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COUNTRY COUSINS

IN the horticultural world, a continuous effort is being made to select the "best" trees and shrubs for ornamental use. In the process, many other plants are relegated to secondary status and then are often ignored by the horticultural public. Later on, a few may show traits that were not obvious at first — and so bid for reconsideration. In other cases, one species has become entrenched in horticultural usage — and for this reason alone continues to overshadow later introductions. An occasional looking back through the lists of little-used plants can be expected to turn up a few that have been overshadowed by better-known relatives, but that have character of their own — and potential usefulness.

Chionanthus retusus **Chinese Fringetree**

Our native (southeastern U.S.) fringetree (*Chionanthus virginicus*) is fairly well known, even though not widely used as a landscape plant in our area. Its oriental relative, *Chionanthus retusus*, is even less used, probably because its flowers and inflorescences are smaller. But the overall effect of *C. retusus* in bloom is almost as spectacular as that of *C. virginicus* (Plate I). In addition, it can be grown with minimal pruning, while *C. virginicus* requires heavy pruning every few years to maintain good form. The largest specimen of *C. retusus* in the Arnold Arboretum is about 20 feet tall and resembles a miniature American elm in outline. This and its interesting furrowed bark keep this tree interesting during the winter months (Plates I and II). Both species of *Chionanthus* are hardy in Boston, and *C. virginicus* is hardy in Zone 4 as well. The hardiness of *C. retusus* in areas colder than Boston is not yet fully known.

Cotinus obovatus (Cotinus americanus) **American Smoke Tree**

In this case, the American native is the less familiar of two species. The more common smoke tree, *Cotinus coggygria* (still listed as *Rhus cotinus* in some books),

is a native of Asia and southern Europe. *Cotinus obovatus*, native to the southeastern U.S., is the taller growing of the two species (up to 30 feet) and is of interest primarily for its sometimes-bright reddish-orange fall foliage. In the Arnold Arboretum it is displayed effectively in combination with *C. coggygria* and members of the related sumacs (*Rhus* species).

Evodia hupehensis **Hupeh Evodia**

The Korean evodia (*Evodia daniellii*) has been used in recent years as a small garden tree, and is of special interest to beekeepers. The lesser known Hupeh evodia (*E. hupehensis*), native to central China, is a larger tree, up to 50 feet in height. Both species have clusters of creamy white flowers in early August, followed by equally showy clusters of fruits, which open in autumn to disclose small shiny black seeds. Fruits of *E. daniellii* are creamy-buff to pink, while those of *E. hupehensis* are dark reddish. Both species have smooth silvery-gray bark not unlike that of beech. Unfortunately both tend to be rather weak-wooded and short-lived. Their hardiness in areas colder than Boston is not yet known.

Exochorda giraldii wilsonii **Wilson Pearlbush**

The common pearlbush (*Exochorda racemosa*) was introduced into the United States from eastern China in 1849. This is still the only species of *Exochorda* that is at all common in the nursery trade, even though several other species and varieties have been introduced from Asia since. In *Manual of Cultivated Trees and Shrubs*, Alfred Rehder singled out *Exochorda giraldii wilsonii*, a Wilson introduction from northwestern China in 1907, as being more handsome than the more common *E. racemosa* (Plate III). It is more floriferous than the latter species and has larger flowers as well. Rehder rated *E. giraldii wilsonii* as hardy in Zone 5, making it appear that it is somewhat less hardy than *E. racemosa*. This may or may not be true. Hardiness zone ratings of some of the less common species are necessarily conservative, for lack of opportunity to observe them in colder places than Boston. If the Wilson pearlbush in time wins greater acceptance as a landscape shrub, the extent of its hardiness will become better known.

Larix kaempferi (Larix leptolepis) **Japanese Larch**

The Arnold Arboretum larch collection includes 8 species, but only the American larch (*Larix laricina*) and the European larch (*L. decidua*) have been very widely used in this country as ornamental trees. In *Trees for American Gardens*, Donald Wyman has pointed out that the Japanese larch (correct name *L. kaempferi* but also known as *L. leptolepis*) is the most ornamental of the larches. It is also the most vigorous, and is being favored increasingly as a forest tree for timber production. *Larix kaempferi* holds its needles later into the fall than *L. decidua* and *L. laricina*, and is not so winter hardy as these species — but still hardy enough (Zone 4) for all but the coldest parts of New England.

PLATE I

The Chinese fringetree (*Chionanthus retusus*) is interesting in winter (top) for its growth habit and furrowed bark, and in summer (bottom) for its masses of small white flowers.

PLATE II

The Chinese fringetree's furrowed bark keeps it interesting in all seasons of the year.

PLATE III

The Wilson pearlbush (*Exochorda giraldii wilsonii*) is the most floriferous of the pearlbushes (left) and has the largest flowers, up to 2 inches in diameter (right).

Pachysandra procumbens **Allegany Pachysandra**

Without question, Japanese spurge (*Pachysandra terminalis*) is the best species of *Pachysandra* for ground cover use — in fact one of the best of all ground cover plants. Still, our native (southeastern U.S.) member of this genus, *Pachysandra procumbens*, can be useful and interesting. This species is not evergreen, as is *P. terminalis*. It is less successful as a quick, aggressive ground cover because it does not spread as vigorously. But its modest vigor can be an asset in certain small-scale situations, and it gains added interest when it sends up its spikes of whitish flowers just before leafing out in late spring. Like its Japanese relative, *Pachysandra procumbens* should be used only in shaded locations, and it should be used where reasonable amounts of soil moisture are available.

Tsuga diversifolia **Japanese Hemlock**

Our native (eastern U.S.) hemlocks, the Canada hemlock (*Tsuga canadensis*) and the Carolina hemlock (*T. caroliniana*) are both widely used and are excellent ornamental trees. The Arboretum collection includes species native to the northwestern United States, China, and Japan. The smallest of these, except for dwarf forms, is the Japanese hemlock (*Tsuga diversifolia*) — a rather shrubby, dense, pyramidal tree with horizontal branching (Plate IV). Its needles are crowded on the twigs and radiate in many directions, showing the prominent white stomatal lines on the undersides. This tree may turn out to be winter hardy in areas colder than Boston. If it receives the increased use it deserves, the limits of its hardiness will eventually be better known than at present.

Harrison L. Flint

PLATE IV

These two trees of Japanese hemlock (*Tsuga diversifolia*) in the Arnold Arboretum (top) show the dense, shrubby form typical of this species. The needles are crowded on the twigs and radiate in many directions, showing the prominent white stomatal lines underneath (bottom).

