However, due to neglect during World War 1, the contents died and the conservatory was demolished.

The center of the Great Conservatory's original site presently contains a yew maze, which was planted in 1961. To the south of the maze are plantings of lupines, which produce a spectacular array of colors in May and June, and to the north are autumn-flowering Michaelmas daisies and dahlias. Although Paxton's greatest achievement at Chatsworth was destroyed, the garden's basic design as it appears today is a result of his work.

A new greenhouse in the Rose Garden was built to replace the Great Conservatory. It contains a collection of camellias, including two rare *Camellia reticulata*, which flower in March and April, and various other interesting plants, such as *Buddleia auriculata* and *Magnolia wilsonii*

The most fascinating elements of the garden are the Cascade and the Emperor Fountain. The Cascade was part of the original garden and is crowned by the Cascade Temple. Water cascades down small, circular steps, which form the domed roof of the temple. Streams rising from the temple jets spill down the stairs of the Cascade, disappear underground, appear again in the Sea-Horse Fountain and finally spend themselves in the fountain on the west-front lawn. Natural water pressure for the Cascade is supplied by a series of nearby lakes. Until the middle of the 18th century, the hillside above the Cascade and Temple was barren of trees. Careful selection of specimens has resulted in a beautifully wooded hillside, a perfect backdrop for the sparkling waters of the Cascade.

TOP: The Cascade Temple is one of several outstanding architectural landscape features of Chatsworth. RIGHT: Fountains abound at Chatsworth. Through clipped hedges, a newer addition to the garden can be seen—a serpentine wall of beech added in 1953.

ABOVE: Iris enjoy their proximity to the Canal Pond, constructed to supply the household with ice. TOP CENTER: Rhododendrons add color accents to a lush planting adjacent to yet another man-made attraction, a waterfall. FAR RIGHT: This bucolic view of Chatsworth House gives no indication of the engineering marvels its surrounding gardens contain. RIGHT: A yew maze, established in 1961, is surrounded by a lovely display of lupine.

In contrast to the aesthetic beauty of the Cascade, the long Canal Pond was constructed for a more practical purpose. It was dug for the 1st Duke, in 1703, to stock the underground ice-house with ice for the summers. The pond now boasts the Emperor Fountain, another example of Joseph Paxton's engineering prowess. With its water pressure supplied by the largest of the ponds on the nearby hilltop, the fountain can shoot as high as 290 feet—the highest in England. The 6th Duke had it designed to honor Czar Nicholas, who was to visit Chatsworth in July of 1844. Unfortunately, the Czar changed his plans and the fountain was unveiled without him.

Although abounding with obviously man-made attractions, Chatsworth Garden has many naturalized settings. Paxton began planting the arboretum and pinetum in 1835. Expeditions were sent to North and South America, Nepal and India to collect seed of plants rare or unknown to England. Several of the plant materials introduced by these expeditions were rhododendrons, trees of the genus *Pinus*, blue spruce (*Picea pungens*), dawn redwood (*Metasequoia glyptostroboides*), Douglas fir (*Pseudotsuga menziesii*), and swamp cypress (*Taxodium distichum*).

Among numerous other attractions to be found in the garden today are the Azalea Dell, planted with Ghent, double-Ghent and Mollis azaleas that are most outstanding in May and June; the serpentine hedge of beech, planted in 1953; golden box, planted in the middle division of the west-front garden, which can only be appreciated when viewed from an upper story of the house; and the Grotto, a conceit built at the request of the beautiful Duchess Georgiana (1757-1806).

Chatsworth flaunts its colors for a large part of the year thanks to England's favorable climate. Showy daffodils, crocus, iris and other bulbs appear in early spring . . . a brilliant display of colors can be seen when the azaleas and rhododendrons bloom in early summer . . . roses, lupines and shrubs flower later in the summer . . . and autumn produces many-colored foliage.

Chatsworth Garden (and the house, which can be visited year-round) should not be missed by any visitor to England. If the sky is gray and the weather damp, see it anyhow, because there could be no setting more peaceful and romantic than this spot during a soft, summer rain.

Wendy J. Sheppard graduated from the Ohio State University with a degree in horticulture. She is now a project coordinator for the Office of International Agricultural Programs at Kansas State University.

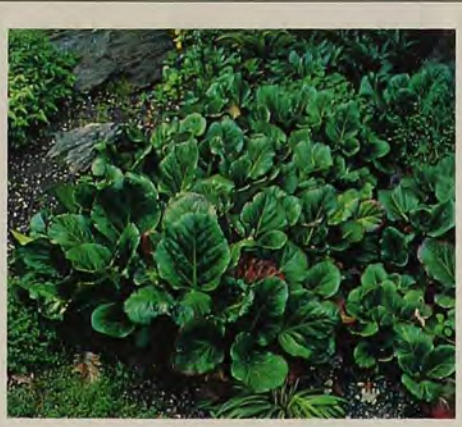
Bergenia

BY MRS. RALPH CANNON

Over 200 years ago a tough group of plants from the Siberian wilds arrived in England to settle down and grow. From England these leathery-leaved perennials migrated to our shores, and, finding our climate to their liking, flourished here. These plants have been classified by various names. First as *Saxifraga*, then *Megasea* and finally *Bergenia*. The present name honors an 18th-century German botanist, Karl Bergen. German nurserymen have always been interested in bergenias and have produced many fine hybrids.

Bergenias' long-lasting flowers appear in early spring. Their leaves are round or cordate, large, glossy, leathery and evergreen. The leaves generally form large rosettes as they grow, which makes the plant a particularly attractive addition to the garden. The leaves of some types change color during the winter, becoming pinkish or reddish on the tips. Because the flowers appear rather early, the blossoms are often subject to early frosts. Plant bergenias in a site sheltered from the early morning sun to prevent the sun's rays from rapidly thawing the frozen blossoms and damaging them. Don't worry about the plant itself, however. Since bergenias are natives of Siberia and the Himalayas, they are extremely hardy.

RIGHT: *Bergenia ciliata* growing at Kew.
FAR RIGHT: *Bergenia* used in the rock garden at New York Botanic Garden.



Bergenias will grow in any kind of soil, but they appreciate good compost and leaf mold. A sprinkling of bone meal is also useful, but they don't like manures high in nitrogen. They also adapt to a sunny or shady location, but dappled shade, where they can get a few hours of sun every day, seems best and still encourages flowers to appear. A windy site is not desirable, however, because the wind easily tears the leaves and makes the planting unsightly.

Once planted, only disturb bergenias when they need dividing. Allow them to grow into large, noble clumps. These large clumps will make dramatic statements in a border, bed or formal garden, or in groups they will make a fine groundcover with their dense rosettes of leaves.

Bergenias are best propagated by division. The main roots, which are thick and fleshy, grow along the surface of the soil. Divide the roots into small clumps, each clump including a few leaves or a growing crown. Replant the division, with the leaves just above ground level, during the fall.

To propagate from seed, first hand-pollinate the flowers to assure that seed is produced—the individual *Bergenia* cultivars are often self-sterile, so they require pollen from another cultivar to set seed. The seed can be sown as soon as it ripens in midsummer, or it can be held and sown in the late fall or early spring. Mature, flowering plants can be obtained in two or three years. Bergenias generally hybridize very freely, so the progeny will probably be quite variable.

There are many species and hybrids of bergenias from which to choose. Two species, both of which are from Siberia, are the most widely grown. *Bergenia crassifolia* grows to a height of about 20 inches and has spoon-shaped, fleshy, bright-green leaves. Its rose-colored flowers stand above the leaves and bloom early. *B. cordifolia* has cordate, glossy, dark-green leaves that turn reddish in winter. It grows to a height of 15 inches, and its magenta flowers appear a bit later than those of *B. crassifolia.*

Other species include *Bergenia* X *schmidtii*, a widely grown plant that is usually the first to flower (rose-pink) in the spring and *B. stracheyi* var. *alba*, a dwarf variety from the Himalayas. It grows to about nine inches in height, has small, deep-green leaves and white flowers.

Several cultivars are partiuclarly outstanding. 'Ballawley', from Ireland, has large, oval, green leaves that turn to a mahogany color during the winter months. In the spring the crimson flowers appear on curved, 12-inch red stems. 'Silver Light', a German hybrid, has white flowers flushed pink and shiny green leaves. 'Evening Glow', another German hybrid, has reddish-purple flowers and cordate, bronze leaves. 'Rosy Morn' is a strong grower with pink flowers. These three hybrids were developed by George Arends and are of the highest garden merit because they flower in the spring and fall.

Bergenias are such hardy, pest-free perennials that they demand consideration in any garden plan. Gardeners over the years have used them in a number of imaginative ways: They are particularly effective planted in a dry wall. As the rosettes spread from crevice to crevice they complement and soften the stonework. Bergenias are also good to use at a turn in the border where their greenery acts as a foil for more prominent flower colors. Beside a small stream a planting of bergenias makes a lovely garden picture. Wherever tulips grow, a fine mass of *Bergenia* will lend stability to the planting and endure after the flowers have died. Or they are pleasing just by themselves. With their early color contribution they act as a curtain raiser for the whole garden, and their autumn color and winter hardiness provide continuity of interest when the usefulness of other plants has been exhausted.

Mrs. Ralph Cannon received her Doctorate from the University of Chicago and is now retired as Emeritus Professor from that institution. She gardens on 26 acres of Illinois woodland.

