The American HORTICULTURAL Magazine

fall 1969 / *volume 48* / *number 4*

Journal of the American Horticultural Society, Inc.

2401 CALVERT STREET, N.W. / WASHINGTON, D. C. 20008

For United Horticulture . . .

The particular objects and business of the American Horticultural Society are to promote and encourage national interest in scientific research and education in horticulture in all of its branches.

THE AMERICAN HORTICULTURAL MAGAZINE is the official publication of The American Horticultural Society and is issued during the Winter, Spring, Summer, and Fall quarters. The magazine is included as a benefit of membership in The American Horticultural Society, individual membership dues being $15.00 a year.

THE AMERICAN HORTICULTURAL MAGAZINE is devoted to the dissemination of knowledge in the science and art of growing ornamental plants, fruits, vegetables, and related subjects. Original papers which increase knowledge of plant materials of economic and aesthetic importance are invited. For manuscript specifications, please consult the chairman of the Publications Committee.

Second class postage paid at Baltimore, Maryland and at additional mailing offices.

FALL • 1969

VOLUME 48 • NUMBER 4

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FRONT COVER ILLUSTRATION

Protea cynaroides, king protea. Flowers 5 to 6 inches across. National flower of South Africa.

PHOTO S. J. LIEBENBERG, COURTESY, SOUTH AFRICAN TOURIST CORPORATION

BACK COVER ILLUSTRATION

"Laurel de la India", Ciudad Victoria, Tamaulipas, Mexico

PHOTO JOHN M. HALLER

Guest Editorial

Because the following editorial states so precisely the need for sound leadership and sound policy in the area of environmental legislation, your editors present it as a matter of certain interest to all members of the Society.

National Policy of Environmental Protection

The chief question raised by President Nixon's creation of a cabinet-level Environmental Quality Council is whether it will be equal to the major tasks which the country faces in this sphere. The destruction of natural resources and the pollution of water and air have assumed proportions which make drastic action imperative. Many observers fear that even a Council headed by the President and including all the Cabinet heads directly concerned may not be able to reverse the trends which now threaten us.

It is not merely a matter of cleaning up the Nation's rivers and attacking the problem of smog, vital as these objectives may be. The country must wake up to the fact that the quality of our living space is seriously deteriorating on a broad scale. Open space is gobbled up for superhighways, airports, factories and suburban developments without much thought of what the consequences will be for both present and future generations. Reckless use of the land strips it of fertility and at the same time fouls once beautiful and useful streams. The proliferation of pesticides threatens to upset the balance of nature and to leave poison residues that may afflict man as well as wildlife. And the spread of urban sprawl, messy industrial areas, junkyards, billboards and power lines gravely detracts from the amentities of life.

No doubt the public will have a chance to air many views through the Citizens' Advisory Committee on Environmental Quality which is to be headed by Laurance S. Rockefeller. Nevertheless, the larger problem seems to be to infuse all governmental programs with a policy of protecting the environment. Fortunately there is agreement between the White House and leaders on Capitol Hill on the need for legislation that will leave no doubt of the national intention to stop fouling our living space.

Senator Jackson, chairman of the Interior and Insular Affairs Committee, has amended his bill to establish a national environmental policy so as to supplement the step the President has already taken. The bill would declare a national policy of preventing and eliminating damage to the environment. It would seek to "assure for all Americans safe, healthful, productive and aesthetically and culturally pleasing surroundings"; to attain the widest beneficial use of resources compatible with conservation and protection of the environment, and the preservation of historic, cultural and natural values.

Probably the most significant aspect of the bill is that it would recognize for each person a "fundamental and inalienable right to a healthful environment" and impose on each a "responsibility to contribute to the preservation and enhancement of the environment." Every governmental agency would be required to carry out its functions in the light of the new congressional policy that the bill would set up. In the past protection of the environment has been nobody's business. Under this proposed legislation it would become the responsibility of every agency whose activities have any bearing on the environment.

Only experience will point to the precise kind of organization that is necessary. But the enactment of a sound legislative policy, the authorization of research and the provision of adequate trained personnel are certainly essential first steps. Congress should lose no time in supplementing the President's efforts.

The Editors

THE WASHINGTON POST

June 3, 1969 Washington, D. C.

Proteads—
A Gardener's Challenge

ROBERT L. EGOLF

Dr. Egolf, a physician, has degrees from Yale and Temple Universities and is at present working in Student Health at the University of South Florida, Tampa 33620. He attributes his early interest in horticulture to a long line of Pennsylvania Dutch farming ancestors on both sides. Since 1962 this interest has been greatly stimulated by his friendship with Dr. Edwin A. Menninger, a leader in Florida and world horticulture and a contributor to this magazine. For several years Dr. Egolf's major efforts have been directed to the introduction and establishment in Florida of some of the greatly neglected wealth of the flora of South Africa, Australia, and New Zealand. This article deals with one aspect of that work. (In the photo of the author, the foliage shown is that of Stenocarpus sinuatus, *a plant mentioned in the text.)*

Plants of the Protea family (*Proteaceae*) are for gardeners a difficult and challenging group to grow. If they were not, the plants comprising it would be far more common than they are in the gardens of our southern and southwestern states. Instead of being common they are nearly unknown. How many gardeners have seen in this country even a single plant of the family in bloom? This is doubly unfortunate because in the family are numbered some of the world's most spectacular flowering trees and shrubs. The only plant of the family common in Florida is the silky-oak *Grevillea robusta,* from Australia; and while this tree is handsome enough in late spring with its large golden trusses of flowers, it is far from being uncommonly showy. Two other plants of the family occasionally seen in Florida are the macadamia nut tree, *Macadamia integrifolia,* and the firewheel tree, *Stenocarpus sinuatus,* both from Queensland, Australia. In California the silver tree of the Cape of Good Hope, *Leucadendron argenteum,* is grown, as well as a few leucospermums, the silky-oak, and *Hakea.* These examples are exceptional because in general many members of the family resist cultivation, especially outside their natural range and habitat.

The natural distribution of the Protea family is almost entirely confined to the southern hemisphere. Australia, with 35 genera and 800 species, and South Africa, with 14 genera and 380 species, are the main centers of distribution. The family is also found in South America, mainly along the western coast, and

Brazil extending as far north as Mexico; in Africa (outside South Africa) north to Ethiopia; in Madagascar; and in the Pacific from New Zealand through the islands of Melanesia to Japan. In all there are 55 genera and nearly 1200 species in the family. Of these, species in not more than a dozen genera are commonly cultivated, mostly in Australia, New Zealand, and South Africa. In the northern hemisphere a number of the hardier grevilleas from Australia, and *Embothrium* from Chile are grown in Ireland, Cornwall, and the Scilly Islands, and our Pacific coast. Whether any of the Protea family are commonly grown in southern Europe, about the Mediterranean, I do not know, but the climate would appear suitable.*

A few plants of the Protea family in northern Australia and on the islands north of Australia are found on wet tropical lowlands or in rain forest. But the majority of the family are characteristic of semi-arid regions. Proteaceous plants are found in abundance in Western Australia, where the annual rainfall may be 10 inches or less, and in smaller numbers in eastern and northern Australia, with a wetter climate.

The South African and Australian species discussed here grow on deep open sand or gravel soils of low fertility, usually dry and with sharp drainage. When the surface soil is closely underlaid with an impervious layer of clay or limestone the plants do not thrive. Acidic soil conditions are a necessity, and nearly the entire family is wholly intolerant of lime. In regions where proteaceous plants are in greatest abundance, in both Australia and South Africa, rain falls in winter; summer is dry and hot. Rain out of season is definitely injurious and may cause rotting of the roots. In Australia native banksias left standing as garden plants when land is

*The Chilean hazelnut *Gevuina avellana* is grown in England and California, and species of *Banksia* are grown in Portugal and on the French Riviera. Another protead, *Roupala macrophylla* 'Corcovadensis' from Brazil, is cultivated in greenhouses in Europe. (*Ed.*)

PHOTO E. E. LORD

***Telopea speciosissima*, New South Wales Waratah. Flowers intense red. New South Wales, Australia, near the coast.**

***Grevillea robusta*, silk-oak. The commonest species of the genus in cultivation. Grown in many warm countries for a street tree, also much grown in pots as a houseplant in the United States and Europe. Produces attractive golden-yellow flowers in heads. Native of eastern Australia.**

PHOTO LONGWOOD GARDENS

***Grevillea petrophiloides*, bottlebrush grevillea. Shrub 4 to 5 ft. high, with plume-like pink flowers. Western Australia.**

***Banksia grandis*. Large shrub to tree about 40 ft., with whitish tomentose branches. Leaves often 1 ft. or more long. Flower spikes 8 to 12 inches long. A striking plant now cultivated in California. Native of Western Australia.**

PHOTO DOUGLAS ELLIOTT

***Hakea laurina*, sea urchin tree. A shrub of 10 ft. or more, or a small tree to 30 ft. Flowers red studded like a pin-cushion with creamy white pins. Cultivated in California and, rarely, in Florida. Native of Western Australia.**

PHOTO E. E. LORD

cleared and developed usually die if artificial watering is begun. For this reason California and the lower southwest of our country would appear to be better adapted to growing plants of the family than Florida or the southeast, where summer rains are the rule. However, summer rainfall areas exist in South Africa and proteas are successfully cultivated there if special attention is given to drainage.

Mycorrhizal Relationships

Why are the plants of the Protea family so difficult to grow? In the first place, production of fertile seed is low, and what there is tends to germinate erratically unless absolutely fresh. Seedlings once germinated are difficult to establish. Mortality in the first year is extremely high, usually over 75 per cent, in my experience, and often more than 90 per cent. The seedlings are apparently dependent upon the establishment of a root fungus for normal growth and development. They are also extremely sensitive to damping off. It is difficult to encourage the necessary root fungus while also discouraging the damping off fungus. Mycorrhizal associations are of widespread occurrence in the plant kingdom, from pine trees to orchids. The fungi apparently invade the roots of the host plant, and it is speculated that they supply enzymes that can break down complex organic materials in the soil into simple nutrients available to the host.

When transplanting proteaceous seedlings Australian nurserymen advise discarding plants that do not have a visible ball of hairy fungus clinging to the roots. The young plants do not adapt well to growing in containers because the necessary soil microorganisms are hard to maintain in the enclosed, limited environment of a container. Soil microorganisms are very sensitive to cultural practices, and the application of chemical fertilizers or animal manures, or even cultivation about the roots of a plant are apt to disrupt an existing balance. It is safest to eliminate such things entirely about proteaceous seedlings and plants. These problems associated with root fungi are compounded for us because imported seeds must be sterilized before entry into the country. After germination, seedlings must depend for survival upon a chance and unlikely contact with a compatible root fungus. Lack of a naturally occurring symbiotic root fungus explains the disproportionately large seedling losses we have.

Importation of larger established plants is not likely to be successful either. A proteaceous plant of any size will not tolerate having the soil removed from its roots, and any attempt to move a plant established in the ground is wholly useless. For the most part cuttings root poorly, and the resulting plants are often weak rooted, misshapen, and unsatisfactory. Plants of the Protea family transplant with difficulty, even when container-grown, I have not found any other group of plants half so resentful of disturbance at the roots as these. Almost every gardener experienced with these plants agrees that the roots of a proteaceous plant are best left strictly alone. There is less unanimity about pruning. On the one hand we are advised to pinch the tips of young plants repeatedly to obtain a vigorous, bushy growth. On the other, hard pruning of an established plant is occasionally followed by total collapse. In this there is much difference among different species and genera. For all of these reasons plants of the Protea family cultivated in gardens have acquired the evil reputation of being in a flourishing condition one day, and dead the next. *Leucadendron argenteum* is considered a short-lived, undependable plant in California, and yet it is one of the few proteaceous plants available in the nursery trade.

In spite of these difficulties, plants of this family can be cultivated successfully. In their native countries they are the ornament of many gardens, and are acknowledged to be worth all the problems they bring, and more. In these countries they even support a cut-flower industry, and there has recently been talk in South Africa of prohibiting the export of protea seed as an economic measure to protect the flower growers.

Culture

The basic cultural conditions should be a poor, acidic soil, sharp drainage, and minimum disturbance. With such contrary plants one must be willing to continually try new things. At one time or another I have used nearly every imaginable germination technique including cold stratification, sulfuric acid, boiling water, mechanical scarification, and complete removal of the seed coats, and for media, vermiculite, sand, moistened layers of tissue paper, and regular potting soil. On several occasions I have kept seeds in soil under what seemed ideal conditions for more than a year, given up in disgust and reused the potting soil, only to have seedlings appear in 2 or 3 weeks among the other plants. Usually, however, if plants are going to come from proteaceous seed they will appear within a month. Seeds of a number of proteaceous genera have resisted every effort of mine to germinate them, but I am inclined to attribute these failures to aged seed. Recently a technique of germinating difficult seeds on fine wire screens under a continuously moving stream of water was described. This I have not yet tried but it might hold promise for the proteas. The technique rests on the evidence that there are water soluble substances in the outer

PHOTO DOUGLAS ELLIOTT

Dryandra formosa. **An erect shrub attaining 8 to 15 ft., with tomentose branches. Leaves 4 to 8 inches long. Flower heads 1 to 1½ inches in diameter, silvery villous hairy. Related species now cultivated in California. Native of Western Australia.**

PHOTO P. H. BRYDON

Banksia speciosa. **Shrub ultimately about 10 ft. high. Leaves 8 to 12 inches long, more or less white tomentose beneath, stems also white woolly. Inflorescence about 5 inches long with silvery bracts and bright yellow stamens. Cultivated in California. Native of Western Australia.**

coats of some seeds that inhibit germination, and that these can be removed by running water.

Keeping seedlings alive, once germinated, is something else again. Australian genera seem to me a little easier than those from South Africa. Seedlings that survive the first year become easier to handle, partly because weaklings have been eliminated. I have had somewhat better success germinating seed in vermiculite than in soil, but seedlings germinated in soil in individual containers are a little more likely to survive because the initial pricking out is bypassed. The best way to get plants from seedlings is to play the game with numbers. If a half dozen seedlings are potted you are likely to be wiped out. If you can get 25 or 50 seedlings the chances are better that some will survive. I have one two-year-old *Protea obtusifolia* alive that represents an original seedling group of about 55. This kind of experience, frequently repeated, can discourage the most enthusiastic gardener.