1968 Spring Classes at the Arnold Arboretum

Field Class in Ornamental Plants **Dr. Donald Wyman**

The month of May is the peak of the flowering period for most of the trees and shrubs in the living collections of the Arnold Arboretum. Field classes will permit observation of most plants as they come into flower. Discussions will include an evaluation of many plants with suggestions on their availability, culture, and proper use. There will be ample opportunity for questions. In case of rain, the meetings will be held indoors.

Five classes: Fridays, 10 to 12 A.M., May 3 to 31, at Jamaica Plain.

Beginning Botany for Gardeners **Mr. George H. Pride**

A course directed to gardeners who desire more knowledge on the structure and activities of the cultivated plant. This is a review of elementary biology, and a chance to become familiar with new ideas on how plants grow and function. Plant specimens and kodachromes will be used in lectures and demonstrations. Some walking at each meeting among the diverse plantings and in the woods.

Five classes: Wednesdays, 2 to 4 P.M., May 1 to 29, at the barn of the Case Estates, 135 Wellesley Street, Weston.

Hybridization and Breeding of Ornamental Plants **Dr. Owen M. Rogers**

The principles and practices of plant breeding are explained, with lectures, demonstrations, and some class practice in making "crosses". Will include study of flower structure as related to plant breeding, demonstration of preparation of slides for chromosome counts, review of elementary principles of genetics, and sufficient practice to permit you to try making hybrids with your own garden flowers this spring. Dr. Rogers is a Mercer Research Fellow at the Arnold Arboretum, currently on leave from the University of New Hampshire.

Five classes: Tuesdays, 7:30 to 9:30 P.M., April 23 to May 21, at the Dana Greenhouses of the Arnold Arboretum. Enter through the gate on Centre Street.

Registration Fee for each series of classes is $5.00 for members of the Friends of the Arnold Arboretum, with priority of enrollment. Registration for nonmembers is $10.00, subject to space being available in specific classes. For further information call 524–1717. Information on membership in the Friends of the Arnold Arboretum can also be obtained at this number.

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THE NEW DWARF CONIFER COLLECTION

APPROXIMATELY 150 different varieties of dwarf evergreens were planted during 1966 and 1967 in the new dwarf conifer collection opposite the Charles Stratton Dana Greenhouses in the Arnold Arboretum. For several years we have been collecting these from all over this country and Europe and propagating them in preparation for this new planting, which augments the old collection of over 50 different kinds that have been growing beside the *Chamaecyparis* collection for nearly 80 years.

Dwarf conifers originate as witches'-brooms, as chance seedlings in cultivation and in the wild, and as sports or variations in the branches of established specimens. European nurserymen have been much more interested in these variations in the past, the reason why so many have been named and originally introduced there, especially in Holland and Germany. Many grow so slowly that the price which must be asked for plants has made American nurserymen shy away from growing them. However, with smaller gardens and smaller houses, there is now an increasing interest in these dwarf shrubs and a few American nurserymen are beginning to grow them.

The 118 kinds of dwarf conifers mentioned here are not the only ones, nor are they necessarily "the best," but all are growing in this new collection. Welch notes in his recent book *Dwarf Conifers* that nearly 1000 different kinds are living in various collections throughout the world at present. New varieties will be added to our collection from time to time so that this will be an ever-changing one. In connection with this, the Arboretum visitor might also inspect the juniper bank at the side of the evergreen nursery by the greenhouses, where more than 30 low-growing junipers are established, all of which might be considered to have some value as ground covers.

Visitors will notice that a few other evergreens, not in the following list, are growing in the dwarf beds. Some of these are not true dwarfs and some have come to the Arboretum with doubtful names, which later may be changed.

A serious effort has been made to display these dwarf plants under their correct names. No group of ornamental woody plants is more mixed than these — in the identification process here, one of our staff members found that the same plant (obtained from different sources) was listed under six different names. One of the reasons is that many of these varieties are not stable, but their foliage and habit are reverting or changing constantly as new growth is produced. As these twigs are cut for asexual propagation they too may result in unstable plants, or they may produce stable, uniform growth for many years. Plantsmen unfamiliar with the variability of such plants often place all kinds of new names on them, thus making the over-all picture most confusing. Then too, if these reversions are not cut out promptly, the original plant may take on a completely new habit. *Tsuga caroliniana* 'Compacta' originated in the Arnold Arboretum in 1882 and later was described as one of the nicest dwarfs in the collection. But sixty years later, a careful inspection of the original "dwarf" showed little difference between its growth and that of the species.

For those interested in obtaining more information about dwarf conifers, the following references are suggested:

Den Ouden, P. and B. K. Boom. *Manual of Cultivated Conifers.* Martinus Nijhoff, The Hague, 1965.

Hillier, H. G. *Dwarf Conifers.* The Alpine Garden Society and The Scottish Rock Garden Club, London and Penicuik, Midlothian, Scotland, 1964.

Hornibrook, Murray. *Dwarf and Slow-Growing Conifers.* 2nd ed., Country Life Ltd., London (Charles Scribners's Sons, New York). 1939.

Welch, W. J. *Dwarf Conifers.* Charles T. Branford Co., Newton, Mass., 1966.

The dwarf conifers in the following list will be found in this new collection by the Charles Stratton Dana Greenhouses. Merely to show how long some of these dwarfs have been known, dates have been placed on the same line as the name, referring to the date introduced, the date originated, or the date when first reference apparently was made to the plant concerned. It is interesting that the majority are of European origin and that some have been known for a century.

Abies balsamea 'Nana' **1866**

This is a rounded shrub with dense branches.

A. koreana – prostrate form

Propagated from lateral branches of *Abies koreana* in the Arnold Arboretum. One plant, 28 years old, still has procumbent branches.

A. lasiocarpa 'Compacta' **about 1927**

Raised in Boskoop, Holland, this is a dwarf, broadly conical, densely branched shrub, at one time termed *A. arizonica compacta.*

PLATE V

Dwarf conifers, planted in 1966 and 1967 in the new dwarf conifer collection below the bonsai house, by the Charles Stratton Dana Greenhouses of the Arnold Arboretum.

A. procera 'Glauca Prostrata' **1928**

First appearing in Hillier's Nursery catalog (England) under the name of *A. nobilis glauca prostrata*. The plant has more or less greenish-blue foliage.

A. grandis 'Compacta' **before 1891**

This low form of the grand fir is very rare now.

Cedrus libani 'Sargentii' **before 1919**

Often incorrectly labeled *C. libani pendula sargentii*, our plant was obtained from Mr. T. A. Havemeyer, Long Island, New York. It is now about 4 feet tall with a 12-foot spread, a slow-growing, horizontally branched, flat specimen.