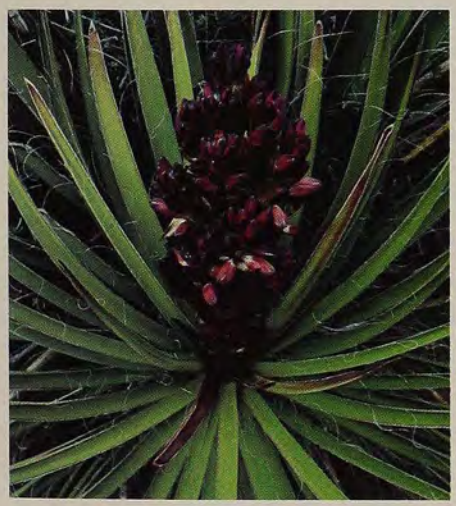
BAJA

BY RITA SHUSTER

Crossing the border from San Diego into Baja California is the first step into an enchanted land—blue skies, rugged mountains, sparkling beaches and friendly people. Our tour group of 36 American Horticultural Society members, guide Elissa Martino and myself started down the Baja Peninsula on March 22, 1981. Driving along in a comfortable, air-conditioned motor coach, we compared views of the Pacific coast to the west and the hills and mountains to the east. Cheerful, yellow bush sunflowers, *Encelia californica*, and desert dandelions, *Malacothrix glabrata*, bloomed along the roadside. Great tangled thickets of galloping or dagger cactus, *Lemaireocereus gummosus*, sprawled over the ground. Gray-leaved chaparral shrubs covered the hillsides, punctuated by the stout flowering stalks of the century plant, *Agave shawii*. This agave was used by early natives as a food resource. Both the bud of the flowering stalk and the plump leaf bases can be roasted and eaten, and the sap is fermented to make mezcal and tequila.

We spent our first night at the beachside El Presidente hotel in San Quintin and took an early morning stroll to watch shorebirds and collect sand dollars. After breakfast we drove inland to the great Vizcaino

ABOVE: Elephant tree. TOP RIGHT: *Agave*. OPPOSITE RIGHT: *Encelia*, yellow bush sunflower or brittlebush. OPPOSITE: *Yucca*.



ABOVE: Cardon cactus, *Pachycereus pringlei*. RIGHT: *Opuntia*, cholla cactus. OPPOSITE: *Fouquieria splendens*, commonly called ocotillo.

Desert. Plants in a wide variety of shapes, colors and textures are mixed together in this rough and rocky landscape. Broad-leaved buckeye trees, *Aesculus parryi*, and laurel sumac, *Rhus laurina*, are found between spiny clumps of cholla and prickly pear cacti, *Opuntia* spp. Giant cardons, *Pachycereus pringlei*, tower up to 40 feet. The slender, crooked stems of ocotillo, *Fouquieria splendens*, wave in the sky, and the massive conical trunks and whisker-like branches of cirios or boojum trees, *Idria columnaris*, contrast with the delicate, leafy shrubs of the creosote bush, *Larrea divaricata*. Within easy walking distance of our hotel in Catavina we reviewed and photographed dozens of the unique plants characteristic of this rich desert flora.

The scenery changed as we drove on to the Southwest, crossing the 28th parallel at Guerrero Negro and entering Baja California South. Due to the higher humidity near the coast epiphytic ball moss, *Tillandsia recurvata*, and lichens wrap the branches and trunks of cardons and cirios. Later only the inclined trunks of the hardy yucca, *Yucca valida*, are conspicuous on the windswept landscape of the coastal plain. Where no other form of wood is available, the trunks of these yuccas are used as firewood and for fenceposts.

Returning inland we stopped for a night at the pleasant community of San Ignacio. Groves of tall date palms, *Phoenix dactylifera*, surround the town and nearby lagoon making an oasis in the desert. Stately old specimens of *Ficus benjamina* (formerly *F. nitida*), commonly called tropic laurel, shade the town square where we bought dried figs and dates for snacks and visited the old Dominican mission. Crossing a range of volcanic mountains in the morning to leave San Ignacio we caught the first glimpse of the lovely, blue Gulf of California and later had a picnic lunch under palm-thatched shelters on the beach of Bahia Conceptión. Unspoiled islands beckoned from offshore, and gentle waves lapped quietly at our feet. Brown pelicans skimmed over the calm water, occasionally diving for fish and then returning to bob on the surface.

Traveling down the peninsula from Loreto to La Paz we found the lovely, endemic yellow morning glory, *Merremia aurea*, and the conspicuous yellow trumpet bush, *Tecoma stans*. Two types of elephant trees, *Pachycormus discolor* and *Bursera microphylla*, with thick, sturdy trunks and smooth bark, grew on the rocky hillsides. The silvery white bark of the graceful palo blanco trees, *Lysiloma candida*, gleamed from the ravines. San Miguel vine, *Antigonon leptopus*, also called Mexican creeper or chain-of-love, displayed showy pink blooms along the roadsides. La Paz is the largest city in southern Baja, and we enjoyed the opportunity for good dining, sightseeing and shop-

Continued on page 38

Floriade '82

BY DONALD VINING

Once every 10 years the Dutch outdo themselves at this special floral exhibition in Amsterdam. Acres of new plants, equipment and gardening ideas are introduced, many of which we can anticipate seeing in America soon. Here are some highlights of this summer's show.

COLOR TREND
That trendiest of color schemes—orange, blue and white—so desirable and so difficult to achieve in the garden, gets some help on the hardest part from a new pansy called 'Tangerine'.

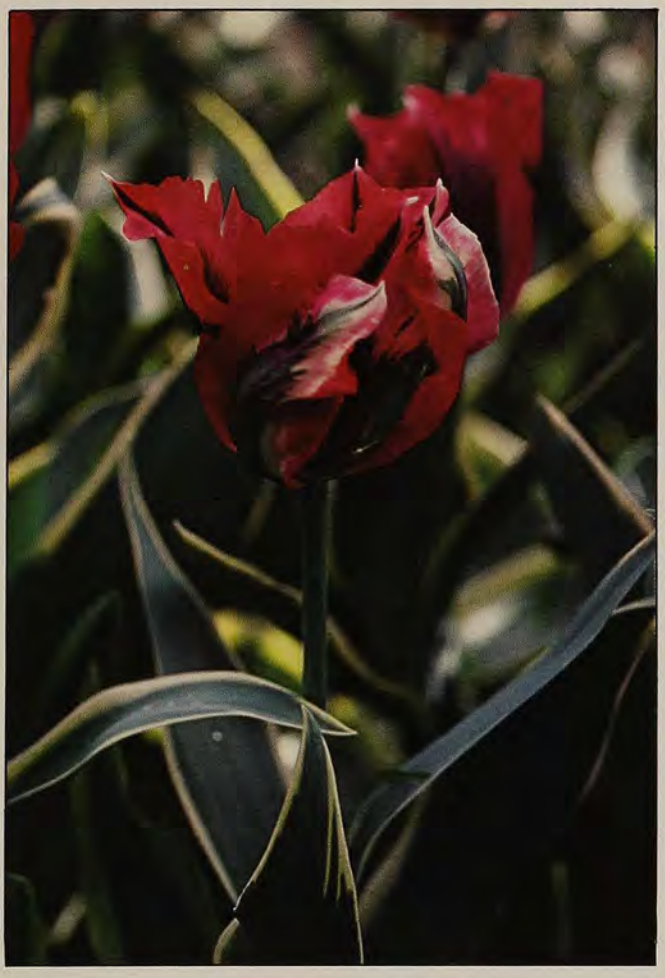
MORE FOR YOUR GILDERS
Bred into the large-flowered hybrids from the species, the multiple-bloom characteristic is the keep-coming thing, seen here in *Tulipa* 'Orange Bouquet'.

GROUND COVER
Dutch vegetable gardeners have taken the notion of the hotcap all the way to blowup: a garden-sized sheet of light, perforated plastic keeps the chill off but admits water and air circulation. The plants themselves—in this case, various lettuces—hold the airy thing aloft. Right next door, more laborious lettuce cold-frames, bow-supported tubes of plastic film, must be opened in the mid-day sun.

BIG SPLASH
Right in the middle of the perennial beds were exclamatory clumps of ornamental rhubarb. The club-like bloom spikes provoked the most frequently asked question: what is it? The beds were planted like a forest floor, with great drifts of one plant gradually giving way to another, the masses punctuated with tall plants like rhubarb.

PLANTER WALLS
Built from pre-cast concrete sections, this low retaining wall brings rock gardening to the edge of the patio. The blocks fit between grooved wooden posts, making a barrier ready to back-fill and plant.

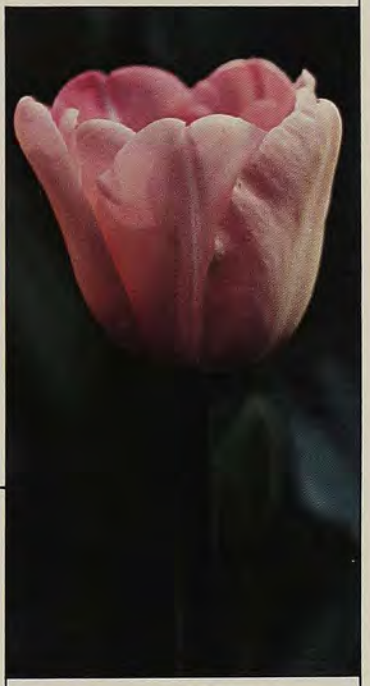
LOOK-ALIKES
Though most people still prefer tulips that look more or less like tulips, there's obviously a market for tulips that look like something else. *Tulipa* 'Peach Blossom' was only one of many peony-flowered tulips, and *Tulipa bakeri* 'Lilac Wonder', pictured, seemed to have the water lily as model.