PHOTO DOUGLAS ELLIOTT

***Protea repens*, sugar bush. A spreading shrub, up to 9 ft. high. Leaves leathery. Flowers with involucral scales glabrous, sticky, deep rose pink or pale cream. Cultivated in California. Native on mountain slopes from the Cape Peninsula to Grahamstown, South Africa.**

In countries where the plants are widely grown a common trick is to germinate seeds in soil taken from beneath an established plant of the same kind, thus insuring inoculation with the proper soil fungus. This, unfortunately, we cannot generally do. If plants can be grown in one locality through two or three seed generations they are prone to become progressively more adapted to local conditions and easier to keep alive. In spite of problems I am working at present with plants and seedlings of *Macadamia, Stenocarpus, Grevillea, Protea, Isopogon, Leucospermum, Hakea,* and *Banksia*. It is my fond hope that at least a few species in each of these genera and others will eventually prove adaptable to growing conditions in Florida.

In point of ornamental value the plants of the Protea family are comparable to nothing else. The plants are often striking in habit and foliage, occasionally even approaching the bizarre, and the large flowers, borne in profusion, are often intensely colored and uniquely fashioned. Among the largest genera in number of species and those most commonly cultivated are the following:

Banksia: 50 species of shrubs and small trees confined to Australia. Banksias are typically large shrubs, somewhat angular and stiff, with upright cylindrical inflorescences in shades of yellow to brick red. The flowers when faded harden into a woody cone. Banksias, as with most of the rest of the family, thrive best on a diet of studied neglect.

Dryandra: 50 species of shrubs and small trees, mostly in Western Australia. The flowers are in pom-poms at the ends of the branches, rather resembling a thistle or a spidery chrysanthemum. *Dry-*

Leucadendron argenteum, silver tree. Tree up to 30 ft. high. Leaves 5 to 6 inches long, silvery-gray, with adpressed silky hairs. Male and female flowers on separate plants, the male flowers in heads and conspicuous, the female heads not showy and hidden by the upper leaves. Fairly common in California gardens, less so in Florida. Native of the Cape area of South Africa.

PHOTO DOUGLAS ELLIOTT

andra, like many other Australia plants, are fire-followers. The seeds do not readily sprout unless subjected to heat, and after a bush fire may be observed sprouting in profusion on the freshly charred earth. Under artificial conditions it is usually advisable to subject such seeds to treatment with boiling water to stimulate germination.

Embothrium: Three species of small trees in western South America and one species in Queensland, Australia. This is a small genus of great ornamental value. They are commonly known as fire bushes in reference to their masses of intensely red flowers. The Chilean *Embothrium coccineum,* when established, can tolerate 20 degrees of frost, making it one of the hardiest of the family. They are much grown in Irish gardens and to some extent in the Puget Sound area of Washington and coastal gardens of Oregon and northern California.

Grevillea: 230 species in Australia, Tasmania, and New Caledonia, ranging from low shrubs to large trees. This is the largest genus in the family, and is very diverse in habit, foliage, and flower. Grevilleas are a little more tolerant of cultivation than most other proteaceous genera, but much variation exists among the individual species. It is possible to establish some grevilleas on limestone or heavy clay soils. I have had some success germinating grevilleas by carefully stripping off all the outer seed coats and planting the naked seeds, barely covered, in sterile vermiculite. This technique, described for grevilleas by an Australian gardener, Mr. J. S. Howard, in 1963, may be worth trying when seed coat dormancy seems to be a problem that cannot be readily broken by less drastic methods.

Hakea: More than a hundred species of shrubs and small trees in Australia and Tasmania. Like the grevilleas, hakeas seem to be a little more easily grown than most of other proteaceous plants. In South Africa some imported species of *Hakea* have escaped from cultivation to become naturalized, and have developed into aggressive, noxious weeds in certain areas. *Hakea laurina,* the most commonly cultivated species, has globular red inflorescences studded like a pincushion with creamy white pins.

Isopogon: An Australian genus of about 30 species of shrubs. They are commonly called cone bushes or drumsticks from the curious thistle-like flower heads held stiffly at the ends of the branches. The inflorescences of the various species are found in shades of white, yellow, pink, red, and purple.

Leucadendron: 70 species of shrubs or small trees in South Africa. The flowering habit of some species of *Leucadendron* is not of particular note but the genus is of interest in that it is one of the few in the family that is dioecious, with male and female plants.

Leucadendron argenteum is famous for its foliage which is densely covered with silvery hairs, giving it a glistening metallic sheen. This tree is subject to a mysterious malady causing a fatal decline even in its natural habitat on the exposed mountainsides of the Cape of Good Hope, and there has been some worry that the species may be disappearing. Yet, it is grown in California, and near Santa Barbara has become sufficiently naturalized to form self-seeding groves.

Leucospermum: 32 species of shrubs almost entirely South African. All proteaceous plants have inflorescences made up of a number of individual flowers more or less densely arranged in a head, on a spike, or along the branchlets. The inflorescences of the *Leucospermum* are in heads, rather resembling spidery chrysanthemums. These shrubs are very floriferous when established, and make an intense mass of color in the garden.

Macadamia: A small genus of 14 species, but interesting because it is found both in Australia and on Madagascar. Although a number of genera in the family occur in both the Pacific and the South American distributions, very few are shared with Africa.

Macadamia is not especially showy in flower, but one species bears edible nuts that are an item of commerce in this country. *Macadamia integrifolia* is a large shrub or small tree with curious strap-like leaves edged with sharp-toothed prickles. The nuts are delicious, but the shell is so nearly impenetrable as to make them very difficult to crack. The plants are grown commercially in Hawaii.

Protea: 90 species of small-to-large shrubs in Africa, most of them concentrated in the Cape Province. This genus has given its name to the family, and is one of the most characteristic elements of the unique Cape flora. The natural habitat of the proteas closely resembles the chaparral scrub of the dry mountain slopes in our western states. In many of the proteas the most intense coloration of the inflorescences is not in the flowers, but in a series of floral bracts below the true flowers. *Protea cynaroides,* for example, bears huge silvery-pink floral heads reaching six inches in diameter, the largest in the genus. As a group these plants comprise a truly stunning group of shrubs.

Stenocarpus: This is one of the less common tropical genera, consisting of 30 species of trees in the forests of New Guinea, New Caledonia, and northern Australia. One species, *Stenocarpus sinuatus,* is grown in Florida and is a handsome small evergreen tree, very compact

PHOTO DOUGLAS ELLIOTT

***Leucospermum reflexum*. Erect-branched shrub up to 10 ft. high, almost wholly covered with bluish-gray down. Flower heads 4 inches long by 2 inches wide, the flowers crimson. Cultivated in California. Native of South Africa.**

in habit, and with deeply lobed, oak-like, glossy green foliage. This tree is very showy in flower, with brilliant red flowers in heads, arranged somewhat like the spokes of a cart wheel. Dr. Edwin Menninger reports this tree may require 15 years or more to flower from seed, although it is fast-growing for me.

Telopea: Three species of large shrubs in Australia and Tasmania. Called Waratah, and at least one of them, *Telopea speciosissima* must be numbered among the finest of the world's flowering shrubs. This plant bears large globose flower heads of an intense red hue. A well grown plant may carry more than 400 such flower heads in a single season. Unfortunately, like most aristocrats, it does not tame easily, and even the Australians consider it one of the most difficult to grow of their native plants. Telopeas grow in areas subject to periodic burning over, and perhaps as a response to this environment develop a large woody excresence, known as a lignotuber, at the base of the plant which is relatively fire resistant, and from which the plant renews itself after burning. Such an environment is not easily duplicated in the garden. It may be that as gardeners we should be grateful for the occasional wild thing that cannot easily be reduced to the status of a garden ornament, and that reminds us of our limitations and our own humble status. Things that grow too easily often become weeds. At the same time we should be aware that gardens have often been the last refuge of plants that would otherwise disappear, and that are disappearing every day through destruction of their natural habitats. In this respect, at least, gardeners bear a certain stewardship for the entire race.

For anyone who is willing to take up the challenge of growing these beautiful but difficult plants I will list a number of seed sources I have found reliable in the past. Remember that it is necessary to secure a permit from the division of the United States Department of Agriculture concerned with plant importation before ordering plant materials of any kind, including seeds, from outside the country. These permits are free upon application to the Agricultural Research Service, Plant Quarantine Di-

PHOTO E. MEMMLER

Leucospermum grandiflorum. Growing in garden of J. Howard Asper, Sr., Escondido, about 30 miles noth of San Diego, California.

vision, 209 River Street, Hoboken, New Jersey.

It would be worthwhile, before trying to grow plants of the Protea family, to become acquainted with some of the gardening literature concerning them. A number of books, mostly South African and Australian in origin, are available from dealers in books on horticulture and natural history, with much valuable information about the Protea family. The delightful quarterly journal "Australian Plants" published at 860 Henry Lawson Drive, Picnic Point, New South Wales, Australia has over the years published numerous articles containing practical advice on the Australian members of the family. The Botanical Society of South Africa, whose address is listed below, has published articles in its journal, many of them available as reprints or pamphlets, about growing South African proteas. Reading any of these books, articles, or pamphlets will be time well spent.

Sources of Seed:

The Botanical Society of South Africa
Kirstenbosch
Newlands, Cape Province
South Africa

Note: This involves membership in the society, which is inexpensive, and an annual seed distribution program similar to that of the American Horticultural Society, except that the seeds are from the Society's botanical garden at Kirstenbosch.

King's Park and Botanic Garden
Perth, Western Australia
Australia

Nindethana Seeds
c/o G. W. Althofer
Box 5
Dripstone, New South Wales
Australia

Honingklip Nurseries
c/o W. J. and Mrs. E. R. Middelmann
"Barosma"
Barmbeck Avenue
Newlands, Cape Province
South Africa

Peter B. Dow & Company
7 Rutene Road
Gisborne
New Zealand

PHOTO E. MEMMLER

Protea barbigera. **Growing in garden of J. Howard Asper, Sr., Escondido, about 30 miles north of San Diego, California.**

Flower Colors and Color Fans

JOHN M. PATEK

The American Horticultural Society is pleased to present this article by Mr. John M. Patek. He is president of Color Data, Inc., was formerly a color expert with Eastman Kodak Company, and is exceptionally well qualified to discuss this subject.

Color is of primary importance to gardeners the world over. The opportunity to study authoritative work in this highly technical field is an opportunity to improve our understanding of color as a basic factor in ornamental horticulture.

This article is based on a paper presented before the American Daffodil Society in April 1969.

Introduction

I am very pleased to be asked to come to Nashville to talk about a subject on which almost everyone is his own expert.

Last month a small garden club in Rochester asked me to talk on this same subject. After I had proceeded for half an hour, one earnest young lady interrupted me to say, "Everyone sees color differently, and why is your idea of color any better than anyone else's?" I decided to satisfy her, if I could. This necessitated going back a few years.

In 1931 the International Commission on Illumination reached an agreement, at a meeting held in London, which established the characteristics of the standard observer. This standard observer was an instrumentally determined numerical definition of color for the average human eye. Tests had shown that my eyes had high sensitivity to color differences and that my color evaluations coincided with those of the standard observer. In other words, I could establish quite accurate Munsell notations for flowers by visual comparison of the flower with a suitable Munsell color sample.

My study of flower colors goes back to August 1966 when the Royal Horticultural Society color fan was introduced at the 17th International Horticultural Congress. The mere process by which the colors were selected was intriguing in itself, because it was bound to influence the results.

To develop the colors of the RHS fan a committee met 26 times over a year's duration. On the committee were representatives from Kew Gardens, the National Dahlia Society, the Royal National Rose Society, the Royal Color Council, and the Royal Horticultural Society. The resulting fan was divided into four books with a total of 808 colors. The results of this effort might or might not be good. I decided to find out.

To test the fan, I used the flowers which were then in bloom in my own garden. I attempted matches between the colors of the flowers and the colors on three different color charts or fans (Fig. 1). Matches were graded A, B, C, or none. Results with the ISCC-NBS (National Bureau of Standards) Centroid Color Chart were almost as good as

434 Mount Airy Drive, Rochester, New York 14617. Member, Board of Directors, The American Horticultural Society.

those obtained with the RHS Color Chart. But the ISCC-NBS chart was never intended for flower colors and it has only 235 colors in all. What did this show? *It showed that a scientifically arranged series of colors is far more efficient than a set of colors selected at random or by committee action.*

Chemistry

I started out assuming that each species would have its own distinctive colors, but soon found that this was not the case. The same purples, yellows, oranges, and reds appeared over and over again, irrespective of the species of flower. There was, in fact, a rather limited number of colors, on the whole, and these fell into specific systematic arrangements.

A review of the chemical literature revealed that my observations were sound. Vegetation, irrespective of species, owes its green color to a single chemical called chlorophyll. A very small change in this chemical, involving primarily a substitution of an iron atom for a magnesium atom, produces the red chemical structure of the hemoglobin found in man. With the chlorophyll in the leaves of trees there are generally two hydrocarbon pigments, related in structure and known as carotenes and xanthophylls, which give the leaves their orange and yellow colors in the fall when the chlorophyll decomposes. These two pigments are included under the larger classification of carotenoids, with the basic chemical structure of Vitamin A. The yellow xanthophylls may be considered as oxidized orange carotenes and are present in most yellow and lemon-yellow flowers, including the tulip, lily, crocus, and daffodil.