Chamaecyparis lawsoniana 'Ellwoodii' **before 1929**

A dense, upright, almost columnar evergreen originating as a chance seedling in England. It has since become extremely popular because of its narrow habit and glaucous foliage, growing about 9 feet high but only a foot in diameter. It may be subjected to some winter burning in Zone 5 unless given protection.

C. lawsoniana 'Filiformis Compacta' **before 1891**

The foliage of this dwarf, globular shrub is similar to that of the more common *Chamaecyparis pisifera* 'Filifera' although it is not as hardy and the leaves are smaller and more blue-green in color.

C. lawsoniana 'Forsteckensis' **before 1891**

This excellent plant seldom grows over 2 feet tall. It is rounded in habit with upright branches, originating at Forsteck in Germany.

C. lawsoniana 'Pygmaea Argentea' **before 1891**

Originally raised in the Backhouse & Son Nursery in England, this is a dwarf, slow growing, globose plant with erect branchlets. Much of the foliage is dark green but the tips of the branchlets are pale creamy white. Unfortunately these burn and turn brownish in direct summer sun.

C. nootkatensis 'Compacta Glauca' **about 1909**

A glaucous form of 'Compacta', rounded in habit and very compact.

C. obtusa 'Compacta' **before 1875**

This rare, dwarf, conical shrub has short branches and dense green foliage.

C. obtusa 'Contorta' **introduced 1945**

Raised from seed of *C. obtusa* 'Nana Gracilis' by the Den Ouden Nursery of Boskoop, Holland. This is slow growing, conical in shape, seldom over 6 feet tall with dense, twisted foliage. Not very attractive.

C. obtusa 'Coralliformis' **before 1903**

Sometimes incorrectly labeled *C. obtusa torulosa*, this is a dwarf shrub to 6 feet, with very dense, glossy green foliage. The twigs are somewhat twisted and

PLATE VI

Dwarf conifers in the new collection, showing planting beds mulched with crushed graystone, path covered with pine needles, and steps made with railroad ties.

reddish. An unusual plant often with monstrous branches, formerly listed as *C. obtusa lycopodioides coralliformis.*

C. obtusa 'Filicoides' **before 1860**

A vigorous plant, sometimes a small tree but it can be pruned as a shrub. The flat fernlike sprays of foliage are typical. It was sent to Holland from Japan by Dr. von Siebold. The foliage is somewhat similar to that of the more common *Thuja occidentalis* 'Spiralis'.

C. obtusa 'Kosteri' **about 1915**

A very attractive, dwarf, pyramidal shrub about 3½ feet tall, with ascending branches but curved tips, and light green foliage. Each spray of the plant is slightly twisted. It is best grown with a central leader. This plant originated in the nurseries of M. Koster & Son, Boskoop, Holland.

C. obtusa 'Lycopodioides' **1861**

Introduced from Japan by Dr. von Siebold, this is a globose shrub about 6 feet tall with ascending, often cockscomb-like branchlets. The large, irregular growth makes this a curious plant, not necessarily a good ornamental.

C. obtusa 'Lycopodioides Aurea' **about 1890**

Introduced from Japan into Germany, this is similar to 'Lycopodioides' except that it is slower in growth and the young foliage is pale yellow.

C. obtusa 'Mariesii' **before 1891**

Formerly listed as *C. obtusa nana albovariegata*, this very attractive dwarf grows into a conical bush about 3 feet high. It has fine yellowish to white variegated foliage which turns to yellowish green in winter.

C. obtusa 'Nana' **about 1860**

The variety 'Nana Gracilis' is a more vigorous plant with lustrous dark green foliage, while 'Nana' has dull green foliage. It grows about 3 feet high and is globular and dense. This is another old Japanese form introduced into Leiden, Holland, from Japan by Dr. von Siebold.

C. obtusa 'Nana Aurea' **about 1867**

A more vigorous dwarf than 'Nana', growing about 6 feet tall, with golden yellow variegated foliage. It was first introduced from Japan by the Veitch Nursery of England. The golden yellow color is produced only in the sun — in the shade it is merely yellowish green.

C. obtusa 'Nana Gracilis' **before 1891**

An excellent ornamental conical shrub, maturing at about 8 feet high, formerly listed as *C. obtusa nana compacta.* It has a broad pyramidal habit and is one of the most common of all *C. obtusa* varieties.

C. obtusa 'Pygmaea' **1861**

Introduced into England from Japan by Robert Fortune, this is a broad dwarf, about 2 feet tall but considerably wider. The sprays are slightly fan shaped, one above the other. It is glossy green during the summer and only slightly bronze during the winter.

C. obtusa 'Pygmaea Aurescens' **about 1939**

Similar to 'Pygmaea' (from which it originated as a sport in a Dutch nursery) except that during the winter the foliage is a decided copper-bronze color.

C. obtusa 'Sanderi' **1894**

This first appeared in Germany listed as *Juniperus sanderi*. It is a dwarf, juvenile form, none too hardy, and may grow to 6 feet tall, although usually it is much lower. The summer color of the foliage is sea-green, but in winter it becomes purplish in color.

C. obtusum 'Stoneham' **before 1964**

A slow growing dwarf with branches in tiers like a miniature *C. obtusa* 'Nana', first offered by Hillier & Son, England.

C. obtusa 'Tempelhof' **before 1964**

A compact, broadly rounded dwarf to about 7 feet tall with fan shaped foliage, either green or brownish-tinted in the winter. Originated in Boskoop, Holland.

C. obtusa 'Tetragona Aurea' **about 1870**

If well grown, this beautiful dwarf conifer is one of the best. It was introduced into England from Japan and apparently varies according to which branchlets are propagated, for some plants may be 15 feet tall, others just as old may be only a few inches high. The foliage is a fine glossy yellow in the full sun, but in even a little shade, it is merely a yellowish green. In deep shade it is a rich glossy green. There is a question as to whether 'Tetragona' is merely this plant grown in the shade where the foliage does not turn yellow.

C. pisifera 'Aurea Nana' **1909**

A globe shaped to conical, slow-growing dwarf shrub with a rich golden yellow foliage. Actually it might be considered a dense form of the common *Chamaecyparis pisifera* 'Aurea'.

C. pisifera 'Boulevard' **about 1934**

Incorrectly termed *C. pisifera squarrosa cyano-viridis*, this plant was first introduced by the Boulevard Nurseries of Rhode Island. It may not be a true dwarf, but while young it functions as such and is especially colorful in winter.