ROCOCO REVIVAL
Watch for a return to favor of the parrot tulips, especially those that offer variegated foliage in the bargain. This mutant of the cultivar 'Hollywood' has yellow-bordered leaves instead of white and a coral cast to the usually pink flower.

LITTLE GEMS
There's more interest now than ever in the species tulips, especially the small flowered forms, which are so perfect in rock gardens and other niches. Look at *Tulipa chrysantha,* 'Tubergen's Gem' combined with muscari—and not much bigger.

BANK ON IT
It's such a simple idea that no one seems to have thought of it before now: weeping trees as "ground" cover to reshape and accentuate a bank.



THE WHOLE THING
Tulip breeders are paying more attention to the whole plant, draining color from the flower into the leaves and stem for a total effect. A standout example was *Tulipa* 'Douglas Baader', whose perfect pink cup was filled from a sturdy purple stem above spruce-blue foliage.

SUNSCREENS
Screening the light and heat in Floriade's vast range of greenhouses was done with flair and efficiency in long, sheered panels of nylon.

THE FUTURE IN TULIPS
The news in tulips is all right here: variegated foliage, which looks somewhat hosta-like after the flowers have passed, and multi-bloom heads, which keep the color coming longer.

Donald M. Vining is on the editorial staff of *Metropolitan Home* magazine in New York City.

Euonymus

It is exciting to see a favorite plant, challenged by a new situation, come through with flying colors. *Euonymus alata* has done that for me. Called winged euonymus or burning bush, this shrub has been used for hedging for years. Each fall, when it actually turns into a "burning bush," its most outstanding attribute demands center stage—its foliage turns a brilliant shade of red.

Searching for more varieties of small woodland, understory trees to grow in the shade of taller trees in my garden, I began to experiment with this old friend. I knew this plant had relatives that were becoming hard to find, so much so that I hesitated to list them on a plan. Fortunately, after years of watching *Euonymus alata* perform with great success in my experiment, I feel prepared to introduce it to you in its new role—as an outstanding, small woodland *tree!*

Corky, winged bark gives this plant a true, tree-like structural appearance, but it appreciates a bit of help to enhance its shape. I prune off lower twigs and branches for the first few years. Each year less growth appears that needs to be removed, and running my hands up and down the trunk will knock off the beginning buds. The natural vase shape is pleasant, with five or fewer stems or trunks. The winter view of a wide-spreading, short tree adds variety to a natural woodland.

The results are worth the effort. Dogwoods, redbuds and whitebuds seem to be the only choices for understory trees when planning a natural woodland area. But put *Euonymus alata* in the front of your woodland, or even in deep shade within, and no matter how long it must wait—until all the neighboring trees lose their leaves—it will eventually demand attention. With other trees as bare-branched background, its leaves give us one last, bright curtain call before winter snows begin to fall.

As an added attraction the dramatic fall foliage gives way to the appearance of equally lovely scarlet fruits, which are small but so numerous that even the cardinals, attracted to red objects, come to decorate the branches. The seeds are sometimes eaten and sometimes not, but for most of the winter they provide another source of interest.

This small tree is eager to leaf, and while other trees are still dormant it puts forth its welcome spring growth, providing a green background for nearby flowering trees. Its leaves arrive so early and stay so late that even in Missouri it is without leaves for only a few months of the year.

Euonymus alata is not demanding, and it will perform without spraying since it has few disease or insect problems. Like most good performers, it needs extra water during long, hot spells, but this is only true until the plant begins to feel at home and really puts down roots. Then it requires less water than most trees and will come through a drought looking fresh and green. A hardy fellow, *Euonymus* has been with me through -17° F winters and 110° F summers.

Euonymus is also available from almost any nursery. To my mind, a plant that is hard to get often makes it undesirable. There is a compact form, *Euonymus alata* 'Compacta', but this cultivar should be used as a shrub. Yet if you meet some of its other relatives, such as the wahoo (*E. atropurpurea*), *E. europaea*, or *E. hamiltoniana*, take them home, for they have the same fine attributes, with variations of fruit, fall color and growth size.

Join other homeowners who are turning more and more of their grounds into wildlife areas, and invite this star performer to become a part of the cast. It will bring color and character to your garden and demand little in return—except appreciation.

Gay McDonnell Bumgarner has been a landscape designer for 17 years and has had articles published in *House Beautiful* and *Flower and Garden* magazines.

BY GAY MCDONNELL BUMGARNER

ABOVE: This rose-covered summerhouse at Badminton, near Bath, England, is a modern adaptation of a favorite medieval garden design element. RIGHT: Designing with supple branches is as simple and effective today as it was during the Middle Ages. Broad planks form a hinged gate suspended from a twisted wood portal. If the gate posts are cut when the wood is green and the upper branches malleable, the entwining of branches is easier.

Medieval Garden Designs

TEXT AND ILLUSTRATIONS BY LORRAINE MARSHALL BURGESS

Gardeners have never been afraid to borrow ideas from other eras. Perhaps gardening, like no other pastime, so values experience. As gardeners have searched in old books for new ways to find comfort, ease tensions or bring refreshment to the spirit, many have discovered the merits of the Middle Ages as one of the brightest sources of garden delight.

Defined by historians as the time between Antiquity and the Renaissance (476-1500), the Medieval era has provided us with a visual heritage of great worth. Tensions eased and fortifications and castle walls gave way to open gardens. Domestic life assumed a happier note. Orchards and herb gardens were still maintained as necessities, but flower gardening came into its own as these lusty people learned the pleasures of leisure time. Gardens were reshaped into pleasure retreats and became the focus of family festivities.

Garden ideas were exchanged. The English borrowed from Italy, France and the Low Countries. Rich men built fountains and water jets to startle their guests and mazes and labyrinths to puzzle them. Arbors were raised up as shelter against sun or rain as the weather dictated, but, more to the point, as an area for idle romancing. Granted, many of the gardens were made for the upper classes, but the urge to garden became more widespread among all people. When the grandeur of great stone walls, fountains and fine statuary were beyond means, inventive plantsmen turned to hedging, wood palings, lattice designs and topiary to provide the refinements desired. Those who could not afford pavilions or summer houses resorted to the construction of boxed spaces planted with flowers and edged with turf seats, places open to the sky but special, where gardener hosts could offer hospitality to their friends. Ingenuity, improvisation and caprice were tools of design, no matter the class. These are tools we might use more often today.

Old drawings and prints give us clues to the caprices that have gone before. The gardens of kings were monumental in scale and remain as such, evoking awe and wonder from tourists. But the ideas and aspirations of modest men are worthy of our study too. In gardening, as in much else, nothing is new. All we can do is review old portfolios and interpret or echo what pleases us. Remember, too, that the drawings we see are not pure. They represent instead the artist's com-

prehension of his own life and times, items he has seen or imagined. As a final caution, realize that the images viewed are dependent upon the artists' abilities to record information accurately. Nevertheless, there is inspiration to be found in Medieval ideas.

1. With a few wood planks and 1×2 stakes, build a turf-covered retaining wall to hold soil in place. As an added feature, include a niche in the wall to allow room for a game table between the turf seats.

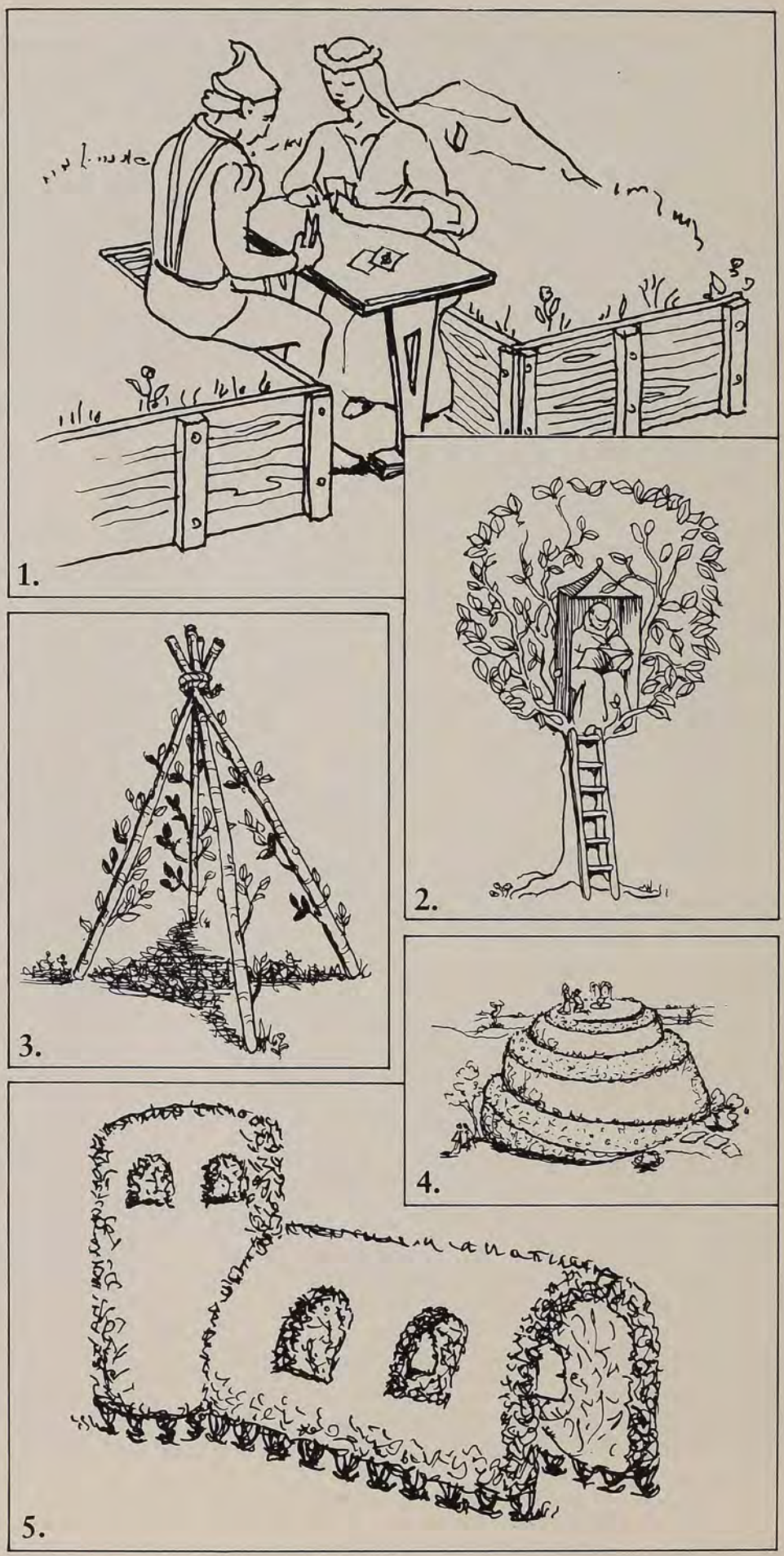
2. A box seat in a tree is a garden folly first reported in 1490. Apparently it offered protection from ground squirrels and people and was a quiet place to meditate.