I have not yet mentioned *the most important group of flower pigments—the flavonoids.* They are limited to the higher order of plants and occur in all flowers. They have a common structure based on flavone and differ from one another by their states of oxidation. Included in this group are the flavones and flavonols which vary from pale cream to deep yellow, depending on the number and orientation of their hydroxyl (OH) groups. Most white and all yellow flow-

COLOR TESTS

Plant	RHS Color Chart		Nickerson Color Fan		ISCC-NBS Centroid Color Chart	
	Notation	Grade of Match	Notation	Grade of Match	Notation	Grade of Match
Geranium 'Orange Glow'	33A	C	7.5 R 5/13	B	34 v r O	C
Yellow Viola	14A	A	-	poor	not tested	
Dark Orange Pansy		none		none		none
Red Hemerocallis	178A	B		none	41 deep r Br	C
Petunia 'Peach Blossom'	58C	C	7.5 RP 6/12	B	not tested	
Petunia 'Purple Plum'	74B	A		none	237 s r P	C
Petunia 'Red Magic'	50A	C	2.5 R 5/12	C	11 v R	B
Petunia 'Masquerade'	83A	B	5 P 3/9	C	220 v d P	A
Red-purple Petunia	61A	B	7.5 RP 3/9	C	256 deep p R	C
Blue Platycodon	88C	C	2.5 P 4/9	C		none
Pudish Dianthus						
Center	60B	A	7.5 RP 3/9	A	14 v deep R	B
Periphery	59D		7.5 RP 5/12		25 v p R	
Purple Verbena		none	2.5 RP 3/8	C	238 r P	C

Fig. 1. Results of a test of three color charts in the attempted matching of flower colors in one garden at one time.

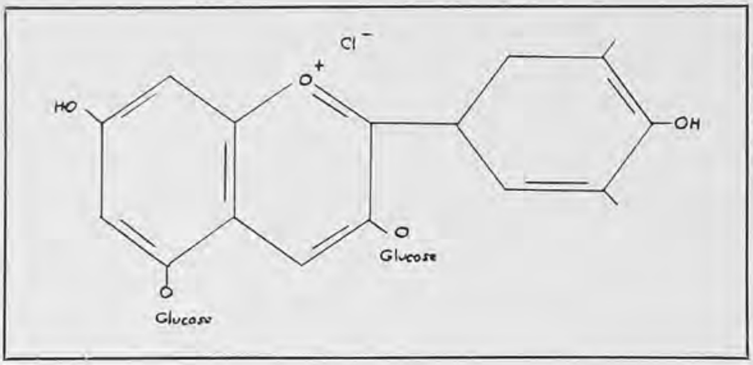


Fig. 2. Basic structure of the anthocyanin molecule showing where the presence of metal complexes at the Cl position, and of additional hydroxyl (OH) groups at the extreme right will change the color from red to blue.

ers contain these pigments, but strong yellow colorations may also be due to an accompanying carotenoid.

The most important and strongest pigments of the flavonoid group are the anthocyanins. They produce the colors ranging from orange, red through pink, red, and blue. They differ from the yellow flavonols by having a free electrical charge which makes them susceptible to changes in cell sap acidity and assists their complexing with metals. The anthocyanins differ from one another in the same manner as the flavonols, that is, by differences of hydration (Fig. 2). Blueness increases with the hydration of the basic compound, but blueness is further increased by lower cell sap acidity and the presence of metal complexes. Thus the blue cornflower or bachelor's button and the red rose have the same cyanidin pigment, but under slightly different conditions.

Basically, the same anthocyanidin pigments account for the orange-red to blue colors of all flowers. Orange and scarlet flowers contain the pelargoniolin pigment obtained from the geranium, crimson and magenta flowers have the cyanidin of the rose, and lavender and blue flowers have delphinidin of the delphinium.

The flavonols and flavones supply creamy white pigmentation and all strong whites are slightly yellow. Whiteness is also produced by the absence of pigment accentuated by the presence of air in intercellular spaces.

Although there are near-white pigments, there are no identified black pigments in flowers. This is the most important single factor in flower coloration, since all colors produced with black are missing in flowers. The nearest approach to black is when chlorophyll green combines with anthocyanin red. The very dark colors in flowers are usually produced by very high concentrations of pigment. Pigment concentration may vary from 0.1% to 15% of the dry weight of a flower.

There are a few additional causes for color differences which I have not mentioned. The brown color of *Primula* × *polyantha* was found to be produced by a magenta anthocyanin on a yellow carotenoid background. The brown iris is similarly a mixture of yellow and violet or magenta. Microscopic examination showed yellow cells, each capped with a spot of purple. Some diffusion of purple from the spot into the yellow cell was observed under 100× magnification, and the depth of brownness increased with the size and number of the violet or purple caps. Colorless flavonoids as co-pigments with anthocyanins will presumably affect color. Tannins will produce gold or brown. Anthocyanins have attached sugar molecules to make them water soluble, and increasing the number of such molecules will increase blueness. Yellow pigments with anthocyanin blues, which are always slightly reddish, will increase the appearance of blueness.

It perhaps should be mentioned that the coloring matter of flowers should not be confused with natural dyes such as indigo which is made from the colorless sap of yellow flowering plants.

I have given you this immersion into

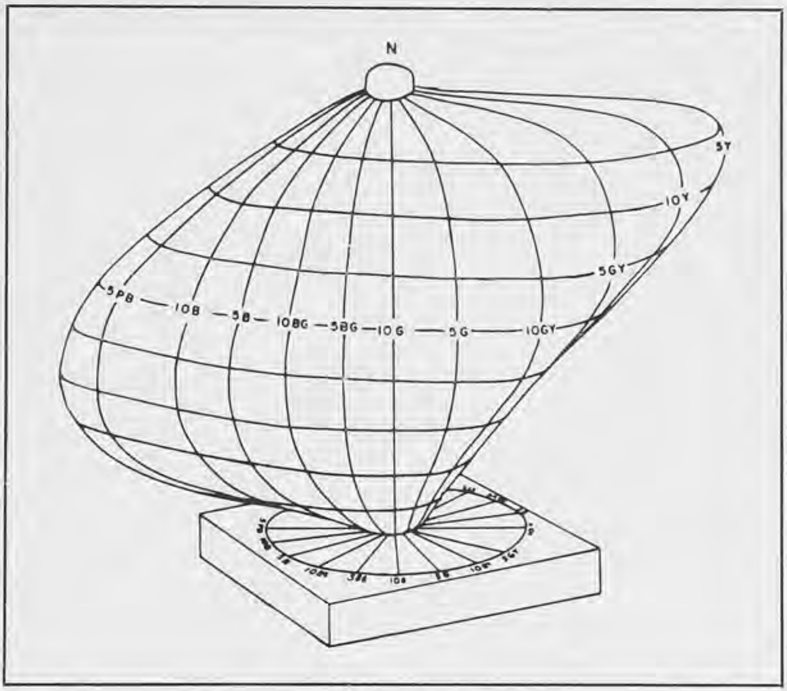


Fig. 3. Munsell color solid showing yellow as a high chroma light color, purple as a high chroma dark color. Projection of the hue circle is at the base, and extension of the neutral axis is at the top.

chemistry to show you that our color problem is related to a very limited number of materials. The colored wine you drink has the same anthocyanin substances as the red roses you pick for the table. Any color card which attempts to give complete coverage of all colors will go beyond the requirements of flower colors, and probably fall far short of portraying those specific colors and arrangements of colors found in flowers.

I have introduced you to the basic factors in the specific problem of flower colors. Now let us discuss color itself.

Munsell Color System

When the light from a very hot object like the sun strikes a colored solid like a flower, some of the light is reflected from its surface and some is absorbed. If all of the sunlight or daylight is reflected, we see the object as white. If none is reflected the object looks black. If some of the sun's rays are reflected and some are not, the object has a color, depending on which rays are reflected.

The eye can detect only a limited range of the reflected radiation from the sun, or in other words, it can only see radiation as colors from violet to red but not ultraviolet or infrared. Green is in the middle of this range and is seen best. However, it is possible with a spectrophotometer to determine the exact percentage of the original light which is reflected by an object, and to do this wavelength by wavelength across the entire visible spectrum from violet to blue to green to yellow to orange and to red. From these individual readings can be calculated the exact color one will see.

Every color has three characteristics which can be individually determined by the spectrophotometric measurements and calculations. These characteristics are the lightness or darkness of the color, termed "reflectance," the strength or saturation of the color, termed "purity," and the color itself, termed "dominant wavelength." The whole system is known as the CIE Color Coordinate System.

As stated above, the eye does not see all colors equally well, and so the color differences "seen" by the instrument are not exactly as the eye would see them. That is, the instrument does not divide color into the same equal steps as the eye. For this reason, an arrangement of the above instrumentally determined data was developed to divide color as the eye sees it, and this is known as the Munsell System of Color Notation. This system has world-wide acceptance for both scientific and commercial applications.

In the Munsell System the reflectance or lightness and darkness is termed "value." The purity, saturation or intensity of a color is termed "chroma," and the dominant wavelength or actual color is termed "hue." This whole system is described as the "Munsell Color Solid," because the three measurements of value, chroma, and hue can be expressed as three domensions of a solid (Fig. 3). The center axis is a vertical scale divided into 10 numbered units from black through shades of gray to white without chromatic color. This is the value scale. As one moves from the center axis out to the outer surface of the solid, color is introduced and becomes more intense until maximum intensity or maximum chroma is reached at the outer surface. This is measured in units up to 18 in number. The hue or color changes as one goes around the solid, or looking down on it from above one sees the full hue circle (Fig. 4).

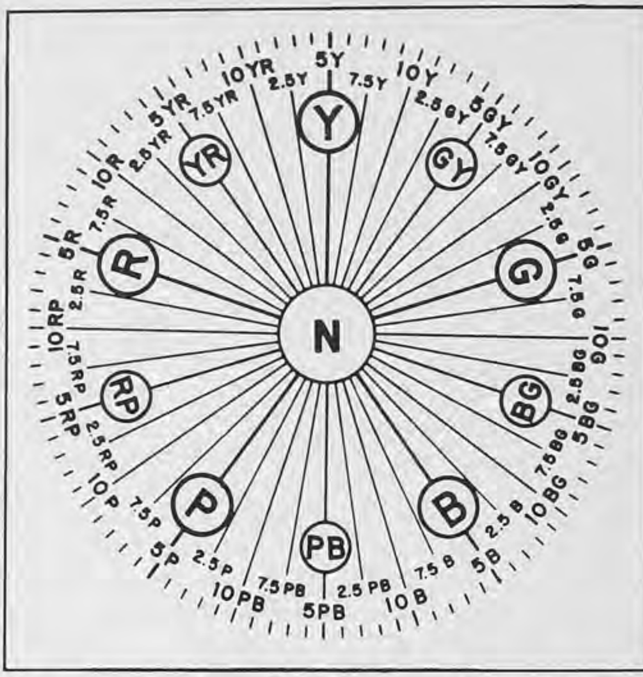


Fig. 4. Complete Munsell hue circle. Shows in detail the circle at the base of Fig. 4.

The Munsell circle of hues has 10 hues, each divided into 10 units. It is similar to the color harmony circle with which your flower arrangers are familiar, except that blue-green rather than green is opposite red. The complementary colors of the Munsell color circle are those of light which produce white when mixed, while those of the color harmony circle are based on pigment mixtures which produce gray or black when mixed. The Munsell color circle in relation to the vertical neutral axis is tilted from the horizontal so that the yellow side is high and the purple side low, since yellow is light and purple dark.

Since each numbered unit in the Munsell System can be carried to at least one decimal place, it is possible to describe, with numbers representing lightness, saturation, and hue, any one of the two million colors which the eye can distinguish. As an example, a daffodil in my garden has a cup with Munsell notation 5.0Y 8.5/13 and petals with notation 5.0Y 9.2/2.

Unless you are accustomed to using the Munsell notations, they will not bring to your mind a particular color. However, the National Bureau of Standards has made available through the Government Printing Office, in their Circular 553 "The ISCC-NBS Method of Designating Colors and a Dictionary of Color Names," a system for giving a color name for each Munsell notation. In addition, there are published Munsell notations for both the Wilson and Ridgeway color charts.

Occasionally it is desirable to coin color names. The use of color names which attract sales is common in the paint industry but added Munsell notations identify the colors.

Color Samples, Cards, and Fans

A color numbering system alone will not meet your needs. You must have physical color samples, such as a color card for color identification. If you wish to determine the Munsell notation of the color of a flower, you can use a spectrophotometer, as I sometimes did, but this is a $15,000. instrument and is not very common. Your other alternative is to use a color sample with a Munsell notation which will match approximately the color of the flower.

An exact match between flower color and sample color will probably not be found. What is required is a series of colors with Munsell data evenly spaced as the eye sees them so that you can estimate where, between two color samples, your unknown color falls. Then you can interpolate or extrapolate the Munsell notation for your flower color. If you have a table of agreed-upon color names for specific Munsell notations, you can correctly name the color of your flower.

Series of colors are presented in the form of color charts or color fans. The making of a suitable color fan for horticultural purposes is not a simple matter. Besides the problems of design, the physical materials which go into a fan are a challenge. The color samples must be water-resistant and fade-resistant and must include colors of maximum color saturation or chroma. It so happens that the strongest, most brilliant, and greatest range of coloring materials are among those which fade most readily, so the choice must be made as to whether one sacrifices color for fading or vice versa. Unfortunately, fade resistance has sometimes been sacrificed for the sake of color.

Since the number of good non-fading pigments is limited, it becomes necessary to mix pigments in order to obtain the exact color desired. As you well know, the mixing of pigments of three primary colors will give gray. When two pigments of differing colors are mixed, there is generally a tendency toward grayness. This means that colors which were intense pure colors before mixing produce a new color which is grayed down or lower in saturation. Thus color card manufacturing processes which mix and then knife or flow the coloring material onto the color card are handicapped in obtaining the needed color saturation for flower color identification. You will recall that the anthocyanin coloring in flowers produces a whole range of colors by changes in compound structure, and only occasionally by admixtures. The Munsell Color Company has largely overcome the color mixture problem by printing many coatings of transparent ink one over the other to obtain the desired color without pigment mixing.

Flower Colors

The examination of a flower petal surface under 100× magnification reveals a layer of translucent cells which have the appearance of clear colored gems. Where the flower shows good substance and strong color saturation, these cells may be packed so tightly together that they assume the hexagonal shape characteristic of the cells of a honeycomb. The intensity of color produced by some flower surfaces of this type exceeds anything man can produce with dyes or pigments.