C. pisifera 'Compacta Variegata' **1939**

This is a sport from *Chamaecyparis pisifera* 'Compacta' with light yellowish foliage, sometimes whitish in flecks or splashes. It is a bush about 4 feet tall and 6 feet across.

C. pisifera 'Filifera Nana' **before 1904**

A deep green, dwarf, bushy evergreen, with threadlike branchlets similar to those of 'Filifera', introduced by the Hesse Nurseries of Germany. At 25 years of age, one plant was 26 inches tall and 36 inches across.

C. pisifera 'Golden Mop' **1966**

This is a name given to a lower, more dense form of *C. pisifera* 'Filifera Aurea' (a tree type), with mop-like yellow foliage. Sometimes termed *C. pisifera filifera aurea nana.*

C. pisifera 'Nana' **before 1891**

A small, tightly branched, dense dwarf. A 40-year-old plant is only about 2 feet tall and 4 feet across. The top is flat, the branchlets fan-shaped, and the foliage a dark bluish green. Sometimes the looser branchlets have been propagated, resulting in larger plants called 'Compacta'. 'Nana' is one of the smallest of the dwarf conifers.

C. pisifera 'Nana Aureovariegata' **known since 1874**

This is a form of 'Nana', the foliage having a golden sheen, especially in full sun. Unfortunately branches sometimes revert to green and must be removed.

C. pisifera 'Nana Variegata' **known since 1867**

Similar to 'Nana' but the foliage has a yellowish white variegation. Unfortunately this also occasionally reverts, with branches of green foliage which should be removed.

C. pisifera 'Plumosa Compressa' **before 1928**

A variable dwarf conifer, probably being grown under several names, slow growing, reaching about 2 feet in height with densely set branches bearing mosslike foliage. The leaves vary in color from light yellow to bluish green. Yellow is seen most on older foliage. It is probably a sport of 'Squarrosa' and originated in the Koster Bros. Nursery of Boskoop, Holland. One of the several names under which we received this plant was *C. pisifera plumosa flavescens aurea compacta nana!*

C. pisifera 'Squarrosa Intermedia' **1923**

A variable dwarf form with bluish foliage, about 6 feet tall if the longer loose branches that occasionally form are cut off. If not it develops into a tree of indefinite form.

C. pisifera 'Squarrosa Minima' **1923**

This is similar to 'Squarrosa Intermedia' but is slower growing, more dense, and more dwarf. It may grow to about 30 inches tall, but often reverts with foliage similar to 'Squarrosa Intermedia', so it must be pruned occasionally to keep it in correct form.

PLATE VII

Juniperus communis saxatilis (top), native to various parts of northern Europe, Asia, and North America. *Chamaecyparis pisifera* 'Squarrosa Intermedia' (bottom), a form that continually reverts to several different types of growth.

C. thyoides 'Andelyensis' **about 1850**

Originally raised in France, this plant is conical and about 9 feet tall, with bluish green foliage and slightly fan-shaped sprays. It is an attractive, closely branched, pyramidal plant, rather slow growing.

C. thyoides 'Ericoides' **1840**

Originated in France, this is a dwarf with juvenile foliage and conical habit. In summer it is grayish green but in the fall it turns violet-brown. The foliage can be burned by exposure to winter winds.

Cryptomeria japonica 'Vilmoriniana' **about 1890**

There are many dwarf varieties of this species but this one from Japan is the only one in this collection at present. Very slow in growth (to about 30 inches tall), it is globular in shape and very neat in appearance. A popular dwarf where hardy.

Juniperus chinensis 'Dropmore' **1938**

A dwarf seedling form sent by F. L. Skinner, Manitoba, Canada.

J. chinensis 'Kaizuka' **1928**

First introduced by the Yokohama Nursery in Japan, this has also been listed as *J. chinensis torulosa* or *J. sheppardii torulosa*. It is not a true dwarf, but when young makes a narrow, erect, small tree with central trunk. The foliage is bright green, borne in mop-like clusters. The plant has proved a popular ornamental in California.

J. chinensis 'Mathot' **1940**

With the flat, wide habit of a Pfitzer juniper, from which it originated in Boskoop, Holland, but more dense.

J. chinensis 'Old Gold' **introduced about 1958**

This is also like a Pfitzer juniper but its leaves are bronze-gold and it is very compact. It was a sport of 'Pfitzeriana Aurea' in the Grootendorst Nursery, Boskoop, Holland.

J. chinensis 'Plumosa Aurea' **before 1885**

This popular, irregularly branched shrub has been offered under many names, often called the gold dust juniper because the leaves are variegated with yellow. It can grow to 15 feet or more, but is often lower in height.

J. chinensis 'Plumosa Aureovariegata' **1873**

Seldom more than 2 feet tall, this is a true dwarf, with short branchlets and golden yellow foliage. It has been known under various names.

J. chinensis 'Shoosmith' **about 1930**

This dwarf shrub, originated in a Pennsylvania nursery, is globular to pyrami-

dal in habit and very compact. Den Ouden notes that it looks like a boxwood in growth habit.

J. communis 'Compressa' **1855**

A tight 3-foot spire of dense, light green foliage, this is a very popular rock garden plant. It stands out remarkably wherever it is grown, but is subject to burning by high winds.

J. communis 'Effusa' **introduced about 1944**

Very similar to 'Repanda' and hard to distinguish from it. Originated in Holland. Seldom over a foot tall.

J. communis 'Gold Beach' **before 1960**

This excellent dwarf form with green foliage probably originated on the West Coast, and is flat, dense, and spreading. Our oldest plant is about 5 inches tall and 2 feet across.

J. communis 'Minima'

It has been noted by P. Den Ouden that this variety has probably been cultivated by Dutch nurserymen for a century. It is very dwarf, not much over a foot tall, with spreading branches. It is sometimes termed *J. communis prostrata*, and is probably a clone of *J. communis saxatilis*.

J. communis 'Prostrata' **about 1894**

Found in Germany, this is a dwarf, prostrate shrub making a good ground cover, growing to be a foot tall and 6 feet across. The foliage turns brownish in the fall.

J. communis 'Repanda' **1934**

A prostrate shrub that can be used as a ground cover because it stays so flat on the ground while it is young. Eventually not over 4 feet tall, with soft dark green foliage, it is similar to 'Effusa'.

J. communis saxatilis

This variety is found in parts of northern Europe, Asia, and North America, and has been variously listed under such names as *sibirica*, *montana*, *nana*, *alpina*. It is a dense, slow growing, procumbent, gray-green ground cover, not much over $1\frac{1}{2}$ feet tall.