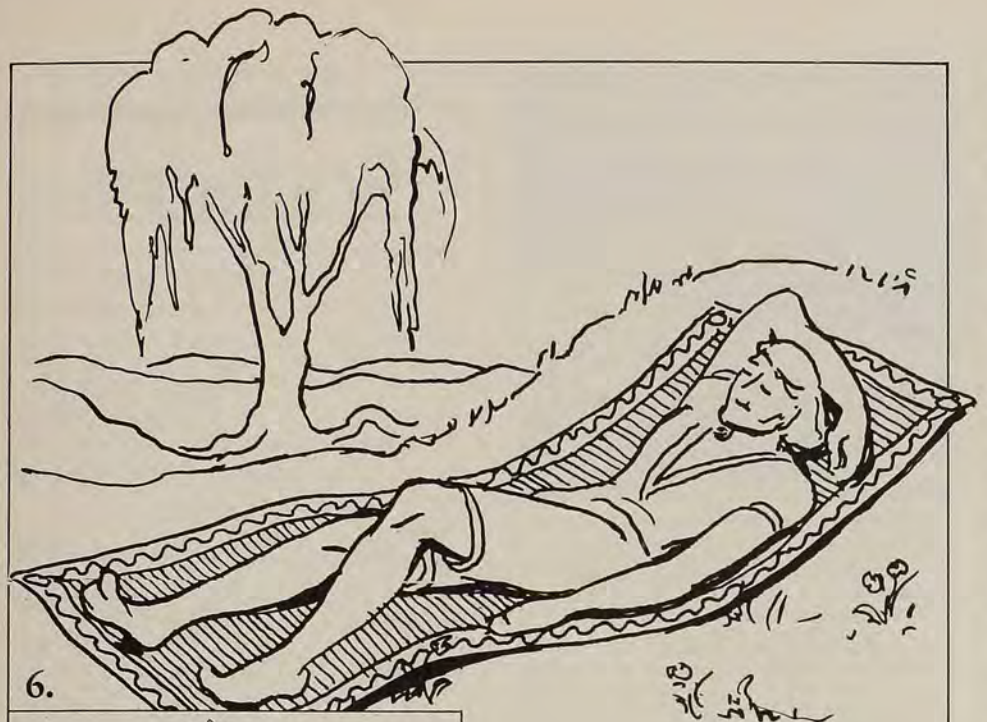
3. Make a portable pyramid arbor from leafy saplings tied together with rope. The more the leaves, the greater the shade. (A similar "teepee" garden was planted in last year's children's garden at River Farm.) Please note: these fresh-cut solutions are for people who live with rampant growth on their own woodland. Those less fortunate should make arrangements with the property owner before cutting down any live growth.

4. In medieval times men often constructed spiral earthen mounts to enjoy the view. Benches or a refreshing fountain were top-side amenities. A similar mound exists in southern England today at the side of a soccer field. Spectators climb as high as they choose for a good view of the game.

5. Hedging and topiary forms flourished in England because of the ease with which the English grew evergreen privet, box, yew and holly. When something sculptural was desired they pruned and trimmed their shrubs into birds, animals and abstract forms. One inventive gardener grew and trained a double row of plants into a "house of hedges" with its own cool tunnel and lookout mount.

6. Medieval gardeners may not have had our barwa chairs or redwood lounges, but they did know

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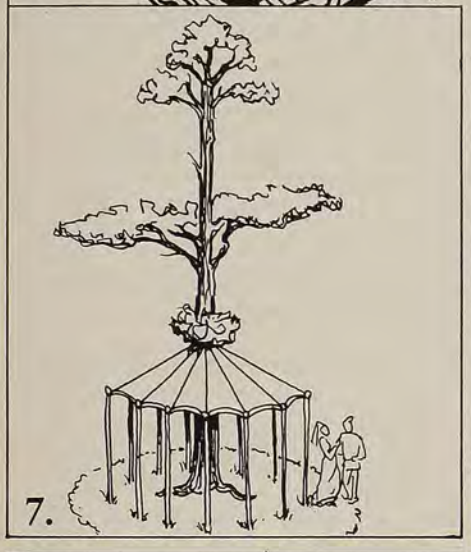
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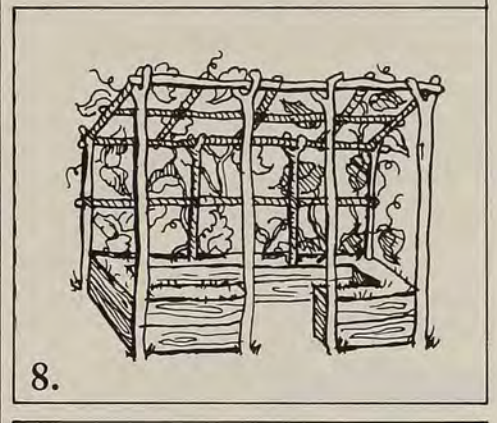
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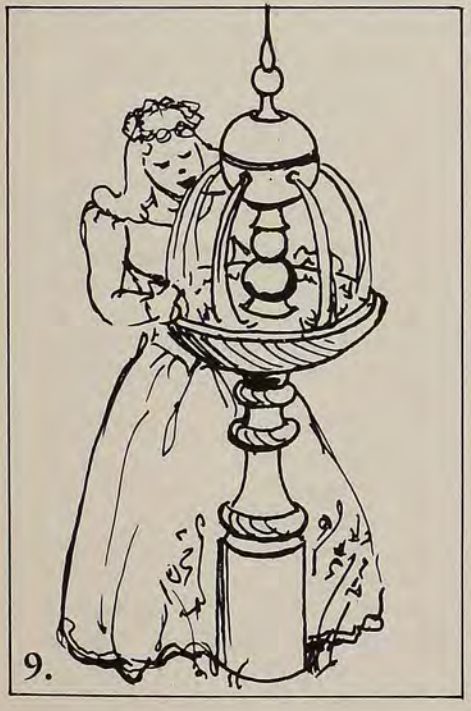
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10.

how to get contour relaxation. They shaped turf into gentle curves to fit the reclining figure. On this they sprawled, with or without a mat between themselves and the grass.

7. The branches of a giant tree, often pine, were trimmed into layers and a summerhouse skirt was added around its base. A feature such as this was encircled by a labyrinth hedging to make arrival at this spot a greater delight. A labyrinth is generally a continuing spiral. If you persist, you arrive. A maze, by contrast, is a puzzle with blocks and detours not always solved.

8. Build a vegetable arbor for vining crops of forked saplings set into the ground around a square of planter boxes. Plant squash, peas and beans in the back box, and turf on either side of the portal should you and your guest wish to sit in the shade of this bounty. Tie the cross pieces of wood together with rope. The same design might be used with grapes, so you can eat them off the vine.

9. With a spring or a waterpipe as an assist, fashion a four-way drinking fountain for your garden. It might be the central ornament in a chessboard arrangement of four to sixteen square, raised beds with paths of equal width between. Enclose the entire garden with a high fence of lattice, wattle or wide wood palings and design and build one gate for all your comings and goings. Presto! You have a *Hortus Conclusus*, an enclosed garden—the purest of human pleasures.

10. Planted in a raised bed in a wattle casing, a fruit tree can be turned for balanced growth or transported to another location. Wattle fencing is woven from fresh cut, flexible shrubbery stalks. Osier twigs are best. Known to be as strong as stone walls as fortifications, wattle was a Medieval favorite—cheap and requiring little skill to build.

Lorraine Burgess is an artist and writer on garden subjects. She is the author of *Garden Art* and *The Garden Maker's Answer Book*.

SOURCES

BERGENIA

A number of sources include *Bergenia cordifolia* and/or its most popular cultivar, 'Perfecta', in their listings. Companies in the list below that offer a wider selection are marked with an asterisk.