The extremely high color saturation of many flowers may be attributed to the presence of a single pure dominant pigment, the light-refracting and light-filtering nature of the surface cells, and the intensification of color produced by internal reflectances. Do you remember the powder room you painted a pale pink which turned out to be an intense pink?

The unavailability of non-fading color samples with sufficiently high color saturation was the major problem in the development of the new color fan for The American Horticultural Society. The Munsell Color Company made up several special color fans with colors of high saturation arranged in steps to show numerical differences in hue, value, and chroma that permitted extrapolation beyond what was available. Over 200 flowers were studied for color evaluation with these special fans. Sources of the flowers were Rochester, New York city greenhouses, rose gardens and parks, the flower trials of the Joseph Harris Company, small growers' fields, and private gardens. Tests covered the entire growing season.

Where flower colors were not covered by Munsell color samples, the flowers themselves often were mounted in cardboard holders and read in a General Electric Recording Spectrophotometer. This instrument records on a chart a curve which shows the relative amount of light reflected from the flower at each wavelength across the entire visible spectrum. When the eye sees two colors at once, only one color is visibly sensed; that is, if the eye sees red and blue at the same time, purple is the color sensed. On the other hand, the spectrophotometer curve shows both the red and the blue, and only by mathematical treatment of this information is the purple determined (Fig. 5).

Colors which are a combination of two colors are called metameric colors. It is these colors which change with the quality of the viewing light. Daylight is much bluer than incandescent light. A purple petunia will look bluer in daylight and redder in incandescent light, because of the metameric quality of the

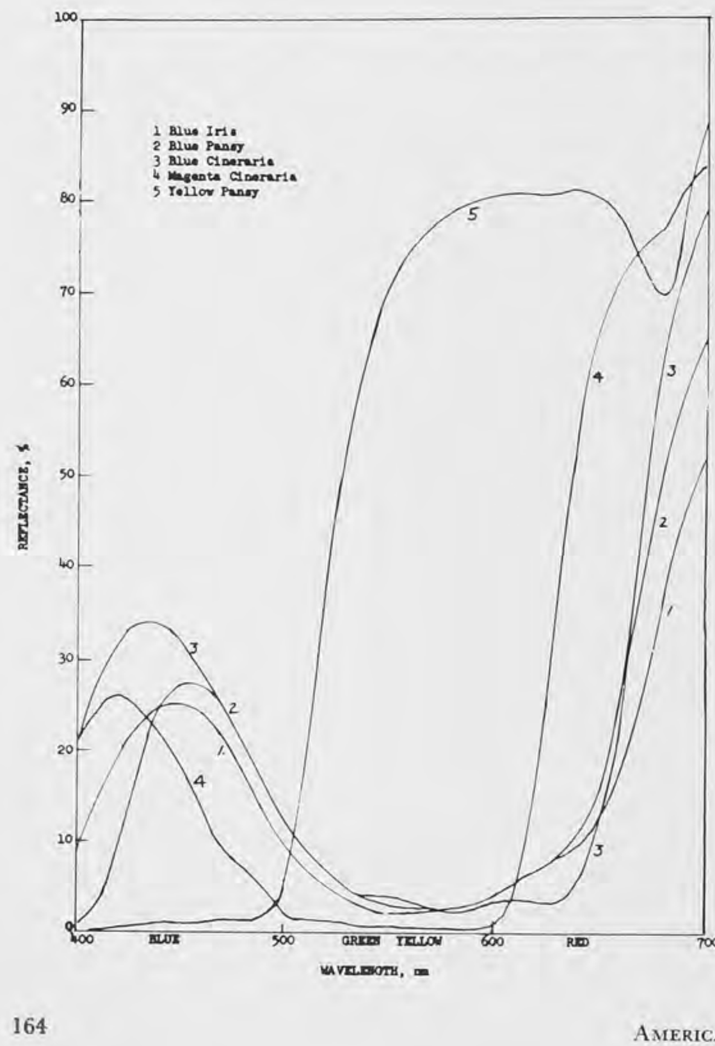


Fig. 5. Spectrophotometric curves showing the similarity of color irrespective of species, the high red content of the blues, their metameric nature, and the slight shift to turn blue into magenta.

anthocyanin coloring material. The spectrophotometric curves of magenta and purple cinerarias are similar except for the relative amounts of blue and red reflected light. They show the metameric nature of the anthocyanin pigment whose tendency to reflect blue will respond to blue in the illuminant, and whose red will respond to red in the illuminant. It can be seen from the spectrophotometric curves that the blue color of a flower would be expected to contain some red.

All of the flowers showed considerable red, and green foliage showed some red when tested in the spectrophotometer. The red increased toward the infrared end of the visible spectrum, and it is apparent that plants reflect considerable infrared energy or heat. It is in this part of the visible spectrum that human ability to see becomes poor, which explains why many photographs show flowers to appear pinker, redder, or more purple than they appear to the eye.

I mentioned that the blue and red flowers obtained their colors from the same pigments under slightly different conditions. This can be shown by exposing certain red flowers to ammonia vapor, or blue flowers to acid fumes to reverse the colors. Under these circumstances one would not expect to find a true blue flower. I sought out all available flowers known to be blue, and never found one which would be rated blue by the Munsell Color System.

I have never found blue-green flowers. However, berries of the porcelain *Ampelopsis* proved interesting because they did show blue-green blending with yellow-green and purple-blue. Blue-green is very unusual. "Blue" foliage is usually gray with a little green or yellow-green.

One would expect all green foliage to be somewhat greyed or low in chroma because of the red coloration shown by the spectrophotometer and fall coloring. This proves to be the case. Red and green produce gray.

Since there apparently is no identified true black in nature's stock of coloring materials for flowers, there is nothing to produce a dark yellow, and no true dark yellow or olive was found.

Some anthocyanin pigments appear almost black. Spectrophotometric curves of an almost black purple iris, an almost black red tulip and a dark brown pansy were very similar.

They all showed red reflectance with a little added blue for the iris and a little yellow for the pansy. These dark colors are difficult to reproduce, because of their high color saturations.

Flower Color Distribution

Let us complete our analysis by going around the Munsell color circle starting with red. The reds in flowers will be very strong, highly saturated colors, starting from dark reds and going toward reds of extremely high chroma and medium lightness. As they become lighter they rapidly lose their color saturation and become pinks.

The yellow-reds or oranges start with very dark colors of extremely high color saturation which are brown that cannot be reproduced in any medium, except as in the brown primrose and iris where brown is a blend of yellow and purple and therefore dull. They follow on a line to a point about two-thirds up the black-to-white gray scale where they show extremely high chroma. Then, as they become lighter, the color saturation drops off rapidly and produces pale salmon pinks. The color distribution pattern may be considered to fall halfway between red and yellow.

Yellow in flowers is unique in that it has usually almost no variation in lightness and darkness. Yellows fall on a straight line that shows only a change in saturation or chroma from a very weak yellow to a very strong one, or a simple decrease in the amount of pigment.

The green-yellows or yellow-greens vary from fairly dark colors of low to medium color saturation to very light low saturation yellowish whites. Most foliage is yellowish green rather than true green, and true greens are usually fairly light and of low color saturation or chroma. They occur as a tint in gray foliage, commonly identified as blue foliage. The blue-greens are so uncommon that they can be ignored, and blue, according to the Munsell Color System, has not been found in flowers or foliage.

Purple-blue follows a straight line from an amazingly highly saturated high chroma, very dark color to a light lavender of low chroma. This represents a straight line diminution of the purple-blue pigment.

Purple has a more scattered distribution than purple-blue. It shows dark colors from low to high color saturation, colors of medium lightness and medium saturation, and those which follow a line toward light colors of low saturation, or pale lavender.

Red-purple or magenta colors extend from colors high in chroma and not very dark to light colors low in chroma, or pink. This again shows a simple continuous decrease in pigmentation.

The AHS Color Fan

Last spring the Munsell company gave me for trial use six sets of a partially completed experimental color fan made by a new process designed to produce colors of high saturation. They were distributed to seven of the largest arboretums in America for use and comment. The general response was that this was the first really useful color fan for flowers.

Excerpt from Peter J. Van Melle

On Landscaping Service (1951)

There are available to you mainly two types of service. One is that of the professional Landscape Architect; the other, that of the commercial nursery establishment, the so-called Landscape Nursery.

How do these two types of service compare?

I should say that in the best instances on either side, the difference between the two services is the least prominent. If you can find a landscape architect with a first-rate knowledge of plants and planting you will get a fine type of service; as you will, also, if you go to a nursery where good design talent is employed. You can hardly go wrong in either case.

But in most instances the two factors, design and plantsmanship, are not so ideally combined. You will find that the average landscape architect majors in design, and the nursery establishment in the practical varieties. Sometimes the landscape architect is more or less deficient in the practicalities, and the nursery outfit in design. Neither has a monopoly of good landscape work.

Since you are likely to be up against the average of the two types of service, I think that in many instances it may be best to employ both.

You may do well to engage a professional landscape architect to design your project. He will probably do a better job of it than a nurseryman. But I think that you may well terminate the professional service after you have obtained a plan and specifications. Then you might take these to whichever appeared to be a reliable, local nursery, and have the plans translated into terms of practical, local plantsmanship, and have the nursery furnish you, directly, an estimate on the cost of the job.

I think that in such a way you may well get the best out of both types of service.

My Friends the Penstemons

GLENN VIEHMEYER

Of all the wild flower tribes of North America none can compete in beauty with those of the genus *Penstemon.* This genus of plants ranges from the Atlantic to the Pacific; from mountain meadow to desert; and through the sub-humid and humid lands of Eastern North America. Authorities differ as to the number of species, subspecies and geographical races but it seems the concensus that these are numbered in the hundreds.

In form, these plants are just as variable as are the habitats in which they grow. They are upright, prostrate, vine-like, or shrubby. In size they range from the ¾-inch height of *Penstemon caespitosus* subsp. *desertipicti* to *P. havardii* and *P. palmeri* which tower to six or more feet. Flowers range from a quarter-inch wide ones in the "mint cluster" penstemons to the two-inch wide bells of the hardy *Penstemon cobaea* × *P. triflorus* hybrids and the new, tender, tetraploid forms being created in California.

Penstemons are the most beautiful, the most variable and the most spectacular of native plants. In a "good" penstemon year you can visit the hills north of Wray, Colorado and see a thousand hills misted pink with the flowers of *P. ambiguus.* You can drive across the gravel fans of northern Nebraska and see acre after acre of *P. grandiflorus.* You can drive the foothills of the Front Range of the Rockies and see the fallen bits of western sky that are *P. glaber.* Prowl the southwest deserts and high plateaus of Arizona, New Mexico and Utah, and see the scarlet bugler, *P. eatonii* sending its bugle call to the humming birds that pollinate it, or watch the scented *P. palmeri* call the bees that transfer pollen from flower to flower.

Route 4, North Platte, Nebraska 69101.

You can visit highland or lowland, mountain or desert or plain to meet and fall in love with the penstemon. You can collect seed and grow seedlings in your own garden and find wild species, the most cantankerous, the most downright exasperating plants you ever tried to grow. You can watch them die of diseases they never encounter in their wild home. These plants are specialists, adapted through millions of years to the habitats in which they are found. They are plants for very special environments,

PHOTO UNIVERSITY OF NEBRASKA

Penstemon Henry hybrid. Seed grown, true breeding hybrids of _P. cobaea_ and _P. triflorus_, introduced by University of Nebraska.

unhappy when moved to the decidedly different type we call a garden. These plants are killed by the kindness of the gardener who overwaters and overfertilizes them. They just are not garden plants.

Many persons do grow the species and anyone can grow them if he is willing to simulate the habitat in which they are found in nature. You can grow them if you protect them from the diseases they seldom encounter in the wild. Most of you will not or can not do this. As a group, penstemon species are not for the gardener who wants maximum effect with minimum effort. As a rule, species native to your own part of the country may perform well in your garden but those from far places may be short-lived, blooming once and then dying.

This probably sounds discouraging to the beginner who would grow penstemon, but the situation is not that bad. Years of work by amateur and professional breeders have produced penstemon varieties and strains that are far better in the garden than are their wild progenitors. The breeders have taken the wild species apart and put them together again in forms unknown in nature. Colors include those not found in wild pents. Characters for repeat bloom are appearing in many lines. Ease of culture and longevity are objectives.

PHOTO UNIVERSITY OF NEBRASKA

Penstemon barbatus

Today we have the materials and the know-how to make these plants important in the garden. Most of the credit for these advances belongs to the dedicated people of the American Penstemon Society. These people have collected and grown the wild species and have blended them into hybrids that are becoming good garden subjects.

Breakthrough

A breakthrough in taming the penstemon of the north occurred when a Montana nurseryman named Murray discovered a natural hybrid of *P. barbatus* growing near his nursery on the shores of Flathead Lake, Montana. This hybrid is presumed to be a cross of *P. barbatus* and an unidentified Montana native. Murray increased the hybrid in his nursery and Anna Johnson of Butte, Montana obtained a plant from him. Seed from this was sent to the Rock Garden Society and distributed by them.

This wild hybrid proved to be the most important northern penstemon collected since the APS started bringing wild species into cultivation. It was important because it was compatible with a wide range of species and has been used to produce fertile or partially fertile hybrids within them. Because of this ability the plant, which had been dubbed "Flathead Lake", was deemed worthy of a scientific name. Ralph W. Bennett and the author described the plant in an article in the Bulletin of the American Penstemon Society, Vol. 20, 1961, pp. 15-16 and named it *Penstemon* × *johnsoniae* 'Bennett'.

The true *P.* × *johnsoniae* perhaps no longer exists except as herbarium specimens. Its descendants, known as the "Flathead Lake hybrids", are plants of considerable garden value.

The North Platte Penstemon Breeding Project Begins

The story now must become a personal one. As far back as 1928 I became interested in attempting to hybridize penstemon, and collected several kinds in my garden at Stapleton, Nebraska. During the blooming season I made several hundred interspecific crosses and obtained a single seed which failed to germinate. This cooled my interest in penstemon breeding.