J. conferta **1915**

Native to Japan and known as the shore juniper, introduced to America by the Arnold Arboretum. A good ground cover, not over 1 foot tall, especially valued for planting in sandy soils at the seashore when other junipers cannot be grown successfully.

J. horizontalis 'Alpina' **known since 1838**

A dwarf, vigorous, creeping juniper, not over 2 feet tall at maturity, with

bluish to grayish green foliage that changes to purplish in the fall.

J. horizontalis 'Glenmore' **1932**

About the lowest and slowest growing variety of this species, with creeping branches held just above the ground and branchlets upright. Dark green in color, this was found in Wyoming.

J. horizontalis 'Marcellus' **before 1960**

A prostrate juniper, with flat plumy sprays of a blue-green color, making an excellent plant.

J. horizontalis 'Wiltonii' **1914**

Sometimes listed as 'Blue Rug', this is an excellent creeping variety with intense, silvery blue foliage, found by J. C. Van Heiningen of the South Wilton Nurseries in Connecticut. It grows slowly, is most colorful, and makes a splendid specimen.

J. procumbens **1843**

This creeping juniper, native to the mountains of Japan, was first sent to Leiden, Holland, by Dr. von Siebold. Low, spreading, steel blue, it may eventually grow as high as 2 or 3 feet but by then may be 20 feet in diameter. Often used as a ground cover, but not one of the best junipers for this purpose.

J. procumbens 'Nana' **about 1922**

Introduced from Japan by the D. Hill Nursery Co. of Dundee, Illinois, it is smaller than the species, slower growing, and a better ornamental.

J. sabina tamariscifolia **known since 1789**

A popular ground cover or low specimen plant from southern Europe, eventually becoming 2 to 3 feet tall and 6 feet across. The main branches are horizontal but the small branchlets are erect.

J. squamata **about 1836 or before**

A variable species producing several clones, this is native to Central Asia and is not a very useful ornamental. It makes a low, prostrate shrub, with ascending branches, the tips of all the branchlets being slightly pendulous.

J. squamata 'Loderi' **about 1925**

Raised in England by Sir Edmund Loder, this is dwarf (about 4 feet tall), narrow, and dense, somewhat similar to *Juniperus communis* 'Compressa' but slightly larger.

J. squamata 'Prostrata' **1904**

A prostrate form of the species raised by Murray Hornibrook in Ireland from seed collected by E. H. Wilson in China.

PLATE VIII

Part of the new dwarf conifer collection at the Arnold Arboretum, showing forms of *Abies*, *Juniperus*, *Picea*, *Pinus* and *Thuja* (top), and including *Picea abies* 'Repens' (top-center and bottom).

Picea abies 'Barryi' **1891**

This is conical in habit, eventually 6 to 7 feet tall, with erect branches. It grows vigorously.

P. abies 'Compacta' **known in Europe since 1864**

This also is conical in habit, but broad and compact, with shining green foliage.

P. abies 'Conica' **known in Europe since 1855**

Conical in habit, broad at the base, and needles a shining green; rare.

P. abies 'Crippsii' **known in Europe since 1896**

A slow growing, conical dwarf evergreen, with branches crowded on the main trunk. Rare in cultivation.

P. abies 'Gregoryana' **known in Europe since 1862**

A widely planted dwarf evergreen with a round broad habit. It may not grow over 3 feet tall, but old plants are several times that in diameter. It is noted as one of the slowest growing of all forms of *Picea abies.*

P. abies 'Highlandia' **about 1923**

Originated in Highland Park, Rochester, N.Y., with a low, dome-like habit, spreading somewhat with age. The foliage is a dark bluish-green.

P. abies 'Mucronata' **about 1835**

Found in France, it is broadly conical and very dense in habit. The main branches curve upward, making it easily recognizable. It grows vigorously and may even reach 30 feet in height.

P. abies 'Ohlendorffii' **about 1845**

Pyramidal, but dense and wide at the base and with very small needles, more like those of *Picea orientalis* than *P. abies.* It may be 6 feet tall by 4 feet across after 30 years. Originated in Spaeth's Nursery, Germany.

P. abies 'Pumila' **known in Europe since 1874**

A low-spreading bush with lower branches procumbent and the upper ones erect. The needles are uniform, not irregular from twig to twig as in 'Clanbrassiliana'. The whole plant looks rather flat, even though it may reach a height of 4 feet at maturity.

P. abies 'Pygmaea' **known in Europe since 1838 or before**

This (with 'Clanbrassiliana') is one of the oldest forms of *Picea abies* we have today. It is a popular variety, conical but slightly rounded at the top, and very compact and slow growing.

P. abies 'Pyramidalis Gracilis' **listed in 1891**

Sometimes incorrectly referred to as *P. abies gracilis*, this uncommon variety is dwarf, rounded, and compact.

P. abies 'Remontii' **known in Europe since 1874**

This is another dense, conical shrub, reaching about 6 to 9 feet in height. It is commonly grown, and one of the larger dwarf varieties of *P. abies*.

P. abies 'Repens' **known in Europe since 1898**

Rather flat in habit and slightly mounded at the top, this seldom grows over $1\frac{1}{2}$ feet high but is several times this in width. It is a popular dwarf conifer.

P. abies 'Sherwood Gem' **about 1948**

This plant, originating in Oregon at the Sherwood Nurseries, Gresham, forms a dense, flattened globe and matures at 2 feet in height with a 4-foot diameter.

P. glauca 'Conica' **1904**

At one time termed *P. glauca albertiana conica*, this was found in southwest Alberta, Canada, by Prof. Rehder and J. G. Jack of the Arnold Arboretum. Dense, definitely pyramidal, with light green foliage, old specimens may be 9 feet high. A very popular plant and widely used.

P. omorika 'Nana' **about 1930**

About 4 feet high but broader at the base, this globose to conical shrub has horizontal branches and glaucous foliage. It originated in Boskoop, Holland.

P. orientalis 'Nana'

This rare dwarf is globular in habit, slow growing, and seldom over 3 feet tall. It could easily be taken for a variety of *Picea abies*.

P. pungens 'Glauca Procumbens' **about 1910**

Originating in Boskoop, Holland, this procumbent shrub is only about 20 inches tall but 4 feet in diameter, with glaucous foliage.

P. pungens 'Globosa' **1937**

A rounded shrub, 3 feet tall, with glaucous foliage. This was selected from a seedling lot in Boskoop, Holland.

P. pungens 'Hunnewelliana' **before 1932**

A slow growing, densely pyramidal tree with light blue foliage which might be considered a dwarf only while young. At 32 years of age it can be 15 feet tall. It originated in Massachusetts.