Plants

Carroll Gardens, PO Box 310, 444 East Main Street, Westminster, MD 21157

Garden Place, 6780 Heisley Road, Mentor, OH 44060

Powell's Gardens, Route 2, Box 86, Princeton, NC 27569, catalogue $1.50

★Shady Oaks Nursery, 700 19th Avenue, NE, Waseca, MN 56093, catalogue $1.00

★Andre Viette Farm and Nursery, Route 1, Box 16, Fishersville, VA 22939, catalogue $1.00

Wayside Gardens, Hodges, SC 29695, catalogue $1.00

White Flower Farm, Litchfield, CT 06759, catalogue $5.00

Seed

Far North Gardens, 15621 Auburndale Avenue, Livonia, MI 48154, catalogue and collector's list $1.00

J. L. Hudson, PO Box 1058, Redwood City, CA 94064, Catalogue $1.00.

Geo. W. Park Seed Company, Inc., PO Box 31, Greenwood, SC 29647

Thompson and Morgan, PO Box 100, Farmingdale, NJ 07727

CAPILLARY MAT

Capillary mat is available by the foot from Barrington Industries, PO Box 133, Barrington, IL 60010, catalogue $2.00. Algicide is also available.

FLORIADE

Write the following companies for more information about the products mentioned.

Perforated Plastic

Gebr. Eveleens
Oosteinderweg 391
1432 AZ Aaismeer
Netherlands

Nylon Drapery

Eo. Ludwig-Swensson Holland B.V.
Langeweg 1
3214 H J Zwidland
Netherlands

MEDIEVAL GARDENS

If your curiosity in old prints is piqued, look for the following books at horticultural libraries:

Early English Gardens and Garden Books, Ellen C. Eyler, Cornell University Press, 1963.

The Gardener's Labyrinth, Thomas Hill, 1577.

The Country Housewife's Garden, William Lawson, 1617.

The English Husbandman, Gervase Markham, 1614.

Paradisi in sole, Paradisus terrestris, John Parkinson, 1629.

Maison Rustique, Charles Estienne and Jean Liebault, (translated by Richard Surflet), 1600.

Mediaeval Gardens, Sir Frank Crisp, 1924, 1966.

The French Garden 1500-1800, William Howard Adams, 1979.

NANDINA

Plants

Carroll Gardens, PO Box 310, 444 East Main Street, Westminster, MD 21157

Wayside Gardens, Hodges, SC 29695, catalogue $1.00

Seed

J.L. Hudson, PO Box 1058, Redwood City, CA 94064, Catalogue $1.00

PHOTOS IN THIS ISSUE:

R = Right; L = Left; C = Center; T = Top; B = Bottom

The Bamboo Alternative: Pamela Harper 4L. Gail Gibson 4TR. Barbara W. Ellis 4BR.

Chatsworth Garden: Michael Selig 16, 18, 19TL, 19TR. Hollen Johnson 17, 19B.

Bergenia: Michael Selig 20. Barbara W. Ellis 21.

Baja: Pat O'Hara 22, 23, 24R, 25. Rita Shuster 24L, 38.

Floriade '82: Bardley Olman.

Euonymus: Gay McDonnell Bumgarner.

Capillary Mat-Watering: Dr. Richard M. Adams II.

NANDINA CONT'D *from page 9*

them with orange-gold bittersweet and mahogany-brown seed pods from a local field. The effect of these splashes of color in an old pewter pitcher was entirely different from the more formal Christmas arrangement using the same berries. This past Christmas I combined some new clusters of nandina berries with white and red candystripe carnations and long-needled pine. These new clusters of berries will last for years, but they will eventually begin to turn to a duller, deeper red.

The cultivar 'Alba' has attractive white berries, and although I could buy only the standard red-berried kind at local nurseries in Pennsylvania, I would expect that the white berries would contrast most effectively with the standard cultivars and with many varieties of evergreens.

The leaves of *Nandina* are a wonderfully complex mixture of colors in any season—pale green shading to dark green, pinkish-bronze shading to reddish-purple, dark green shading in the fall to scarlet and in the spring to bronze-green. These compounded leaflets are as attractive as the berries in flower arrangements; they will last a week or two when cut and placed in warm water.

Nandina offers contrasts of color and form rarely combined in one shrub. Even though severe winter temperatures will delay leaflet and stem growth in the spring, and berry production in the fall, tenderness in the shrub should not be considered a serious limitation because so many areas in the sheltered garden or in the house will foster healthy growth in the plant. Nurseries in the mid-Atlantic states are beginning to offer a greater variety of standard nandinas, and mail-order suppliers specialize in the more unusual dwarf cultivars.

Nurseries in the South and in western California offer a wide selection of both standard and dwarf cultivars. In these sections of the country where temperatures are mild and winters are short, growth of stems and side-shoots of *Nandina* is vigorous enough to require frequent and often extensive pruning. But in any section of the country, when *Nandina* is properly thinned, pruned, watered, sheltered and trained, it develops into an adaptable shrub of Oriental grace and beauty.

—Gail Gibson

Gail Gibson is a free lance writer and amateur gardener whose articles have appeared in *American Horticulturist, Plants Alive* and *Home Garden.*

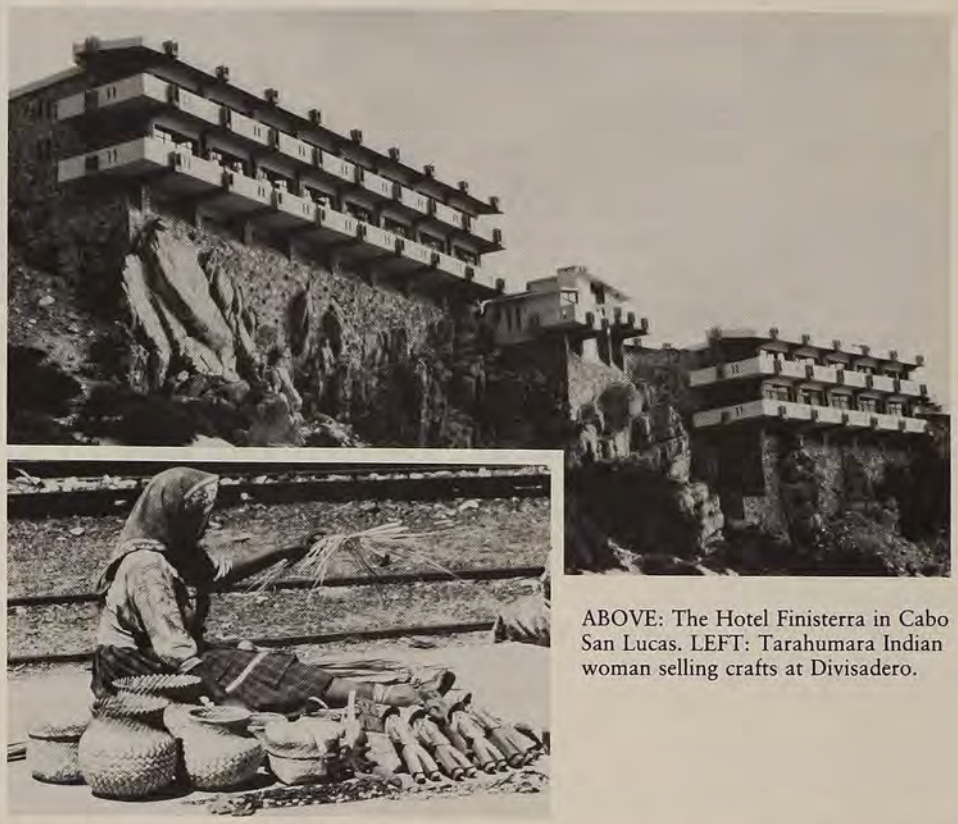
PRONUNCIATION GUIDE

Guide to Botanical Names in This Issue

The accent, or emphasis, falls on the syllable that appears in capital letters. The vowels that you see standing alone are pronounced as follows:
i—short sound; sounds like i in "hit"
o—long sound; sounds like o in "snow"
a—long sound; sounds like a in 'hay".

Aesculus parryi ESS-kew-lus PAIR-ee-eye
Agave shawii ah-GAV-ee SHAW-ee-eye
Antigonon leptopus
an-TIG-o-non LEP-toe-pus
Arbutus xalapensis
ar-BEW-tus zal-ah-PEN-sis
Arctostaphylos pungens
ark-toe-staff-FY-los PUN-jinz
Bergenia cordifolia
ber-GEN-ee-ah cor-di-FO-lee-ah
B. crassifolia b. crass-i-FO-lee-ah
B. X *schmidtii* b. SCHMIDT-ee-eye
B. stracheyi var. *alba*
b. STRAY-kee-eye AL-ba
Bombax palmeri BOM-bax PALL-mer-eye
Bougainvillea glabra
boo-gan-VEEL-ee-ah GLAY-bra
Bursera microphylla
BUR-ser-ah my-kro-FILL-ah
Dasylirion wheeleri
da-si-LEER-ee-on WHEEL-er-eye
Encelia californica
en-SEEL-ee-ah kal-i-FORN-i-ka
Erythrina flabelliformis
air-ry-THRINE-ah fla-bell-i-FORM-iss
Euonymus alata yew-ON-i-mus al-A-ta
E. atropurpurea e. at-tro-pur-pur-EE-ah
E. europaea e. your-o-PEE-ah
E. hamiltoniana e. ham-il-ton-i-A-na
Ficus benjamina FY-kus ben-ja-MY-na
Fouquieria splendens
foo-key-A-ree-ee-ah SPLEN-denz
Idria arborescens
ID-ree-ah ar-bo-RESS-ens
I. columnaris i. coll-um-NAIR-iss
Ipomoea bracteata
ip-o-ME-ah brack-tee-A-ta
Larrea divaricata
LARE-ee-ah dy-vair-i-KAY-ta
Lemaireocereus gummosus
le-mair-ee-o-SEER-ee-us gum-MO-sus
Lysiloma candida
ly-si-LOW-ma CAN-did-ah
Malacothrix glabrata
mal-ah-COTH-ricks gla-BRAY-ta
Merremia aurea mare-EM-ee-ah AW-ree-ah
Metasequoia glyptostroboides
met-ah-se-QUOY-ah
glip-toe-stro-bo-EYE-deez
Nandina domestica
nan-DEE-na doe-MES-ti-ka
Opuntia o-PUN-tee-ah
Pachycereus pecten-aboriginum
pack-i-SEER-ee-us PECK-ten a-bor-RIDGE-in-um
P. pringlei p. PRING-lee-eye
Pachycormus discolor
pack-i-COR-mus DIS-col-or
Phoenix dactylifera
FEE-nicks dack-til-IF-er-ah
Picea pungens PY-see-ah PUN-jinz
Pinus ponderosa PY-nus pon-der-O-sa
Pseudotsuga menziesii
sue-do-SUE-ga men-ZEES-ee-eye
Rhus laurina ROOS law-RY-na
Spathodea campanulata
spath-O-dee-ah kam-pan-yew-LAY-ta
Tabebuia tab-ah-bew-EE-ah
Taxodium distichum
tacks-O-dee-um dis-TY-kum
Tecoma stans te-KO-ma STANS
Tillandsia recurvata
till-ANDS-ee-ah ree-cur-VAY-ta
Tulipa bakeri TOO-lip-ah BAKE-er-eye
T. chrysantha var. *tubergeniana*
t. cry-SAN-tha too-ber-gen-ee-A-na
Yucca valida YUCK-ah VA-lid-ah