In 1951, Mrs. Edgar Irving of Omaha, Nebraska sent me a package which contained seed of a dozen species of penstemon. Among them was a packet of seed of the Flathead Lake hybrid. These I received with no great enthusiasm but I planted them. Perhaps it is just as well that some people are slow to learn, for in spite of the 1928 fiasco, I made several hundred interspecific crosses which were, with the exception of those made with Flathead Lake hybrid as one parent, unsuccessful.

When harvest was over I had three packets of seed with Flathead Lake hybrid as a female parent and *Penstemon strictus, P. glaber* and a pink form of *P. alpinus* as male parents. These three were the beginning of a penstemon breeding program that turned a group of wild species into rather promising garden material.

At the time of the first successful crosses I was employed as horticulturist at the North Platte Experiment Station. In that capacity I was able to expand penstemon breeding and grow thousands of seedlings. This work continued until my retirement in 1967. Recently it has been reactivated by Dr. Roger Uhlinger who has succeeded me at that Station.

Over three decades of breeding and selection have produced seed grown strains and vegetatively propagated clones of penstemon. Among the seed-grown strains are the Fate-Seeba hybrids of a controlled cross of *P. grandiflorus* × *P. murrayanus* combined with a *P. grandiflorus* cross with an unidentified species belonging to section *Peltanthera*. Unfortunately the Fate-Seeba strain is short lived and for that reason is not popular with nurserymen. Clonal material has been selected from Flathead Lake hybrids, which are better nursery plants and are being grown by nurseries across the United States and Canada. One Flathead hybrid strain, 'Prairie Jewels', has been grown and sold by a major mail order nursery company for several years.

At the North Platte Experiment Station, the author has named and released three clones to growers. These are 'Prairie Dusk', a deep violet blue; 'Prairie Dawn', a light pink; and 'Prairie Fire', a scarlet red. More recently, my successor, Dr. Roger Uhlinger, has released two additional Viehmeyer hybrids, 'Mesa', a light blue upright, disease resistant clone, and 'Arroyo', a red with good disease tolerance.

PHOTO UNIVERSITY OF NEBRASKA

***Penstemon* 'Prairie Dusk'. Introduced by University of Nebraska.**

The major value of these named cultivars is the high level of disease tolerance. In addition to disease tolerance, all five cultivars repeat bloom during summer and fall if not allowed to produce seed. All five are compatible with a wide range of species and are proving effective in intercrosses and outcrosses. The range of their compatibilities has not been fully explored but there is some evidence that they can make it possible to bring species of the sections *Anuliarius* and *Peltanthera* into the present *Elimigera* and *Habroanthus* gene pools.

It is interesting that as additional species are added to the gene pool, a few individuals with increased disease tolerance are appearing. Thus, species which are themselves susceptible to disease seem able to contribute tolerance to these complex hybrids. The reason for this is unclear, but the response is there. Perhaps the hybrids concentrate many bits of disease tolerance in these resistant individuals; we do not know; we report the phenomenon for what it is worth.

Whatever the mechanisms are, it has been possible to take a group of plants poorly adapted to garden use—a group of specialists which a million years of evolutionary pressure has fitted to specific and narrow ecological niches—and change them to new forms that have the ability to thrive under conditions that killed their ancestors.

Looking Ahead

The years since a little band of amateurs formed the American Penstemon Society have been a time of trial and error. We have a beginning in understanding the genus *Penstemon*. We know how to bypass barriers of cross incompatibility imposed by reproductive isolating mechanisms by using intermediary parents. We have created a series of parents that can be expected to further breach the walls of incompatibility. We have created complex gene pools that yield new and better garden forms. This is nothing compared to what might and will be done as the years pass.

Two sections of the genus have made the most contributions to the existing hybrids. *Penstemon barbatus* and *P. labrosus* from Section *Elmigera* and *P. alpinus, P. glaber* and *P. strictus* of Section *Habroanthus* have contributed the bulk of the germplasm. *P. albidus* of Section *Aurator* and *P. secundiflorus* of Section *Anuliarius* have made a small contribution, while the Mexican species are just beginning to enter the picture.

Combining only a dozen or so of the hundreds of species, subspecies and geographical races has brought us a long way. But this is only a start. The reservoir represented by the lovely reds, blues and pinks of the brilliant *Peltanthera*, the sky blues of *P. nitidus* and *augustifolius* and others of the *Anuliarius* should be combined with the Fate-Seeba hybrids to create garden varieties.

The elegant little *P. secundiflorus* with its rosy lavender trumpets and the brilliant red-pink *P. utahensis* could add excellent flowers and glaucous foliage to the low border.

The little *Ericopsis* section consisting of *P. laricifolius, P. liniaroides,* and *P. caespitosus* subsp. *desertipicti* might be combined with the alpine *Dasanthera* to form new kinds of ground cover and shrubby forms for the rock garden.

The Mexican species of section *Fascicularis* which have contributed to such cultivars as 'Fire King', 'Garnet', 'Ruby King' and 'Firebird' may contribute much to northern penstemons. Indeed, the Mexican *P. kunthii* is a grandparent of the cultivar 'Prairie Dawn' mentioned above.

The large flowered hybrids produced by the west coast seedsmen might be combined with the *P. cobaea* $\times$ *P. triflorus* hybrids to outshine the Canterbury bell as a garden plant.

Much of this business of looking into the crystal ball and forecasting future developments in penstemon is speculation, but speculation based upon years of working with penstemon. Foundations have been laid and new and different combinations are now possible. Greater disease tolerance can be expected, and the character for repeat bloom will be increased. All this will lead to better penstemon and greater interest in these new and little known hybrids.

One of the biggest needs and one of the greatest possibilities for this job of creating new penstemons for the American garden is still the amateur who takes the time and makes the effort to select and breed better kinds for gardens.

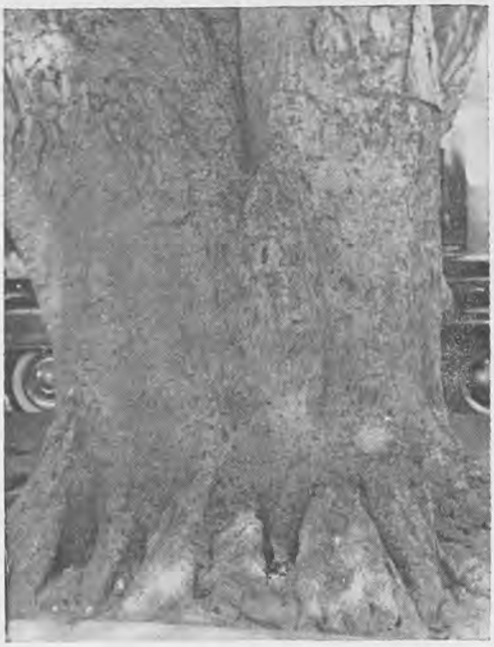
This business of creating new plants is a fascinating one. Somehow I can't forget that in a few spare moments I pollinated a desert penstemon with snapdragon pollen and produced normal capsules that contained aborted seed that had reached one-fourth the size of normal penstemon seed. Does this mean that we may cross generic lines to produce a blue, hardy snapdragon? Can we turn to embryo culture to produce new and entirely different plants?

We have the know-how. Will we use it?

Excerpt from Peter J. Van Melle

On Foundation Plantings (1951)

Solid foundation plantings of (large growing conifers) have gone out of style. The modern house has not the high foundation of its predecessor, and needs no continuous screen of this kind. If you like a band of green along the base, by way of a "line beneath a drawing," you may provide it easily with a mere ribbon of *Pachysandra*—not necessarily immediately against the house. With or without it, you will probably want a few evergreen things by way of an extension of, or introduction to the architecture of the house. These should be of sufficiently impressive size to be immediately effective in the overall picture. Have no more of them than is strictly necessary for a good picture. If two or three will do, don't plant five or six. No need of a low plant beneath each window, or of a tall one between each two. Do the job with a few well chosen, well placed plants—mainly at the house ends and by the doorway.



Laurel Fig—An Exceptional Shade Tree

JOHN M. HALLER

"Laurel de la India", Ciudad Victoria, Tamaulipas, Mexico. *(See Back Cover for another view.)*

"What are those large trees in the public square?" asks the tourist as he drives into his first Mexican town. "So huge, so green, so dense!"

Nine times out of ten the tree referred to is *Ficus nitida**, called by the Mexicans "Laurel de la India." This euphonious designation, admittedly more agreeable than *Ficus nitida,* is, however, a misnomer, for the tree is not a laurel nor anything related to a laurel (although it may well be an importation from India). As examination of its fruits at once indicates, it is a kind of fig and hence a member of the versatile and ubiquitous mulberry family. Widely planted for shade and ornamental purposes through-

Calle 26, No. 526 Mendez y Ocampo, C. Victoria, Tamaulipas, Mexico.

* The correct botanical name is *Ficus microcarpa* var. *nitida.* (*Ed.*)

out Mexico, from Guatemala to the Texas border, the "laurel" is one tree that every traveler to that country is certain to have seen.

In well-watered situations this *Ficus* grows to be one of the largest of all shade trees. Well-watered or not, it is at all times and in all circumstances a front-runner candidate for the title of the world's champion shade tree. Even when surrounded by impervious deserts of asphalt and concrete, it prospers; even when battered by passing cars and trucks; even when enclosed in unyielding iron gratings; even when wrapped in chains. Young or old, watered or unwatered, in good soil or bad, it bestows the miracle of its shade impartially on all who seek refuge under it. Vigorous, evergreen, tolerant of urban conditions, incredibly dense, it is one of the very best species for planting in a country where shade is as essential as food or clothing.

So numerous are the leaves and so thickly and evenly distributed the leaf-bearing twigs that the shade produced is almost solid; few are the rays of light that can struggle down through that leafy barrier. When the trees are planted in groups or rows, as is often done, the effect is to transform what was a hot, dry, insupportable public street into a forested canyon. Small wonder that the tree is a favorite for plazas and market-places; what other would do as well? In Ciudad Victoria, Tamaulipas, the three chief plazas are all shaded by the "laurel"; one exceptionally fine specimen in the Plaza de Armas is regularly watered by the fire department as a matter of civic pride. Almost every town and city in Mexico has the *Ficus* planted in its plazas or along its avenues, and the particular way they are disposed remains long in the memory and serves to give each place its distinctive personality. In León, Guanajuato, and other cities of the same state, the trees are commonly trimmed into the shape of bells, truncated cones, bowers, and even animal forms, the plant's density and rapidity of growth making it an ideal subject for topiary work.

Few other trees have so many twigs in proportion to their height and trunk diameter. From big branch and little branch (itself a twig but yesterday), from primary limb and secondary limb, the twigs shoot out radially, like the spokes of a bicycle wheel. Moreover, new twig growth is not confined to the outer third of branches, as it is on our temperate-zone trees, but occurs all along the length of the massive limbs, from the tree's very center outward to its farthest extremity, by means of which arrangement an unbroken block of shade is produced. Only toward the interior where competition for light is keenest is the radial pattern modified; here the twigs are absent from the upper side of the limbs, paradoxically and anti-geotropically growing downward from the underside, like hanging vines.

The trunk crotches low, many times at a point four or five feet from the ground, dividing into two, three, four or more main limbs, four being the most usual number. Such a four-pronged crotch, instead of the commoner two-pronged crotch characteristic of, say, the oak or the elm, exactly doubles the total twig-bearing surface and helps explain the denseness of the shade.

The large *Ficus* in Ciudad Victoria measures 5 feet through near the bottom and 7½ feet through at the point of crotching. Each of the four main limbs measures 2 feet through. Height approximates 45 feet, spread 60 feet. Planted between sidewalk and street, the tree provides total shade for both at all hours of the day; indeed, its branches extend entirely across the street and rub against the store fronts on the other side.

In Xicotencatl, Tamaulipas, I took the following measurements of an even larger tree: trunk diameter, 7 feet; height, 60 feet; spread of branches, 120 feet; circumference of branch spread, measured at high noon by pacing its circle of shade, 410 feet. In the solid shade of this huge specimen the farm animals seek shelter from the sun, in its ample crotches ducks retire from the world to lay their eggs, and among its topmost boughs 30 or 40 bird nests hang secure, almost completely invisible from below. The tree crotches about 7 feet above the ground, sending its massive, 2-foot limbs straight outward for 10 or 12 feet before curving upward. Aerial roots, characteristic of many of the tropical figs, are found on it in all stages of development: some just budding from the limbs; others swaying in the air in their descent downward; others doubled back onto the trunk and grafted to it.

Leaves are elliptical, 2½ inches long, 1¼-1½ inches wide. The base is wedge-shaped, the tip acute (but rounded, not pointed, at its very extremity). Margins are entire, venation is pinnate, obscured by the darkness and thickness of the blade. Both surfaces are smooth; in color and texture the leaves much resemble those of ligustrum. The petiole is ¼-½ inch long, thick and stout, and grooved along the top side. Leaves are attacked by the oyster scale and more seriously by a sucking insect which feeds on the upper surface and causes the blade to curl up and wither. Sometimes about one leaf in ten is thus affected, but with no perceptible effect on the tree and no diminution of its shade.

Bark is light gray, smooth, and often covered with a multitude of well-healed scars. Twigs are slender; when cut or broken they exude the milky juice characteristic of figs and mulberries.

Fruits are tiny, sweet-smelling figs, too inconspicuous to be recognized as such by the people but eaten with gusto by birds, particularly by the Mexican crows (*hurracas*), which frequent the trees in large numbers.

The wood is lightweight, easily decayed, and of no known commercial value. But this of course was not to be expected. Of a tree which gives such magnificant shade and gives it so unstintedly at all seasons of the year and for so little recompense in the way of care, what right do we have to ask for more?

Excerpts from Peter J. Van Melle

On the Name, *Viburnum* (1947)

If there were a good English name for these shrubs, one would like to use it. "Snowballs" won't do. It's an old name for the medieval "Guelder Rose" (*Viburnum opulus* 'Roseum') and, by courtesy, for other snowball-flowered kinds of later vintage. But most of them just aren't snowballs, nor Hobble-bushes or Way-faring-trees, like *V. alnifolium* and *V. lantana,* with their reclining and rooting branches to trip the wayfarer. The Latin name is derived from a mention of a "viburnum"—a lowly bush of some sort—in one of Virgil's Pastoral Poems, which has been supposed to represent *V. lantana.* Can anyone think up a good *English* name for the genus?