P. pungens 'Pendens' **about 1910**

This is Alfred Rehder's name for a procumbent sport of the upright, pyramidal *P. pungens* 'Kosteri'. Popularly called the Koster weeping blue spruce, it has also been called 'Glauca Procumbens' or 'Kosteriana' or 'Glauca Prostrate' because of the bluish white foliage. The main branches are procumbent to pendulous and the plant makes a picturesque, almost horizontally branched specimen.

Pinus aristata

A tall species native to the southwestern United States, but in the East it grows slowly and can be considered a striking dwarf tree for many years. The glaucous foliage, interesting horizontal branching habit, and slow growth make this tree a desired asset in the eastern garden.

P. densiflora 'Pendula' **known since 1890**

An untidy plant that may be either pendulous or prostrate. It is not a desirable ornamental.

P. mugo mugo

One of several dwarf forms of this species, this widely used plant is a broad shrub, often cone-shaped and symmetrical, sometimes prostrate.

P. mugo pumilio

Subglobose to ovoid, usually a prostrate shrub without a definite leader.

P. nigra 'Hornibrookiana' **before 1932**

Originating as a witches'-broom on an Austrian pine in Rochester, N.Y., this is a low, compact bush with lustrous, dark green needles.

P. pumila **introduced 1817**

Native to northeastern Siberia, this is seldom over 9 feet tall and is closely related to *Pinus cembra*. Both have five needles in each bundle. Sometimes termed *P. cembra pumila*, it is usually a prostrate shrub about 7 feet in diameter.

P. strobus 'Pendula' **known since 1866**

Not a true dwarf, but because of its pendulous and irregularly grown branches, this tree certainly makes a picturesque specimen until it grows too tall.

P. strobus 'Pumila' **known since 1875**

A dwarf, globular bush, this shrub has twigs that elongate only about 1/5 of an inch annually.

Pseudotsuga menziesii 'Compacta' **known since 1891**

This is a conical compact bush.

Taxus baccata 'Nutans' **about 1910**

A miniature form of the English yew, which at thirty years of age is 3 feet tall and $2\frac{1}{2}$ feet in diameter. Small, open, flat-topped, without a central leader, and with very small needles about $\frac{1}{4}$ inch long. First introduced by P. Den Ouden & Sons, Boskoop, Holland.

T. baccata 'Pygmaea' **1910**

A dwarf conical shrub, about a foot high and as broad, with small needles only $\frac{1}{2}$ inch long that are very dark green. First raised in Boskoop, Holland.

T. cuspidata 'Aurescens' **1919**

A low, almost vase-shaped form of the Japanese yew with the foliage of the current year's growth colored deep yellow that, after the first year, gradually turns green. Introduced by the Arnold Arboretum from Japan. Plants 20 years old are only 1 foot tall but 3 feet in diameter.

Thuja occidentalis 'Compacta' **known since 1855**

A dwarf evergreen sometimes incorrectly termed *dumosa* or *pygmaea*, this is about 32 inches tall, with bluish green foliage and somewhat conical habit.

T. occidentalis 'Ellwangeriana Aurea' **before 1895**

This originated at the Spaeth Nurseries in Germany, as a sport of 'Ellwangeriana'. It is a slow growing dwarf with golden yellow foliage, somewhat resembling 'Rheingold', ovoid when young but as it matures it grows pyramidal and may reach 9 to 10 feet in height.

T. occidentalis 'Ericoides' **known since 1867**

This dwarf is a compact rounded shrub about 3 to 4 feet tall, with juvenile foliage that is quite different from the mature arborvitae foliage. It is yellowish green in summer but turns purplish in the fall and brown in the winter.

T. occidentalis 'Filiformis' **known since 1901**

Commonly called the threadleaf arborvitae because of its long threadlike branchlets, somewhat similar to those of *Chamaecyparis pisifera* 'Filifera'. It is globular in habit and about 4 feet tall. Unfortunately the leaves turn brownish in winter.

T. occidentalis 'Hetz Junior' **about 1930**

An 18-year-old plant of this variety is 3 feet tall, 6 feet across, pyramidal and dense, and with juvenile foliage. This selection was made by the Fairview Nursery Company of Fairview, Pennsylvania.

T. occidentalis 'Hetz Midget' **about 1930**

Selected by the Fairview Nursery Company, Fairview, Pa., this makes extremely slow growth. It is globe-shaped and 10-year-old plants are scarcely 12 to 15 inches tall.

T. occidentalis 'Holmstrup' **before 1950**

Merely a compact, pyramidal, slow growing form, originating in Denmark and recommended for hedges.

T. occidentalis 'Malonyana' **before 1913**

Originating in Hungary, this is a dense, compact, columnar form, but only can be considered in this dwarf group while young.

T. occidentalis 'Minima' **known in Europe since 1865**

This is a slow growing, stunted form, about 3 to 4 feet tall, rather open and pyramidal in habit.

T. occidentalis 'Ohlendorffii' **before 1887**

A popular variety and common in cultivation (sometimes referred to as *spaethii*), this is a very curious dwarf, bearing small, upright, whip-cord branches of juvenile foliage with adult, scale-like leaves. Introduced by a German nurseryman, it is slow growing, clump-like, and 4 feet tall, and varies considerably depending on the type of growth from which it is propagated.

T. occidentalis 'Recurva Nana' **before 1867**

Originating in Europe, this pyramidal, compact dwarf may grow to 6 feet tall. The ends of the branchlets are slightly recurved, making it most attractive.

T. occidentalis 'Rheingold' **before 1902**

A popular, old-fashioned variety, originating in a German nursery, this has golden yellow foliage. Thirty-year-old plants are only 6 feet tall and about $4\frac{1}{2}$ feet in diameter. Similar to 'Ellwangeriana Aurea' except that 'Rheingold' retains a goodly amount of juvenile foliage. Both are colorful garden specimens.

T. orientalis 'Juniperoides' **known in Great Britain since 1850**

A form with juvenile foliage which does not vary, it is dwarf, slightly columnar but rounded on top, with grayish foliage.

T. orientalis 'Meldensis' **1850**

Originating in France, this is a rounded bush about 3 feet tall and 20 inches in diameter at 20 years of age. The green, mostly juvenile foliage turns purplish in the fall and winter.

T. orientalis 'Minima Glauca' **known in Europe since 1891**

A beautiful, dense, globe to oval-shaped evergreen with semi-juvenile foliage turning yellowish to brown in the winter, this is $3\frac{1}{2}$ feet tall and $2\frac{1}{2}$ feet in diameter after 30 years of growth.