BAJA CONT'D *from page 24*



ABOVE: The Hotel Finisterra in Cabo San Lucas. LEFT: Tarahumara Indian woman selling crafts at Divisadero.

ping. The town is bright and tropical with plantings of *Bougainvillea glabra* and the African tulip tree, *Spathodea campanulata*.

We had come over 1,000 miles when we arrived in Cabo San Lucas, and for three nights we stayed at the very tip of the Baja Peninsula in the Hotel Finisterra. This hotel is built into the rocks of a cliff that overlooks the Pacific Ocean and the Gulf of California (also known as the Sea of Cortez). By day we could go swimming, walk into town and shop, take a boat ride to view the rock formations at "Land's End," or drive back into the desert to see fossilized remains of ancient whales and sharks. Pleasant evenings were spent dining to the music of a mariachi band. Then, with a fond *adios* to this lovely spot, we boarded our flight from Cabo San Lucas to cross the Gulf of California and land on the Mexican mainland for the second half of our trip.

Everyone was surprised to see huge fields of marigolds as we flew into Los Mochis. Here the flowers are harvested and dried as a crop and then used as an additive to chicken feed to brighten the color of egg yolks. Sugar cane crops also contribute to the prosperity of this modern commercial city, and the warm tropical air is rich with the sweet scent of the refineries' products. We spent an afternoon touring the city and took a boat ride in the nearby harbor of Topolobampo, where we saw groups of seals diving in the water and Magnificent Frigatebirds circling high overhead.

Los Mochis is the western terminus of the famous Chihuahua al Pacifico railroad. The train starts east across the coastal plain early in the morning, passing orchards of citrus fruit and avocados. This region is characterized by thorn forest where many kinds of trees, shrubs and cacti occur, all armed with thorns, barbs and spines. Among the mimosa, mesquite and acacia trees grows the hairbrush cactus, *Pachycereus pecten-aboriginum*. The spiny fruits of this cactus have been gathered and used as combs by natives of the region. The thorn forest is gradually replaced by the sub-tropical deciduous forest where the train begins to ascend into the mountains. At the end of the winter dry season many trees come into bloom before leafing out. We saw the silk-cotton tree, *Bombax palmeri*, with spectacular white-petalled blooms up to eight-inches in diameter, and the showy flower clusters of both pink and yellow primavera or trumpet trees, *Tabebuia* spp. Two unusual relatives of the morning glory occur in the canyons of the region. The bracted morning glory, *Ipomoea bracteata*, climbs over trees and shrubs and makes a show with masses of rosy

bracts. The stark branches of the tree morning glory, *Ipomoea arborescens*, bear fragrant white blooms that open at night and attract bats as pollinators. Altogether the train crosses a system of 39 bridges and 86 tunnels between Los Mochis and Chihuahua. Climbing the canyon of the Rio Fuerte we passed deep gorges, alluring waterfalls and shady side canyons. Many surprises and treasures await the botanist who ventures into this steep and rugged terrain. We marvelled at the robust *Ficus* trees with roots spreading over rocks, the spider-shaped agaves clinging to sheer cliffs and the wild dahlias with glossy scarlet petals.

By mid-afternoon we reached the top of the canyons and rode out into the Sierras where the terrain levels out and the pine and oak forest extends for hundreds of square miles. Here and there the smooth, red bark of the madrone tree, *Arbutus xalapensis* (formerly *A. texana*) shines out between the somber pines. The common shrub, Mexican manzanita, *Arctostaphylos pungens*, with its red bark, evergreen leaves and pale-pink flowers, is a smaller relative of the madrone (both are in the Ericaceae). At the station in Divisadero we stepped off the train and walked down a short sidewalk to our hotel on the rim of the Copper Canyon. Leaning on the rail at the rim we looked down at buzzards sailing on the wind currents in the canyon and at the Urique River 4,000 feet below. We had climbed from sea level at Los Mochis to 8,000 feet at Divisadero in one day, and the air felt thin and cool. The rustic hotel at Divisadero had small fireplaces in every room, though, so we could each enjoy a warm and cheerful blaze that night.

In the morning we hiked along the canyon rim identifying many species of pines and oaks in the forest. Small clearings in the vegetation that clothed the canyon walls identified the distant cornfields and dwellings of the Tarahumara Indians who live in the area. Some Tarahumara women and children gathered around the station platform to sell lidded baskets made from sotol, *Dasylirion wheeleri*, dolls and figurines carved from pine bark, *Pinus ponderosa*, and coral beans, *Erythrina flabelliformis*, strung as beads.

A short train ride over the mountains brought us into the town of Creel, center of the logging industry in the region and a headquarters for Indian activity. Creel is a major marketplace for local crafts and we chose from blankets, mugs, baskets, pottery and woodenware. Many of the Tarahumara Indians still wear traditional costumes and live in caves or hand-hewn log houses. We visited some local families and took an excursion to see the 250-foot waterfall at nearby Cusarare.

Our trip ended in Chihuahua City with an extended tour of the main plaza, the cathedral, Pancho Villa's mansion and the central markets. We had traveled over 1,500 miles and had seen plants of tremendous diversity: seaside plantings and mountain flora, plants of the sub tropics and those of the desert, all within an area possessing a distinctly different culture from our own. Our tour of Baja had lived up to its promise of being a true horticultural exploration.

Rita Ann Shuster recently received her master's degree in botany from the University of Colorado in Boulder. She has also taught adult education courses in gardening and greenhouse management.

CAPILLARY-MAT WATERING

Ferns, sundews and a pitcher plant, grown by the author in this terrarium, thrive in the environment he has created with the help of a capillary mat.

Thick, fluffy, pure-white capillary mat fabric draws up water and transfers it efficiently to pots with soil in contact with it. This property, which allows indoor plants to be watered continuously and automatically without underwatering, may be one of today's most liberating advances in indoor horticulture.

With a capillary mat system I no longer water the plants in my fluorescent light garden one-by-one; I just add water to a central reservoir, and water reaches each plant all week long. A capillary mat dips into the water trough and loops over a flat sheet of crystal clear acrylic sheeting. Water is drawn into the mat, then into the pots through string wicks or soil sticking out of the drainage holes. Since I switched to capillary-mat watering my plants have never looked better, and I have more time for things other than watering.

A capillary mat or "cap-mat" is simply a piece of water-conducting cloth. Its effectiveness is based on capillary action, the tendency for water to be drawn into small spaces when the molecules stick to other surfaces as well as to each other. Some examples of people who could benefit from capillary-mat watering:

- The self-effacing "brown-thumb" who claims not to be able to pick up the knack of watering, or tends to water by the calendar rather than need.
- The green-thumb who never has enough time to water plants when they need it.
- People who go away and don't want to neglect their plants or leave them in the hands of a potential brown-thumb or calendar-waterer.

And plants that could benefit:

- Flats of seeds or cuttings: these require continuous moisture to germinate or grow but, if overwatered, may be susceptible to damping-off.
- Terrariums, easily overwatered because of their closed bottoms, easily neglected because they don't need watering often.
- Prized specimens coming into flower: if over or under watered their blooms may wither.
- Kitchen herb gardens: they require optimal water levels for the best growth, appearance and pungency.
- Bonsai: growing in minuscule amounts of soil, they may need watering twice daily; forget to water, and the results of years of pruning, shaping, training may be over with in a day.

THE CAP-MAT CONCEPT

The explanation of capillary mats begins with water. Plants, weight-wise, are largely water, but most of it is transient, flowing continuously from substrate to roots, roots to shoots, and evaporating from shoots to air. Although the water accounting for most of the plant's weight is in continuous flux, being absorbed, conducted and transpired, the total quantity must remain within close tolerances for the plant to survive.

Cultivating plants involves balancing their water flow. We supply water at the input point, the roots, and we help regulate its outflow through the leaves by adjusting ventilation, temperature and light level.

Watering would be simpler but roots have conflicting demands. They need water around them to absorb, but they also need to "breathe." Roots are living tissues that need oxygen for respiration, but oxygen diffuses through water much more slowly than through air. Some aquatic plants have foliar air passages through which oxygen

Building a Cap-Mat Terrarium or Planter

1. **BASE.** Select as a water reservoir a three-dimensional clear plastic picture frame, 5 × 7, 8 × 10 or 11 × 14 inches.