On Selecting Varieties of Shrubs (1950)

Let us not, in our selection of shrubs, be swayed entirely by the single, obvious attraction of floral effect, but hold out, instead, for something more than it. Floral effect, important as it is, is only one of a number of good qualities we should look for in the shrubs selected to fill the limited space at our disposal. Other good qualities are, for instance, pleasing foliage throughout the summer, autumn color, pretty fruit, and winter appearance. Combinations of these values, with or without a good display of flower, will stretch out interest in, and enjoyment of our shrubs over a much greater part of the year than will a mere display of seasonal flowers.

Recent Developments in Producing More Crops on Straw

P. G. ALLEN*

(From The Grower, *Vol. 68, No. 19, p. 841-843, November 4, 1967)*

Overseas visitors to England's vegetable producing glasshouse areas are often intrigued and sometimes startled at seeing tomato plants growing on what appear to be bales of straw. Closer inspection reveals that this is indeed the case.

Producing crops on straw is attracting attention from many parts of Europe and from areas as far away as Canada, Israel, and Africa. The technique of growing vegetables and flowers on straw bales allows the production of a full crop where soil conditions would otherwise make this impossible because of poor physical conditions or the presence of soil-borne pests and diseases.

*Director, Lee Valley Experimental Horticultural Station, England.

Straw bales, or more frequently 6 to 10 inch thick slabs cut from a bale (termed "wads"), are laid on strips of polythene plastic which are slightly wider than the bales. The straw is then wetted thoroughly and a complete fertilizer added and watered in. A small "bed" is built on top of the straw to take the roots of the tomatoes or other plants. Sterilized soil, peat and spent mushroom compost, or peat and sand have proved satisfactory. The straw ferments, producing some bottom heat and carbon dioxide beneficial to rapid growth, early flowering, and fruiting. Since the straw does not supply nutrients until it decomposes, regular light applications of fertilizer are necessary to keep the plants growing well. When the roots are through the straw, growers turn up the edges of the polythene, holding them in

PHOTO BY IAN CLOOK

Three systems of growing tomatoes in England: on half-bales of straw; in 8-in-deep plastic trays; in a capillary-fed wooden trough.

place with a little soil, and thus making a trough 1 to 2 inches deep. This serves as a water reservoir and lessens the need for frequent watering.

Cucumbers, chrysanthemums, stocks, and snapdragons, in addition to tomatoes, grow well on straw. The photo shows three systems of growing tomatoes —on straw wads, in plastic trays 8 inches deep, and in a wooden trough, capillary fed.

So if you are unhappy with your garden soil and want to try something different, get a bale of straw, slice it into "wads" and try the English system of "soil-less culture." Remember, though, you will need to provide some support for the plants.

Flower Necrosis in *Cattleya* Orchids

ROGER LAWSON*

(Adapted from a manuscript to be published in the American Orchid Society Bulletin)

Have you noticed a Cattleya *orchid flower producing brown streaks and spots when it should be still in its prime? Or did that newly purchased* Cattleya *corsage suddenly become "old"? Perhaps this was the expression of a virus disease and not just senescence. Dr. Lawson presents evidence in this report that* Cattleya *flower necrosis can be caused by a single virus that is carried by orchids of the* Cymbidium *genus. This finding is of great significance in view of current emphasis on rapid propagation of virus-free plants by meristemming.*

Introduction

Cattleya orchids are affected by a pathogenic organism that produces brown spots and streaks in the flowers. This disease is of particular concern since leaves of infected plants often show no distinct symptoms and flowers appear normal when they first open. Necrotic symptoms may develop a few days after the bud breaks open, or expression of necrosis may be delayed up to 3 or 4 weeks. Because the disease reaction may not appear in the flowers until 2, 3, or 4 weeks after the flower opens, the disease symptoms have often been mistaken for symptoms of senescence that would occur in a disease-free plant.

The infectious nature of this disease and transmission of the disease agent to healthy orchid plants by mechanical inoculation on a contaminated knife blade has been reported by Thornberry and Phillippe (6). In addition to reporting transmission of the agent, these authors stated that *Cymbidium* mosaic virus (CyMV) and the orchid strain of tobacco mosaic virus (TMV-O) were both consistently isolated from plants showing flower necrosis. A causal relationship between these two viruses and *Cattleya* flower necrosis was recently reported (7). These authors concluded that inoculations with pure cultures of CyMV or TMV-O alone did not produce flower necrosis in healthy plants. Corbett (2) reported that the flower necrosis symptoms described by Thornberry were rarely observed in Florida although TMV-O and CyMV were present in many genera, species, and hybrids.

This report presents evidence that *Cymbidium* mosaic virus alone can produce necrotic flowers in *Cattleya* orchids. Although TMV-O can be found in *Cattleya* plants that produce necrotic flowers, the presence of this virus is incidental and has no causal relationship to the disease.

Materials and Methods

A plant of *Cattleya* 'Angel Island' was used as a source of CyMV in all experiments. Lead samples from this plant were tested on *Chenopodium amaranticolor, Nicotiana tabacum* 'Xanthi', and *Gomphrena globosa* for the presence of TMV-O. Assays were made using standard mechanical inoculation procedures as well as the liquid nitrogen extraction method described by Thornberry (6). No TMV-O was detected in the source plant. Preparations made for the electron microscope showed no distinct population of virus particles characteristic of TMV-O.

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CyMV was extracted from the source plant by grinding a 50 g leaf sample in four volumes of 0.1 M phosphate buffer at pH 7.5. The ground tissue was squeezed through cheesecloth and the solution centrifuged at av. 5900 *g* for 15 minutes to remove the large cellular components. The resulting supernatant fluid was centrifuged at av. 69,600 g for 90 minutes to concentrate the virus. The virus was suspended from the centrifuged concentrate and further purified by centrifugation in sucrose density gradient columns. Density gradient centrifugation is a procedure commonly used to separate a mixture of macromolecular components which differ in density, size, and molecular weight. This method can be used to separate mixtures of viruses from each other and from contaminating non-viral components. Centrifuged gradient columns were analyzed and the ultraviolet absorbing fractions separated. Each fraction was tested for biological activity and observed in the electron microscope to determine the size and shape of the particles in the fraction.

Results

Three distinct fractions (*a*, *b*, and *c*) were consistently present in fractionated samples from 'Angel Island'. Fraction *a* contained mostly small particle contaminants and short lengths of rod-shaped virus particles and a low level of CyMV activity. Fraction *b* contained a high concentration of flexuous rods which were shorter than the normal particle length of 475-480 mu described for CyMV (1, 3). This fraction contained the highest level of CyMV activity. The predominant particle lengths in this fraction were 415 mu, 425 mu, 435 mu, and 445 mu. Fraction *c* contained about an equal number of particles 450 mu and 475 mu long and contained a low level of CyMV activity. Particle length measurements were also made from virus present in unpurified sap. Ninety-three percent of the particles in this type of preparation measured 435-460 mu in length.

In another experiment, TMV-O was purified from an orchid plant that was inoculated with a pure culture of the virus. In order to determine whether TMV-O could be completely separated from CyMV in our gradient system, a portion of the purified TMV-O sample was mixed with the CyMV from 'Angel Island' and the mixture was separated by the fractionation method described. Assay of the gradient fractions from the CyMV and the TMV-O mixture of 'Xanthi' tobacco and *Chenopodium* showed that a low level of TMV-O contamination could be present in fraction *c*. No TMV-O activity was detected in fractions *a* and *b* in the upper portion of the gradient column, but fractions *d* and *e* and the lower portion of the column contained a high level of TMV-O activity and produced many lesions on the indicator species. From these results we conclude that TMV-O sediments more rapidly than CyMV and can be effectively separated from a mixture of the two viruses.

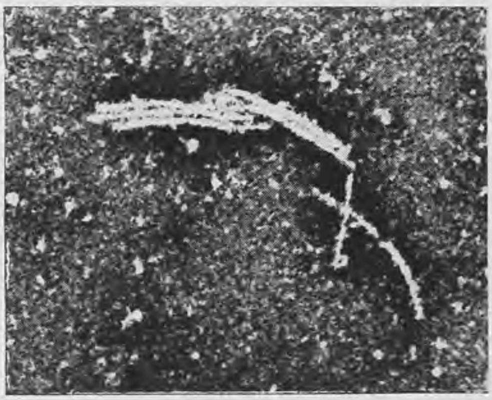
Seedling *Cattleya* 'Bow Bells' crosses were used in all bioassays. Plants were inoculated when buds were fully formed, usually 2 to 3 weeks before flowering. Inoculations were made by jabbing a razor blade contaminated with the test preparation into the pseudobulb of a budded lead and by rubbing the preparation on the leaves. Flowers of plants inoculated with gradient fractions *a* and *c* did not develop flower necrosis. This is probably because the concentration of CyMV was too low to produce flower symptoms using the test procedure described. Flower necrosis often appeared within 5 to 10 days after opening in flowers of plants inoculated with fraction *b*. The necrotic reaction progressed rapidly with severe necrosis becoming prominent 24 to 48 hours after the first symptoms appeared.

An experiment was carried out to determine if CyMV is the only virus in fraction *b* measuring 400 to 500 mu long and if it is solely responsible for inducing flower necrosis. A sample of fraction *b* was absorbed with CyMV antiserum to remove the CyMV particles from solution. Another sample of fraction *b* was treated with normal serum. The samples were incubated at 35°C for 1 hr. and centrifuged at 3000 g for 15 minutes. The preparation was left overnight in the refrigerator and recentrifuged the next morning. The supernatant fluids were examined in the electron microscope. A high concentration of virus particles was present in the virus solution treated with normal serum (Fig. 1). This result shows that normal blood serum does not precipitate the virus from solution. The virus suspension treated with CyMV antiserum showed only a few virus particles in the supernatant fluid (Fig. 2). All of the particles showed specific antibody attachment along the surface. No reaction occurred along the particle surface in fraction *b* incubated with TMV-O antiserum and the electron microscope picture appeared the same as the sample treated with normal serum.

A plant from a 'Bow Bells' cross with 2 flowering leads was divided into 2 parts in the flower pot to prevent possible transport of the virus from one flowering lead to the other. One lead was inoculated with gradient fraction *b* treated with CyMV antiserum and the other lead was inoculated with the virus suspension treated with normal serum. Strong necrosis occurred 8 days after flower opening in the lead inoculated with fraction *b* treated with normal serum (Fig. 3). Fraction *b* treated with CyMV antiserum did not produce the necrotic flower reaction. Plants inoculated with fraction *b* treated with TMV-O antiserum showed necrosis in the flowers. Leaves of some of the *Cattleya* seedlings inoculated with untreated fraction *b* showed sunken spots and necrosis 3 to 4 weeks after inoculation.

Discussion

Rapid development of flower necrosis in experimentally inoculated *Cattleya*



(Top Left)
Fig. 1. Electron micrograph of density gradient fraction *b* particles incubated with normal serum (enlarged about 61,600×).

(Top Right)
Fig. 2. Electron micrograph of density gradient fraction *b* particles incubated with CyMV antiserum. Note specific antibody attachment along the surface of the particles (enlarged about 61,600×).

(Lower Left)
Fig. 3. Flower necrosis in *Cattleya* 'Bow Bells' inoculated with gradient fraction *b*. Photo taken 8 days after opening.

PHOTO U. S. DEPARTMENT OF AGRICULTURE

plants is correlated with density gradient fraction *b* which contains a higher concentration of *Cymbidium* mosaic virus than gradient fractions *a* or *c*. Since gradient fractions *a* and *c* contain some CyMV activity, the rapid development of necrotic symptoms may depend, at least in part, on the concentration of virus in the original test preparation.

The experimental finding that CyMV alone can induce necrotic symptoms in *Cattleya* flowers requires a new assessment of the virus problem in cattleyas and consideration of the following points.

1. Diagnosis of the flower necrosis disease can be simplified since only one virus must be detected. An assay on the host plant *Cassia occidentalis* can be used to perform this test (1). However, bioassay for TMV-O should also be included since this virus can cause colorbreaking in lavender *Cattleya* flowers.

2. Plants showing flower necrosis that are not infected with TMV-O may possibly be freed of CyMV by meristem culture. Cattleyas have been freed of CyMV by repeated excision of protocorms when virus-free plants were not obtained from the first excision. In contrast, TMV-O remains in small tissue pieces and is carried over in the new meristems even when very small pieces are cultured.

3. *Cymbidium* mosaic virus is reported to infect *Cymbidium, Cattleya,* and *Phalaenopsis* (1,4,5). No distinction has so far been made between *Cymbidium* mosaic virus isolates, and whether the flower necrosis disease is induced by a single strain or a mixture of strains of this virus is unknown. We do know that isolates of the virus from *Cymbidium* can produce necrotic flower reactions in *Cattleya* (unpublished data). It is, therefore, important to recognize that although flower necrosis may not develop in plants of some genera infected with CyMV, the same virus may produce necrotic flowers in cattleyas.

Comments

Articles that have appeared from time to time in the AOS *Bulletin* leave the reader confused about the *Cymbidium* mosaic virus problem in cattleyas. One such article appeared in the *Bulletin* in May, 1966.

The article "Viral Problems in Orchids," states that *Cymbidium* mosaic virus "does not affect the bloom in any great degree but does show up when the flowers start getting old." It is true that virus-induced flower necrosis may appear similar to symptoms of senescence that result from the natural aging process. It is extremely important, however, to recognize that virus-induced necrosis may appear within a few days after the flower opens and is different from browning due to aging which in a virus-free plant would appear only after a month to 6 weeks.