Tsuga canadensis 'Cinnamomea' **1929**

Two plants of this dwarf were found in Vermont. It grows slowly and is globe-shaped and broader than high. Each branch tip is slightly pendulous.

T. canadensis 'Cole' **before 1928?**

A beautiful little prostrate dwarf, regarded by Mr. Gotelli (South Orange, N.J.) a few years ago as the best and smallest of all his *Tsuga canadensis* variants. His best plant measured 6 inches high and 40 inches wide. It originated near Boston, Mass.

T. canadensis 'Dwarf Whitetip' **about 1890**

This dwarf, conical shrub probably originated in New England. The young branchlets have tip foliage that is white in the spring but fades by late summer.

T. canadensis 'Nana' **known since 1855**

This is a slow growing shrub usually about 3 feet tall, although Mr. Hillier in England has a 30-year-old plant 9 feet tall and 11 feet in diameter. It is slightly more dense than the species.

T. caroliniana 'Compacta' **1882**

This plant, found in a batch of seedlings in the Arnold Arboretum made a beautiful low dense dwarf for many years, but 60 years later it looked very much like the species. Hence it should be considered dwarf only while young.

Donald Wyman

WGBH - TV (Channel 2) AUCTION

Like most educational television stations in this country, WGBH–TV (Cambridge, Mass.) has found it difficult to meet operating expenses each year. As a partial solution to this problem, the station held an auction in 1966, in which merchandise donated by local concerns was auctioned "on the air", proceeds going to the station. It was repeated in 1967, and in both years proved to be highly successful and entertaining.

This year the Arnold Arboretum will participate by donating a number of interesting ornamental plants. Colored pictures of these plants (listed below) will be shown during the auction and in advance publicity. Please watch the auction, to be held during the first week of June, if you can and tell your friends about our contribution to its success.

Cedrus libani stenocarpa	**Cedar of Lebanon**
Chamaecyparis nootkatensis 'Compacta Glauca'	**Nootka False-Cypress**
Davidia involucrata vilmoriniana	**Dove Tree**
Franklinia alatamaha	**Benjamin Franklin Tree**
Halesia monticola 'Rosea'	**Pink Silverbell**
Juniperus communis 'Suecica'	**Spire Juniper**
Kalmia latifolia 'Rubra'	**Deep Pink Mountain Laurel**
Metasequoia glyptostroboides	**Dawn Redwood**
Picea abies 'Conica'	
Sciadopitys verticillata	**Japanese Umbrella Pine**
Stewartia koreana	**Korean Stewartia**
Taxus media 'Flushing'	**Columnar Yew**

ARNOLDIA

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ALBIZIA JULIBRISSIN AND ITS CULTIVAR 'ERNEST WILSON'

Albizia julibrissin, commonly called silk tree or mimosa, is a small tree that produces an abundance of pink, powder puff-like flowers from June or July until September. It grows naturally from Japan to the Caspian Sea. It is commonly cultivated, and frequently has escaped from cultivation, in warm temperate areas of the world. In the southeastern United States it is frequently seen from Washington, D.C. southward. The fact that certain clones are hardy at the Arnold Arboretum is less well known. Because information about *Albizia julibrissin* is scattered in the horticultural literature, it has seemed useful to summarize it here.

The silk tree is reported to have been introduced into cultivation in Italy, brought from Constantinople by the Cavaliere Filippo Albizzi in 1749. From this material Antonio Durazzini described *Albizia julibrissin* in the Magazzino Toscani in 1772. Somewhat earlier, in 1745, it had been introduced into England by one Richard Bateman, Esq. The earliest records of the cultivation of the silk tree in America that I have been able to find are in a plant list dated 1814, entitled *Catalogue of Trees, Shrubs and Herbaceous Plants . . . Cultivated and for Sale at Bartram's Botanical Garden . . .*[1] and in a book entitled *The Practical American Gardener* published anonymously in Baltimore in 1819.

In the first volume of Torrey and Gray's *Flora of North America*, issued between 1838 and 1843, *Albizia julibrissin* is listed (as *Acacia julibrissin*) with the comment "In gardens and yards, Louisiana, Prof. Carpenter ! cultivated and somewhat naturalized." Today, it is commonly seen cultivated as a yard or lawn tree throughout the Southeast. Not uncommonly it is found persisting around old house sites, in hedgerows, along roadsides, and around dumps.

About 1864, seeds were received at the Museum National d'Histoire Naturelle

[1] "Bartram's Botanical Garden" is the Bartram homestead where John and William Bartram cultivated plants found on their journeys and sent to them by foreign and domestic correspondents. It is now part of the City of Philadelphia Park System.

in Paris from an unspecified North American source. Seedlings were grown and in 1871, E. A. Carriere described and illustrated one of the seedlings as *Albizia rosea* (*Revue Horticole*, vol. 42, p. 490). This publication was the basis for the name *Albizia julibrissin* var. *rosea* (Carriere) Mouillefort (*Traite des Arbres et Arbrisseaux*, Vol. 1, p. 686, 1894), and *Albizia julibrissin* forma *rosea* (Carriere) Rehder (*Bibliography of Cultivated Trees and Shrubs*, p. 351, 1949).

In 1875 Louis Van Houtte, the editor of *Flore des Serres* . . . published an illustration (nearly identical with Carriere's except that it is a mirror image) and said that the plant should be called *Acacia Nemu.* Under this name, or as *Albizia Nemu*, the tree was spread in cultivation around France. It was generally considered to be a hardy form of the *Albizia julibrissin* that had been growing in French gardens as far north as Lyon at least as early as 1849.

Because *Albizia julibrissin* is a valuable small tree for summer flowering, there have been a number of attempts to introduce the plant into the Arnold Arboretum. In 1889 a plant called *Acacia Nemu* was obtained from the S. B. Parsons Nursery in Flushing, N.Y. Since Parsons is known to have introduced plants from abroad, this may well have been a plant of the true *Albizia rosea.* In any event, it did not survive at the Arnold Arboretum. In 1921 seed was obtained from an unspecified area in China, but the seedlings did not survive.