2. **TOP.** For the terrarium or planter, cut (or have a plastics retailer cut) pieces of ⅛ inch-thick acrylic sheeting, sized to fit on top of the frame, as follows: **2 sides:** *length* that of the frame by the *height* you choose for the terrarium **2 ends:** *width* that of the frame *plus ¼ inch* (or twice the thickness of the plastic used, to compensate for the thickness of the frame's sides), by the *height* chosen for the terrarium. **Bottom:** *thickness* of plastic 3/16 or ¼ inch to support the weight of the soil, *length* that of the frame *minus ⅜ inch* (to allow for end gaps for the mat to pass through), *width* the same as the frame's. **Top:** *length* and *width* that of frame, both *plus ¼ inch,* to allow top to sit on sides.

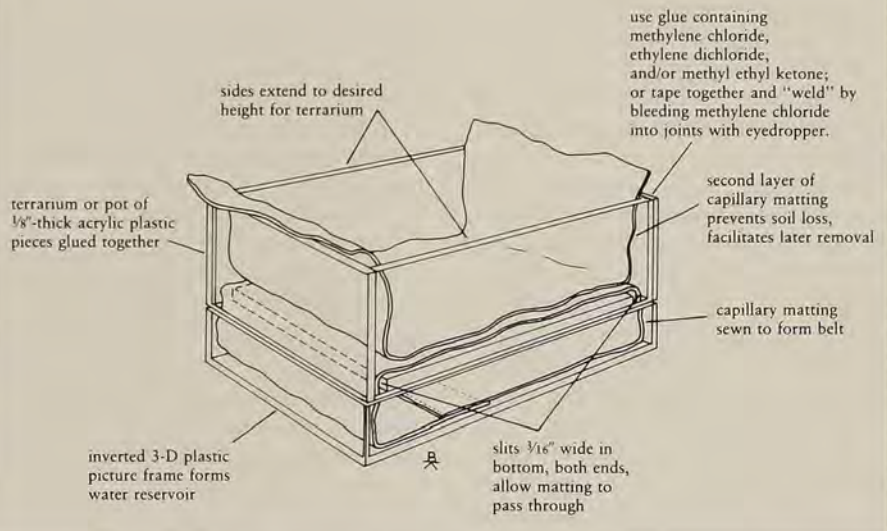
All pieces must be precisely cut for a good fit. If you visit a plastics dealer, write down the number of pieces needed and their dimensions to facilitate ordering. When you pick up the pieces, take a ruler and check the accuracy of the cutting.

3. **GLUING.** Join the plastic pieces with an acrylic glue, one containing methylene chloride, ethylene chloride and/or methyl ethyl ketone. Or, for a more finished appearance, assemble the pieces in their final form with removable tape (e.g. drafting tape) and apply methylene chloride along the joints using an eye-dropper or fine-pointed applicator bottle (available from plastics dealers). The methylene chloride will be drawn by capillarity into the joints and will "weld" the pieces together in a strong, neat-looking bond. In assembling, allow the *sides* to extend 3/16 of an inch beyond the bottom at either end, leaving a gap for the matting to pass through. The *ends* should abut the sides, given the above dimensions, so the outside edges of the terrarium and frame will be flush.

4. **MATTING.** Cut a strip of capillary mat fabric the width of the inside and a little longer than twice the length. You will need enough to cover the bottom and dip into the water reservoir in a continuous loop. Thread the ends of the matting through the slits in the bottom of the terrarium and sew them together.

5. **LINER.** Cut another strip of matting to line the inside (see diagram). This will prevent soil from seeping through the end slits into the reservoir and will also make it easier to remove the medium if you should replant.

Figure 1



6. **SUBSTRATE.** Mix the growing medium, add a wetting agent if desired to speed water uptake, moisten and spoon into the terrarium. Soil moisture, aeration and weight can be controlled by adding perlite and/or vermiculite. As an alternative to adding soil, place individually potted plants, wicked to ensure moisture flow, directly on the mat. This is good for rooting cuttings or germinating seeds.

7. **PLANTING.** Use plants that prefer moist soil. This includes most species except epiphytic plants like orchids with roots that need to dry out and xerophytic succulents and cacti. Succulents might do well if the water reservoir were filled only briefly, drained and refilled only when the soil dried again.

8. **FILLING RESERVOIR.** Distilled or rain water is best. Refilling will be required about once a month, depending upon closure of top, air exchange, number of plants and other factors that influence transpiration and evaporation.

9. **LIGHT.** Place the terrarium in diffuse light, bright or dim according to the plants' requirements, but not in direct sunlight, as the "greenhouse effect" (the plastic's admission of visible radiation and retention of infrared) will overheat the inside of a covered terrarium.

Sizes of plastic pieces required for building capillary mat terrariums on top of picture frames of given sizes.

	Frame size			Formula
Pieces	5 × 7	8 × 10	11 × 14	length × width
2 sides	7 × height	10 × height	14 × height	$1 \times$ height
2 ends	5¼ × height	8¼ × height	11¼ × height	$(w + ¼) \times$ height
top	5¼ × 7¼	8¼ × 10¼	11¼ × 14¼	$(w + ¼) \times 1 + ¼$
bottom	5 × 6⅝	8 × 9⅝	11 × 13⅝	$w \times (1 - ⅜)$

reaches their roots, and many succulents can stay dry a long time, but ordinary plants' roots—those not so specialized—need to have both moisture and oxygen in the proper balance, and that balance makes watering an art. We must strive for the optimal moisture level, staying on a fine line between too much and too little.

To do this, we need to know something of the forces that control water. Gravity and capillary action are two of the most powerful controlling forces. You can see them come into balance by dipping a sponge into water, pulling it out and holding it up to drain. As you pull the sponge from the water, gravity draws water from it—a stream at first, becoming finer, breaking into droplets that gradually slow in formation and cease. At this point the sponge is still wet; the remaining water is held by capillarity.

Soil is like a sponge in that gravity and capillarity control its water content. In a plant container gravity draws water down and out of the soil, while capillarity draws it in. More specifically, a well-structured soil is approximately 50 percent pore space, about half of this micropores—spaces so small and narrow that they draw in water like capillary tubes. The other half of the pore space is macropores—larger spaces where gravity predominates and draws water downward. To plants, this means micropores soak up water that roots can absorb, while macropores allow water to drain out and air to diffuse in.

In the ground a "tug-of-war" between these two forces balances the water content. Capillarity takes its grip in the micropores that form a vast, sponge-like network absorbing water and spreading it uniformly through the soil. Gravity predominates in the macropores, draining them. After a rain, when the soil equilibrates, the micropores are full of water and the macropores are empty. At this point the soil is said to be at field capacity (as opposed to saturation, where all spaces are full, or the wilting point where all spaces are nearly empty).

Growing a plant in a pot, we isolate a cylinder of soil from the capillary network of which it would, in the ground, be a part. We break the imaginary rope through which the counterbalancing forces tug. By direct analogy, gravity has a shorter length of soil upon which to pull, and this smaller segment of soil is isolated from the larger, capillary sponge of soil. So, *after watering, potted soil retains more water* than would soil in the ground, but since it also has less total absorbent capacity *it also dries out faster*. Its water level cannot as readily be balanced at field capacity, so the plant is continually subjected to extremes of sogginess and drought.

The capillary-mat or "cap-mat" system for watering potted plants has the effect of making each pot part of a larger system with the properties of soil in the field.

The mat itself is a sheet of water-absorbing material. You lay it on a level, waterproof surface, keep it moist, and set pots on it with their medium in contact with the mat (directly or by a wick). The substrate in each pot draws water from the mat by capillary action, so it is maintained continually at field capacity. The moisture level can be varied by adjusting the height of the mat above the water source. Continuous moisture may be excessive for plants that need to dry out between waterings, like succulents or epiphytes, and it may be insufficient for those preferring to stand in water, like aquatics and some kinds of bog plants, but for most plants, those thriving in soil that is evenly moist and near field capacity, it is ideal. A capillary mat system is quite simple: it requires a sheet of water-conducting fabric, a water source and contact between the soil and the mat.

HISTORY

The first capillary "mats" were layers of sand on benches. The sand drew water from channels underneath or was moistened continuously by automatic or drip irrigation systems. But sand is heavy and difficult to put down and remove. Later, cloth mats were developed to replace sand. Today, a large-scale commercial set-up may consist of a cotton or synthetic-fiber mat underlaid by polyethylene sheeting atop a level bench. It may be watered intermittently by timer-controlled spray nozzles, or continuously by water-permeable tubing or a network of Chapin "spaghetti" tubes, the water draining freely from the bench.

Those who grow a variety of plants in different media and pots can realize a key advantage of cap-mats: as long as the mat is moist and mat-soil contact is good, *all pots will be kept continually at the same moisture level*, regardless of how much water they use. Here, the cap-mat eliminates both the application of water and the decisions as to which plants need watering.

MATERIALS FOR SET-UPS

Mats. These are made of organic or synthetic fibers. Organic fibers may be cheaper, but synthetic fibers last longer. One brand of organic-fiber mat is advertised as having a useful lifespan of 2½ years, while synthetic mats may last for several years. Mats are generally sold by horticultural supply companies (see the Sources Section on page 34) in long rolls, say 150 feet. If cap-mats become more popular with homeowners, the material may become more readily available by the yard or foot.