The *"discussion"* above states that plants infected with CyMV which produce necrotic flowers may be freed of the virus by meristem culture. So far, this method of obtaining virus-free plants cannot be used successfully in routine production. Because of the large size of the protocorms excised from *Cattleya* compared to *Cymbidium*, it has not been possible to obtain virus-free cattleyas in a predictable manner. Therefore, it is essential to test and certify virus-free nucleus stock plants if the propagation and distribution of thousands of virus-infected meristemed *Cattleya* plants are to be avoided.

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Weeds

This section on weeds is a new feature of the American Horticultural Society's journal. Its editor is Dr. Loran L. Danielson, *Leader, Weed Investigations, Horticultural Crops, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland 20705.*

The purpose of this new service is to help Society members become knowledgeable about weeds and their control.

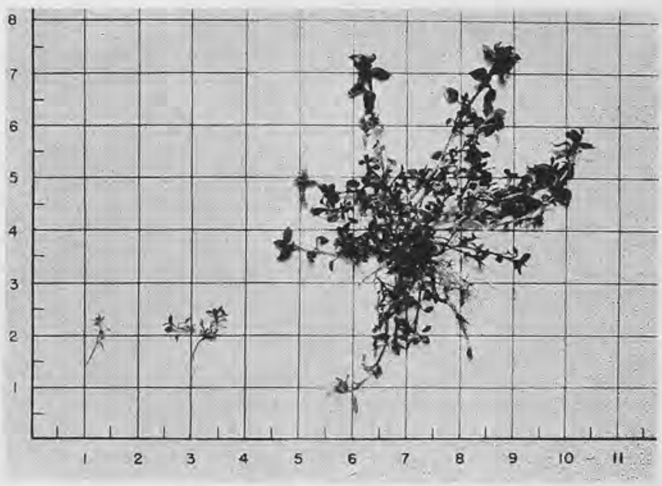
WINTER WEED CONTROL

An old axiom in the physical sciences tells us that nature abhors a vacuum. When we think of weed encroachment, we know that this axiom is equally true in the science of living things. Thus, we see each open space between our domestic plants quickly filled with weeds that crowd and stunt them. Nature has a vast number of weed species ready at hand to fit into every seasonal, climatic, soil, and cultural condition. As a result, the weed problem does not end with a change of seasons, but the species change and the problem continues almost unabated.

Cool-weather weeds such as annual bluegrass [*Poa annua L.*], corn spurry [*Spergula arvensis* L.], knawel [*Scleranthus annuus* L.], field madder [*Sherardia arvensis* L.], shepherds-purse [*Capsella bursa-pastoris* (L.) Medic.], common chickweed [*Stellaria media* (L.) Cyrillo], henbit [*Lamium amplexicaule* L.], and many other emerge in the period from September through November in most climatic areas of the continental United States. Emergence occurs at specific times because of the rest period required by the seeds before germination or associated with reduced soil and air temperature levels and day lengths. With the approach of fall weather, we should plan our weed control strategy and put it into effect as quickly as possible.

Two of the most common cool-weather weeds the home gardener must contend with are common chickweed and henbit. Chickweed (Figure 1), also sometimes known as starwort or star-

Fig. 1. Three stages in the growth and development of chickweed from the seedling on the left to the mature flowering plant on the right. Chickweed is a winter annual that germinates in the cool fall weather. It flowers and matures some seed throughout the winter, but the warm days of spring trigger maximum seed production and senescence. It is a low-growing member of the pink family with a small, white flower having five petals.



weed, is a winter annual weed belonging to the pink family [Caryophyllaceae]. Maximum germination occurs when night temperatures reach an average of about 40° F, though scattered earlier germination occurs. Reproduction is mainly from seed, but rooting at the stem nodes and growth of the axillary buds produces additional plants when the parent plant is divided by cultivation, or when the stalk dies for any reason. The stems are slender, averaging about 1/8 inch in diameter. They are semiprostrate and spread out fanwise to a length of 6 to 8 inches from the main stem. The simple leaves are opposite, ovate to oblong, and have a smooth margin. The small, white star-shaped flowers are clustered at the nodes. Flowers and seed are produced all during the winter each time the weather moderates. Many seeds are produced in the single capsule left by each flower. Chickweed is a nitrogen-loving plant and is therefore seldom found in unfertilized or waste-areas.

Henbit (Figure 2), also known as deadnettle and blindnettle, is a winter annual or biennial weed belonging to the mint family [Labiatae]. It reproduces from seeds and rooting stems as described for chickweed. The slender, smooth, semiprostrate stems are square in cross section, about 1/8 inch thick, and 6 to 8 inches long. The hairy leaves are rounded to slightly lobed and palmately veined. The pink to purplish flowers are in axillary whorls. Flowering and seed maturation occur throughout the winter in many areas.

Control of winter weeds without use of herbicides can be achieved by mulching plantings with black polyethylene mulch or tightly-woven burlap at the time of germination.

Many of the germinating winter weeds can also be controlled by application of certain herbicides to the soil. These herbicides include isopropyl *m*-chlorocarbanilate [chlorpropham], 2-chloroallyl diethyldithiocarbamate [CDEC], dimethyl tetrachloroterephthalate [DCPA], α,α,α-trifluoro-2,6-dinitro-*N*, *N*-dipropyl-*p*-toluidine [trifluralin], 2-(2, 4-dichlorophenoxy) ethyl sodium sulfate [sesone], and others. (These are generic names for trade-marked products.) Spray treatments with these herbicides are effective but must be carefully directed to avoid contact with the ornamental foliage. Granule formulations of the herbicides should be used wherever available because they minimize injury to the valuable plants. Limitations of use on various plant species differ from one herbicide to another and are stated on the manufacturer's label. Rates of application and other specific directions for use are also given on the label on each product. Read the instructions and follow them carefully to avoid injury to your plantings.

Weeds often emerge and become established before we realize it. Such weeds can be safely destroyed in woody ornamental plantings by carefully directed sprays of 1,1′-dimethyl-4,-4′-bipy-

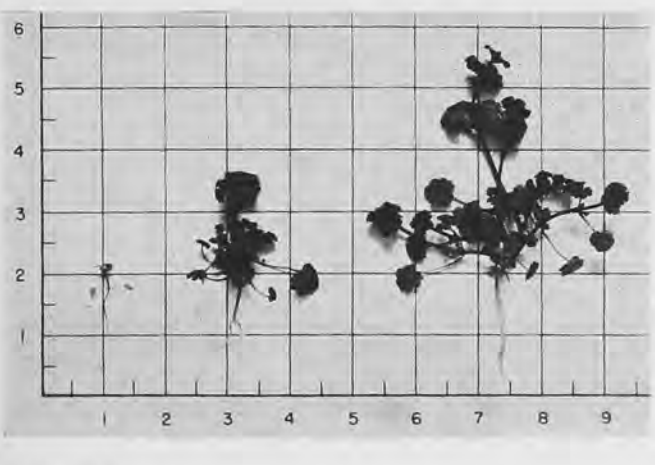


Fig. 2. Three stages in the grow h of henbit from the seed ing on th left to mid vegetative on the righ'. Henbit is a winter annual or biennial that germinates in th fall and grows, flowers, and matures seeds throughout the winter. It is a low-growing member of the mint family and has a pink to purple flower.

ridinium salts [paraquat] herbicide that thoroughly wet the foliage but do not strike the ornamentals.

The soil should not be hoed or cultivated after use of any of the herbicides. Such soil movement brings new, unaffected weed seeds to the soil surface where they germinate and renew the problem.

Avoid the use of mulches of untreated cereal straw, grasses, or other plant refuse that may contain crop or weed seeds as a means of minimizing weed problems. Also, large amounts of mulch often give cover to woods mice that feed on the bark and roots of ornamentals.

All agricultural chemicals recommended for use in this report have been registered by the U.S. Department of Agriculture. They should be applied in accordance with the directions on the manufacturer's label as registered under the Federal Insecticide, Fungicide, and Rodenticide Act.

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Act of October 23, 1962; Section 4369, Title 39, United States Code)

1. Date of filling: October 1, 1969.
2. Title of publication. The AMERICAN HORTICULTURAL MAGAZINE.
3. Frequency of issue: QUARTERLY.
4. Location of known office of publication: 3110 Elm Avenue, Baltimore, Maryland 21211.
5. Location of headquarters or general business offices of the publishers: 2401 Calvert St., N.W., Washington, D. C. 20008.
6. Names and addresses of publisher, editor, and managing editor:

Publisher: The American Horticultural Society, Inc., 2401 Calvert St., N.W., Washington, D. C. 20008.

Managing Editor: Elizabeth G. Eastburn, 2401 Calvert St., N.W., Washington, D. C. 20008.

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8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None.
9. For completion by nonprofit organizations authorized to mail at special rates (Section 132.122, Postal Manual).

The purpose, function, and nonprofit status of this organization and the exempt staus for Federal income tax purposes have not changed during preceding 12 months.

10. Extent and nature of circulation:

A. Total no. copies printed (Net Press Run)	5,237*	5,100**
B. Paid Circulation		
1. Sales through dealers and carriers, street vendors and counter sales	0*	0**
2. Mail subscriptions	3,844*	4,852**
C. Total paid circulation	3,844*	4,852**
D. Free distribution (including samples) by mail, carrier or other means	0*	0**
E. Total distribution (Sum of C and D)	3,844*	4,852**
F. Office use, left-over, unaccounted, spoiled after printing	1393*	248**
G. Total (Sum of E & F—should equal net press run shown in A)	5,237*	5,100**

*Average no. copies each issue during preceding 12 months.

**Single issue nearest to filing date.

I certify that the statements made by me above are correct and complete.

ELIZABETH G. EASTBURN

A GREAT IRIS GARDEN

Barbara Walther has been hostess to most of the famous iris hybridizers of our century.

Presby Memorial Gardens is world renowned as a repository of historical and contemporary hybrid iris. The story of its development could serve as a blueprint for any town which wants to organize and maintain a successful botanical project.

The idea for this particular public park in Upper Montclair, New Jersey came after the death in 1924 of Frank H. Presby, a public spirited citizen who campaigned for more community trees and flowers. He often said in his lectures, "In addition to water supply and sewage, Montclair should provide parks to satisfy man's esthetic side." He encouraged everyone to grow his favorite flower, the bearded iris, which he was hybridizing.

Since its inception in 1927, Presby Gardens has been most fortunate in its unsalaried director, the gentle and persevering Mrs. Barbara Walther. She was a well known lecturer on trees and wild flowers who was singled out by the mayor for the monumental task of making a dream become reality. By lucky chance, she lived next door to these grounds with her husband and children. Through all the years of the park's evolution she has never left the helm.

Today Montclair is proud of and supports Presby Memorial Gardens by zoning the grounds as a sanctuary and sending city laborers and equipment to help. To preserve integrity in the operation, Barbara—as friends call her—adhered to a motto, "Consider the iris first." Although this accomplished many of their aims and the display ran smoothly to all appearances, behind the scenes many crises arose.

For one thing, there never seemed to be enough laborers. To pay for overtime work, private funds had to be solicited.

Streamers of iris beds unfurl their beauty in Presby Memorial Gardens, Upper Montclair, New Jersey. Superb landscape design is by Dr. John C. Wister.

PHOTO BY AUTHOR

Some of the workers who came could not speak English and Barbara conveyed digging, dividing and planting operations with sign language, smiles and vigilance. Over the years, after employees mastered skills, they were transferred or retired.

Hardly a visitor was aware of it, but until a few years ago, no water was piped into Presby. Sustaining a great garden without a faucet wasn't easy. When the need was dire, a water truck was driven in. Luckily, long droughts can be tolerated by the rhizomes of bearded iris, the backbone of the plantings. Other kinds of iris at Presby, such as Siberians, Japanese and spurias which crave pre-bloom moisture, fared less well.

At last hydrants were installed, but were placed inconveniently to some of the beds and in positions where visitors tripped on them. However, one can count on Barbara to arrange further negotiation.

In the early years, excess rain created a predicament worse than drought. Water ran downhill and settled in the lower beds, causing fatal iris rot. Barbara undertook intensive research until

Simple marker, placed in honor of Frank H. Presby, in 1927, is encircled by brilliant blooms. PHOTO BY AUTHOR

she read that in moist areas of England they elevate perennial borders a little higher than the surrounding terrain. When Presby's beds were raised with one foot of additional soil, rot diminished.

School groups begin to arrive at the start of the iris season. Children from the school across from Presby call themselves the "guardians" of the park. PHOTO BY AUTHOR

A real scourge came with the iris borer, *Macronoctua onusta*, a widespread pest along the Eastern seaboard and elsewhere in the U.S. The worm-like larva hatches in the spring from an egg that has wintered over on old iris foliage or nearby plants. It tunnels into a fresh leaf, always an iris (although it will attack the blackberry-lily, *Belamcanda chinensis*), and then eats underground to fatten on the rhizome.

In its wake rot and often total plant destruction follow. Old fashioned insecticides and other methods proved so ineffective or costly that Barbara developed her own remedy—cutting back the iris foliage after egg laying in November, leaving only six inches of greenery above the ground. Clippings and weeds were carted away, aborting millions of borers—not all, but enough to keep them in check.

"At Presby the main task is organization," Barbara admitted with a sigh that fleetingly covered a lifetime of labor.

She referred mainly to the supervision of many volunteers who serve in various capacities without compensation.

Women from the local garden club care for the 20 large beds—two to each bed—which they tend by checking identifications, keeping records, printing and positioning labels, routing weeds, making room for new arrivals and overseeing the planting operations. They don't consider it light housekeeping during hot weather. The most exhausting chore is midsummer replanting of the rhizomatous iris, which are lifted, divided and replanted every five years on a rotating basis.

It is a tribute to Barbara that the workers accept tasks willingly and waste no time on petty jealousies, which scuttle so many club projects. If a novice pleads ignorance of iris, Barbara tells her, "I was like you when I started. We'll teach you."

A sea of beautiful blooms spanning the history of iris reaches a peak each year, usually around Memorial Day. Then the ladies of the staff become hostesses to the estimated 5,000 visitors. Some of the admiring crowd don't know an iris from an orchid, others are experts. Even city dwellers descend with cameras. It is a 40-minute drive from New York's Washington Bridge via Routes 80 and 46 (west), turning right on Valley Road, right on Mt. Hebron, and left on Upper Mountain Road.

The sloping hillside is in full view of the road, luring many passersby. All are welcome free of charge.

Barbara Walther dropped everything one spring day to give an impromptu talk to a busload of underprivileged school children. On another day she was overjoyed to see a group of somber mental patients, brought on a therapy outing, responding with pleasure to the many iris colors.

In the early morning a few fortunate friends inspect the neat rows with Barbara.

"What do you think of 'Violacea Grandiflora'?" she inquires, referring to a cultivar in the historical section of the garden. The label identifies the prolific clump as an 1856 introduction of Colonel De Barry. "It has been in bloom for three weeks. Smell its fragrance."

In another aisle she bends down to address a brown-toned modern hydrid, "Good morning, 'Thotmes!" To the lady walking alongside, she adds, "This was named 'Thotmes III' for a conquering pharoah of old who found iris on his campaigns and brought them back to Egypt."

She will not select a single favorite but is obviously partial to tall blue iris such as the Dykes winner 'Pacific Panorama'. Of whatever color, the famous ones are all at Presby.

Credit for the living museum concept goes to the first president of the American Iris Society, Dr. John C. Wister, who came to the rescue with a three point master plan. At the start of Presby, he designed the handsome landscaping without accepting a penny for his professional services. Next, he donated representatives from his private collection of historical iris, dating back to the 17th century when the bees were the only hybridizers. Last, he instructed Barbara to write to the leading hybridizers who had known and respected Mr. Presby, to persuade them to donate the newest and best of their craft.

This suggestion was valuable because currently there are over 900 registrations a year and acquiring the most exciting of these is essential to sustain public interest. However, each one averages $25 each, a prohibitive price for Presby's small budget, which is contributed by the Montclair Garden Club and interested individuals.

By patient correspondence and negotiation, thousands of cultivars were solicited by Presby Gardens, with the only recompense to the nurseries an amount to cover packing and mailing costs.

When styles in iris change as rapidly as women's fashions, the commercial growers discard things that are over ten years old, but Presby continues to grow the respected old ones. This has saved some from extinction and has spread the fame of the gardens as a valued repository.

Although Presby does not give or sell iris, it will not turn down botanical gardens or breeders who want unavailable items. In 1955 when another international iris garden was established in Florence, Italy, Barbara and her workers spent weeks packing valuable parcels. These sailed overseas and arrived safely. Now Presby is the proud "parent" to the world's second most important historical iris garden.

In 1967, which was the 40th anniversary of Presby Gardens, Barbara Walther received three honors for her years of service to Presby—the Special Achievement award from the National Council of State Garden Clubs, the Certificate of Merit from the Garden Clubs of New Jersey, and the coveted Foster Memorial Plaque from the British Iris Society.

When friends compliment her, she insists, "It's not Barbara Walther who receives these awards but the town of Montclair, the Garden Club, the contributing hybridizers, Dr. Wister, and the volunteer staff."

Yet everyone knows who makes Presby what it is, and that is why the rainbow on the hillside is unofficially called "Barbara's garden."

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Itea virginica—Virginia Sweetspire or Virginian Willow

Virginia sweetspire is native in low, wet habitats from New Jersey and Pennsylvania to Florida and Louisiana, and is often associated with the Coastal Plains.

In cultivation, it is adapted to sun or shade and to general garden soils. Here at Calloway Gardens we find it is best used in mass planting in a naturalized area, or combined in a border planting with other shrubs.

It is a native shrub of the Saxifrage family, with only one species indigenous to North America. *Itea* is the Greek name for willow, applied to this genus because it has willow-like leaves and is, like willow, found near water. A medium-sized shrub, with upright spreading branches 4-6 feet in height; deciduous, with alternate tapering serrate leaves, 2-4 inches long.

The late spring or early summer flowers are creamy white, fragrant, and produced in dense spire-like clusters or racemes 3-6 inches long. Virginia sweetspire is best known for its long racemes of small creamy white flowers and its brilliant autumn foliage. The leaves turn a rose red to brilliant red in early fall.

Propagation is by seed, softwood cuttings, or division.

Six or more species of *Itea* inhabit tropical and subtropical Asia. *Itea ilicifolia,* hollyleaf sweetspire, a native of central China, has attractive, partially evergreen, holly-like, spiny-toothed foliage. The small white flowers are 6-8 inches in length, in terminal dropping racemes. Unfortunately, it is not as hardy as *I. virginica* and is seen more frequently on the West Coast than in the East.

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***Itea virginica*— Virginia Sweetspire or Virginian Willow**

PHOTO BY AUTHOR

Carpenteria californica

I would like to comment upon the cold-hardiness of *Carpenteria californica* as described in Part I "Useful California Natives for Gardens," page 338, *American Horticultural Magazine,* Fall, 1968.

The Book of Shrubs, by Hottes, states that *C. californica* is hardy in Philadelphia; this is not the usual statement referring to zone hardiness, but merely an observation that a plant was actually growing there, and thriving.

Plant hardiness is a many-faceted thing, cold-hardiness being but one factor of many which determine not just survival, but normal, healthy growth; many plants can survive if pampered, but are not really thriving; and if left to the vagaries of climate, would soon give up the ghost.

Such arid region plants as *C. californica,* when grown in regions of ample rainfall, must be in well-drained—in fact, sharply-drained—soil.

The flora of the arid west does not, as a general rule, tolerate the climatic conditions and soils of the eastern and southeastern United States without pampering and special site preparation.

Arid region plants are characterized by grayish leaves with pubescent undersurface, a survival mechanism to retard water loss due to transpiration.

Arid region soils have high pH, while the soils of regions with ample rain are below the neutral point and are anywhere from mini-acid to acid, depending upon the parent material.

However, these comments are not to be construed as meaning that we should not attempt the growing of arid region plants in the east, or for that matter, any exotics away from their normal environment. If we followed this principle we would have nothing in our gardens, for almost all of our cultivated plants are exotics from varied climatic and soil environments. This is merely an effort to point out to less experienced plantsmen the several factors involved in the criterion of plant hardiness.

Many plants are very adaptable, and can be acclimatized easily, even amazingly, for instance, plants that are aquatics but are also rampant growers in very dry soil.

For the true plantsman, the challenge is in doing the difficult!

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Hemerocallis for Dark Patios

Our patio is densely shaded, and by July becomes rather like Poe's "dank tarn of Auber." Begonias and *Impatiens* sprawl and expire pallidly, and we have given up moving potted flowers in and out of the shade. By hazard this summer we came upon a spectacular solution when we were dividing our daylilies in full bloom. Instead of throwing the surplus plants aside, I stood them in tubs, stuffed the roots with peat and Perloam, and watered them in with a mild fertilizer solution. Presto—a fairyland!

Every bloom opened perfectly over several weeks. The plants continued green and fine, and were in perfect shape for replanting when they finished blooming. The effect of those great lavish sheaves of bloom, glowing in the shade in every color from lemon-green to crimson, was magical. Even mediocre varieties looked so elegant I hated to give them away.

The beauty of the system is: no work. One merely digs the hems a few weeks early. Tubbing takes only a moment. Hems are not fussy about losing a few roots or having air pockets, and this is their time for making new roots anyway. The rest of the year they can grow in the vegetable row, or any sunny spot, in the normal way, with none of the bother of potted plants.

If you decide to try this, water *lavishly,* and of course be sure there are drain holes. Choose cultivars that stay open in the evening, and avoid the frosted pinks which require full sun to blanch the pigments. Be sure to try reds: you will never see them so gorgeous in the open garden.

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Book Reviews

Trees

Andreas Feininger. Viking Press, 625 Madison Ave., New York, N.Y. 10022. 1968. 116 pages. Illustrated. $22.50. (Library)

The author, a renowned professional photographer, states in the introduction that he ". . . had set my mind on a new kind of tree book—a project that had kept me occupied on and off for the previous 9 years—not a textbook or manual, nor a tree identification book, nor still another picture book proving that trees are beautiful, but a tree-appreciation book".

He has produced a beautiful large-format volume which largely fulfills his aim. The outstanding feature of the book is 160 superb full-page photographs (40 in color) of 67 tree species. These have been photographed primarily in North America. The book is divided into 16 chapters which treat various aspects of trees (structure, trunk and bark, wood, the forest, etc.) and some distinctive species (bristlecone pine, live oak, the two sequoias). Considering the broad scope of this tree-appreciation book, I wonder why the vital aspects of flowers, fruits, and seeds are not discussed or illustrated. A final chapter urges individual participation in conservation efforts and describes the major national conservation organizations. Each chapter is followed by a group of appropriate photographs. The captions precede each group of photographs; I would have found them more useful had they been on the same page as the corresponding photograph.

It would be good to see this book reprinted in a less expensive, paperback edition so that it might have wider distribution. The awareness and appreciation of trees and the role they play in our lives is an important part of the respect for the whole natural environment which is increasingly vital for life in our urbanized society.

ROBERT L. BAKER

Plant Propagation, Principles and Practices, Second Edition

Hudson T. Hartmann and Dale E. Kester. Prentice-Hall Inc., Englewood Cliffs, New Jersey 07632. 1968. Illustrated. 702 pages. $14.00. (Library)

This second edition, with its added recent research and development information, continues to stand as the most definitive book on plant propagation available. While it serves as an excellent college or university text, it should also be on the shelf of every reference library that is concerned with plants.

The chapters are divided into five sections: General Aspects of Propagation, Sexual Propagation, Asexual Propagation, Special Methods, and Propagation of Selected Plants. Wherever appropriate, the technical phases of reproduction and propagation are discussed, such as environmental conditions, or the anatomy and physiology of the plant. These chapters are then followed by those covering the techniques of propagation, which contain good illustrations that further add to their usefulness. A most important addition is the chapter on Aseptic Methods of Micro-Propagation concerned with embryo culture, tissue culture and shoot tip or meristem culture. These newer techniques are becoming of greater importance in studies on plants, and from a very practical horticultural point are essential in order to obtain certain disease free plants.

For the student who wishes to study in greater detail, extensive bibliographies are included. The person who only wants to propagate a plant will find the chapters on the techniques carefully written; or he may turn to the final chapters that provide specific information on the propagation of fruit and nut species, on ornamental trees, shrubs and vines, and on selected annuals and herbaceous plants.

CONRAD B. LINK

Handbook of North American Nut Trees

Richard A. Jaynes, Ed. Northern Nut Growers Assn., Inc., 4518 Holston Hil's Road, Knoxville, Tenn. 37914. 1969. 421 pages. Illustrated. $7.50.

An excellent reference for the many kinds of nut trees that can be grown in Canada and the continental United States.

Dr. Jaynes, associate geneticist, Connecticut Agricultural Experiment Station, is editor of this volume which contains contributions from twenty-four additional and equally well known specialists.

The techniques and problems in culturing and developing better nut tree cultivars are the main subject of this handbook. The book is divided into four major sections, consisting of thirty-two chapters.

Part I is an introduction and history of nut trees.

Part II covers culture and propagation and includes chapters on soil management, pruning, mulching, herbicides, control of mammal and bird damage, plant pests (insects and diseases), and labels.

Part III, The Tree, emphasizes the production of thirteen major nut trees including pecans, walnuts, chestnuts, almonds, coconuts, cashews, macadamias and pistachios. A chapter entitled "Oaks, Beech, Pine and Ginkgo" completes this section.

Part IV includes chapters on nut trees for planting for wild life; breeding, naming, judging, cleaning, storing, and cracking nuts.

This handbook is a valuable reference and should increase the interest in nut trees, contributing to their more widespread use and efficient production.

F. C. Galle

Bonsai, Saikei and Bonkei

Robert L. Behme. William Morrow and Co. Inc. 425 Park Ave. S., New York, N.Y. 10016. 1969. 256 pages. Illustrated. $9.95. (Library)

Bonsai is a technique of growing plants that continues to intrigue certain gardeners. This is a non-technical, easy to read book on the topic. The author develops the subject with well chosen illustrations to support the text. He includes a few pictures of natural plants, or plantings, that could serve as models for growing and training bonsai. The author seems quite practical in suggesting soils and materials that are available, and although he mentions some of the less available types of fertilizers used by the Japanese, he also recommends liquid, readily available kinds such as those used for house plants.

The development of tray landscapes is less common. Saikei includes live plants and Bonkei is a "dry" landscape without living plants. Such developments are naturally related to bonsai because of the size of the plants and their relation to the landscape on a miniature scale. They require skill and imagination to develop.

This is a book which a beginner will find helpful, and the more advanced bonsai enthusiast will use as a reference.

Conrad B. Link

The Lily Yearbook, Vol. 21

George L. Slate, Ed. North American Lily Society, Fred N. Abbey, exec. secy., North Ferrisburg, Vt. 05473. 1968. 197 pages. $7.50. (Library)

Another in a series of well prepared yearbooks on the lily, an important garden plant. It includes cultural articles which provide growers with guidance in such areas as the effects of herbicides, seed germination, growing lily seedlings, and control of root lesions. It also has articles on breeding and genetics; on the new Barber lilies, hybrids of *Lilium pumilum*; and hybridizing experiments with *Lilium* 'Black Beauty'; and a report on the western native lilies. As a yearbook of a specific plant society, it includes society information, and stories of people who have contributed to the information and development of the lily. This issue also contains the cumulative index to the Lily Yearbooks from Vol. 7 (1954) to Vol. 20 (1967).

Conrad B. Link

Ficus: the Exotic Species

Ira J. Condit. University of California, Division of Agricultural Sciences, Berkeley, Calif. 94720. 1969. 363 pages. Illustrated. $4.00. (Library)

This is a technical publication on an important plant which includes many species that have ornamental value and are useful in landscape plantings in tropical countries. It is based on the author's many years as a research scientist at the University of California at Riverside. For the nurseryman and landscape gardener the keys for identification, with description and observations of the author and other sources, will probably be of the greatest value. The author has included an extensive bibliography and description of the genus itself, including its growth, flowering, and fruiting habits. Wherever it is known the author has also included the name of the insect associated with the fruiting. This work will be a standard reference on the genus.

Conrad B. Link

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