Growing Media. In experiments with capillary-mat watering at Cornell University, peat-lite mixes have been used. They are light in weight and have a high cation-exchange capacity (the ability to hold nutrients and release them gradually). These mixes consist of varying proportions of peat moss, vermiculite and perlite. The proportions of these ingredients determine the properties of the medium—its moisture content, aeration, cation-exchange capacity and weight. Peat, decomposed sphagnum moss, is organic, acidic, has high moisture and cation-exchange capacities and is heavy; pure peat is poorly aerated, however. Perlite, exploded lava rock, is neutral in pH, holds little moisture and has a low cation-exchange capacity, but is lightweight, promotes good aeration and is durable. Perlite contains trace amounts of fluoride, which may be toxic to some plants, but this can be removed by rinsing in running water. Vermiculite, exploded mica rock, is also lightweight but, because it is many-layered, it has high cation-exchange and moderate moisture and air-holding capacities. It is easily compressed, however, and does not last a long time.

Pots. Hard plastic (e.g. polystyrene) pots have thin walls and can often be used on mats without wicking if they do not have long feet. Clay is permeable to water, and clay pots lose moisture faster than plastic pots. (Also, the moisture lost through their sides may support growths of algae, moss and fungi.) Styrofoam plastic pots do not lose moisture through their sides and are light-weight, but they are thick-walled for strength, so there is often a gap between the soil and the bottom of the pot; the pots must be wicked to be used effectively on a capillary mat.

—Dr. Richard M. Adams, II

Dr. Richard M. Adams, II is the Curator of the University of California, Riverside, Botanic Gardens.

Setting Up a Capillary-Mat Watering System

Figure 2—Large Scale, Trough-Type Set-Up

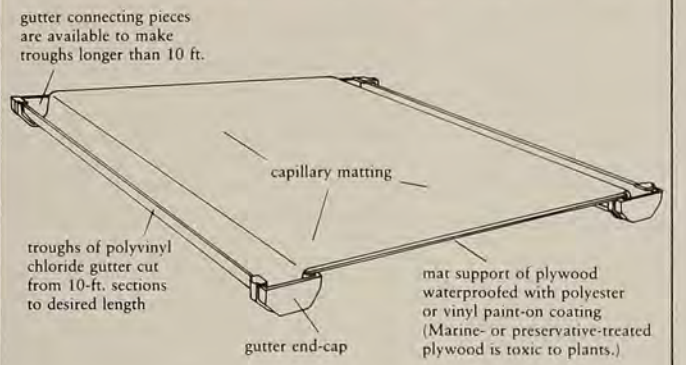
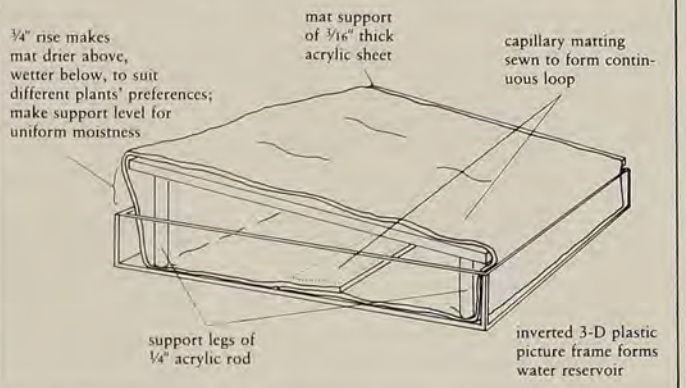


Figure 3—Stand-in Mat



1. **MATERIALS.** A level, waterproof *support surface* and a *water reservoir* are all you need. Suitable support materials include acrylic plastic sheeting (e.g. Plexiglas, Lucite), wood coated with vinyl or polyester or covered with polyethylene sheeting, and (for the smallest set-ups) glass. The reservoirs can be any stable containers into which the matting can extend. The size of trays and troughs can be made to fit the required space, even narrow windowsills. My set-ups, which stand on a fluorescent light plant cart shelf, are of two types:

- **The trough-type** (Figure 2) has a 3/16-inch-thick acrylic sheet (15 × 18 in.) that straddles two troughs (18 × 3 × 1½ in. high) made of acrylic. The capillary mat covers the support and dips into the troughs at either side. The troughs were made from cheaper, "scrap" acrylic, leftover pieces from large sheets, often sold by the pound by plastics retailers. I have also used balsa wood for supports and troughs. Balsa is inexpensive and can be cut with a razor blade or X-acto knife, but several coats of vinyl are needed to make it waterproof.

  For large-scale set-ups, acrylic sheeting becomes expensive as area and thickness increase. It is cheaper to use plywood (with a waterproof plastic coating, but not marine or other treated plywood, which can be toxic to plants) for supports and polyvinyl chloride gutter sections or slit-open, 4-inch polyvinyl chloride tubing (available from building suppliers) for troughs. If you have an automatic watering system, it can be used to keep a capillary mat moist. Simply lay the mat on top of a layer of 4-mil polyethylene sheeting and set up enough watering tubes or nozzles to adequately moisten the mat.

- **The stand-in** set-up (Figure 3) has an inverted picture frame as the reservoir, in which stands a piece of acrylic on four legs. The mat forms a continuous loop over the support and into the inverted frame. One such set-up consists of an 8 × 10 inch frame with an 8 × 10 inch acrylic support. (The frame is actually a little larger than 8 × 10 inches, to hold artwork of that size, so the support fits nicely inside.) The acrylic sheet is supported by legs made of ¼-inch-diameter acrylic rods. The mat is higher on one side to give a range of dampness for growing plants with different moisture preferences. There can be several stand-in supports in a single, large reservoir. Another of my set-ups is a 11 × 14 inch frame with four supports, 5½ × 7, each a different height.

2. **RESERVOIR SIZE.** How large should the water reservoirs be in relation to the mat area? The greater their water-storage capacity, the less often you will have to refill them. How often will depend upon the relative humidity, air flow, amount of light, number and sizes of plants on the mat and their transpiration rates. In general, I have found that to go a week or more between refillings indoors, the volume of the reservoirs should be approximately equal to the area of capillary mat surface. For example, a mat 15 × 18 inches (270 square inches) will require two 18 × 5 × 1½ inch (270 cubic inches) reservoirs.

3. **SETTING UP.** Cut a piece of matting of appropriate size and lay it over the support, dipping into the reservoirs (see Figure 2). The mat may be slow to take up water at first but you can sprinkle water on it; excess will drain into the reservoirs. Use rain or distilled water, if available, since hard tap water may, as it evaporates, leave salt deposits that will clog the mat.

4. **POTS.** To take up water, the growing medium must contact the moist mat through a pot's drainage holes, either directly or via a wick. Use string, cord or yarn (preferably synthetic, since cotton and other organic fibers can rot). To test wick materials for capillarity, wet a piece, place one end in a glass of water, and let the other end hang out. If the string conducts water, it will draw water and form a puddle outside of the glass. Wicks are best incorporated at potting time. For small pots with several drainage holes, insert a continuous loop of wicking down through one hole and up into another. Fray both ends for good soil contact, and hold them into the pot while adding soil. With only one drainage hole, insert one or more pieces of string, leaving an inch or so sticking out of the bottom of the pot to contact the mat. Use pieces of crocking if necessary to keep soil from leaking out of the holes. Otherwise, no drainage material is necessary. After setting up the mat, check periodically to see that each pot is receiving adequate water. The soil should feel moist to the touch. If it is not, check the moisture of the mat, the contact between wick and mat and the contact between wick and soil.

5. **CONTROLLING MAT MOISTURE.** The amount of water in the mat depends upon its height above the water reservoirs, the higher the drier. This is useful in regulating the mat's moisture content to suit the moisture preferences of plants. For carnivorous plants, I keep the water level within half an inch of the mat surface to keep these bog dwellers wet. For palm trees and ferns that like it drier, the mat is an inch or more above the water. I have successfuly grown succulents on mats six inches above the water supply. You can get different moisture levels on the same mat: tilt the support surface by propping up the back of trough-type mats or using two different lengths of legs on stand-in set-ups, raise the mat in small areas by putting thick pieces of plastic or other supports underneath it, or set pots on top of moisture-conducting florist's foam. To test the range of moisture conditions obtainable, I am experimenting with bog plants and desert plants—on the same mat!

6. **ALGAE.** If algae grow on the mat, they can be controlled if necessary with the application of a fungicide/algicide, such as Physan 20.

7. **FERTILIZATION.** Liquid fertilizer, if it drains from pots or is applied to the mat, will encourage the growth of algae. To avoid this, use solid, timed-release fertilizer in the soil.

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The lower half of the Nutriponics® planter shown above is transparent so you can see the water level. The roots grow down into the liquid and pull up water and nutrients as needed. You need add water only every week or two depending on the plant. Tomatoes may require more frequent watering when the plant is large.

• Our instruction leaflet on growing tomatoes indoors is free for the asking. Also we have written an illustrated 52-page book on NUTRIPONICS which is included in each of the kits listed in the coupon shown below.

The tomatoes in the above photo are Pixie which are sweet and very red, and they are larger than cherry tomatoes. They are growing in our attractive planter which makes plants grow faster and better. We have had similar success with all types of plants from African Violets to Geraniums to Sunflowers. You can also use Nutriponics to give your plants a head start for planting later outdoors.

You will be thrilled at how easy it is to grow your favorite plants using this new technique. We do not grow plants for sale, but we have hundreds of different kinds of plants growing in our experimental areas. Write us for more information or use the coupon below.

Windowsill Gardens, Grafton, N.H. 03240, Dept. AHJ

☐ Send Information Name_____

☐ Send $9.95 kit Street_____

☐ Send $19.80 kit City_____ State_____ Zip_____

Includes planter shown above. Include $2.00 for shipping

WINDOWSILL GARDENS

Grafton, New Hampshire 03240