In 1918 E. H. Wilson collected seeds in Seoul, Korea from a tree of *Albizia julibrissin* cultivated in a hotel courtyard. Wilson did not see the species in the wild in central Korea (around Seoul), so this particular tree must be considered to be a cultivated selection from the wild forms, whose northern limit of natural occurrence seems to be in the southern parts of the Korean peninsula, or around Port Arthur in Manchuria. In writing of this tree in 1929 (*Arnold Arboretum, Bulletin of Popular Information*, 3rd Series, Vol. 3, p. 58), Wilson said:

"The origin of the plant in the Arboretum affords a good illustration of the importance of obtaining for northern gardens types which grow in the coolest regions they can withstand. The particular tree was raised from seeds collected in the garden of the Chosen Hotel at Seoul, Korea, by E. H. Wilson in 1918. It grows wild in the southern parts of the Korean peninsula but appears quite at home in the more severe climate of the central region. A few seeds only were collected and seedling plants were set out in the Arboretum when about four years old; several were killed the first winter but one came through with but slight injury and since that time has not suffered in the least. From its behavior during the last seven or eight years there seems reason to believe that this Korean type will prove a useful and valuable addition to gardens. It has a long flowering season, continuing in blossom throughout August. Albizzia is a member of a tropical tribe of the great family Leguminosae and it is astonishing that this tree should be able to withstand New England winters. Apparently it is happy in fully exposed situations, where good drainage and a sandy loam prevail."

Wilson, and apparently Rehder, identified this plant with Carriere's *Albizia*

PLATE IX

The single plant of *Albizia julibrissin* remaining in the Arnold Arboretum from seeds introduced from the Lu Shan Arboretum, Hupeh, China in 1935 shows the upright growth habit that is predominant in this species.

rosea, presumably because of its hardiness. Apparently they did not give much weight to the matter of flower color. In the Korean plant, the stamens are pink in the upper half but whitish below, quite different from the concolorous pink of the plates of Carriere and Van Houtte. *Albizia rosea* appears to be a name properly considered as belonging to a clonal or pure line selection from the population of *Albizia julibrissin* growing in the southeastern United States about 1864. In other words it is best treated as a cultivar.

It appears that only a single plant originally existed of Carriere's *Albizia rosea*, so all plants of the hardy *Albizia rosea* (or *A. Nemu*) are pure line descendants of the single plant. It is certain that only a single plant survived of Wilson's collection from Korea. Finally, only a single plant survives in the Arnold Arboretum from an introduction of seed from the Lu Shan Arboretum, Hupeh, China, in 1935. The latter two hardy clones are planted only about 150 feet apart in the Arnold Arboretum. Seeds from these plants cannot be guaranteed to be the result of self pollination. Therefore, only vegetatively propagated material of 'Ernest Wilson' can be guaranteed true to name.

Carriere's *Albizia rosea* and the Arnold Arboretum seedling from Lu Shan seed are similar in habit to each other and to the common form of silk tree found throughout the southeastern United States. That is, they develop one or more trunks 1½ to 4 feet tall, at which height the trunk breaks up into a series of ascending, then widely spreading, branches (Plate IX). Wilson's Korean plant, however, differs in producing several widely spreading branches from about ground level (Plate X). Our limited experience suggests that this growth character is inherited by the seedling progeny.

It is proposed here that the plant grown from Wilson's seed, and its vegetative progeny, can be treated as a distinct cultivar, to be named 'Ernest Wilson'. This cultivar is distinguished from all others in the species by both habit and hardiness. The type specimen for this name is the plant in the Arnold Arboretum, accession number 13381, raised from seed of E. H. Wilson's collection number 11245, collected in Seoul, Korea, in 1918.

Albizia julibrissin grew and flourished without disease in the southeastern United States for more than one hundred years. Indeed, it was widely recommended for yard planting, since it grows quickly and flowers while quite small. But in 1935 a wilt disease caused by *Fusarium oxysporum* f. *perniciosum* (Hepting) Toole, was reported around Tryon, North Carolina. This disease spread rapidly through the Southeast. It was reported to have reached New York by the 1950's. It also had been reported from Russia in 1920 and Argentina in 1943. For susceptible trees, the disease is invariably fatal. But the U.S. Department of Agriculture has selected and distributed two disease resistant clones for southern conditions: 'Tryon' with dark pink flowers and 'Charlotte' with light pink flowers. In a single trial, these have not proved hardy at the Arnold Arboretum. So far as we know, the hardy strains of silk tree at the Arnold Arboretum have not been

PLATE X

Albizia julibrissin 'Ernest Wilson' differs from the species in growth habit in that it produces widely spreading branches at about ground level and remains wider than tall to maturity. The original plant, shown in winter (top) and in summer (bottom) will become 50 years old in 1969.

tested for disease resistance—nor do we know if the wilt organism has sufficient cold tolerance to survive a New England winter.

The great value of *Albizia julibrissin* and the cultivar 'Ernest Wilson' reside in their long season of abundant bloom. Beginning in late June or early July, and continuing until late September in Boston, the trees are almost continuously covered with the showy pink and white, powder puff-like inflorescences.

GORDON P. DEWOLF, JR.

PLATE XI

Flowers of *Albizia julibrissin* expand from early July through much of September. Fully open flowers and unopened buds are found together on the plant during most of this long blooming season.

PROPAGATION OF ALBIZIA JULIBRISSIN

Natural dispersal of *Albizia julibrissin* seeds take place during late fall and into winter. Pods, which develop in clusters, are firmly attached to the tree and require high winds to tear them loose, with the result that they can be found lodged against obstacles some distance from the mother plant. This method of distribution allows wide latitude in time of pod collection, quite unlike many fruits which must be harvested immediately when ripe. The suspended clusters of pods can be gathered quickly, a handful at a time. Blooms from which the pods develop open from early July to mid-September. Because of this long flowering period, seeds in various stages of development will be found at the time of collection. Those which arose from flowers early in the season will be plump and ripe while others from late flowers will be immature.

Seed Longevity

When pods of *Albizia julibrissin* have reached maturity and are about to change from green to straw-color, the coats of the seeds within consist of thin, soft membranes. At this stage they offer no barrier to germination and seedlings appear shortly after the seeds are sown. But as ripening continues, the seeds are reduced to about one-third their original weight and develop flinty-hard water-impermeable coats. When sealed from moisture in this way, respiration takes place at such a low rate that viability is retained for a remarkably long time when conditions are unfavorable to germination. In 1964 a few seeds from one of our own herbarium specimens that had been prepared in 1897 were treated with hot water, and one germinated after having been kept for 67 years under the dry conditions of an herbarium.

Inducing Germination

Germination of *Albizia julibrissin* seeds is hindered only by impervious seed coats that retard the entry of water. If seeds are not pre-treated before being sown, germination can occur erratically over a period of many years. Pretreatment can be done by mechanical scarification, acid scarification, or hot water treatment.

Mechanical scarification. In small quantities, seeds can be held between the fingers and scraped along the upper edge of a small, sharp, three-cornered file laid on a table top. When seeds are being processed in large volume, their coats can be abraded in scarifying equipment designed for this purpose.

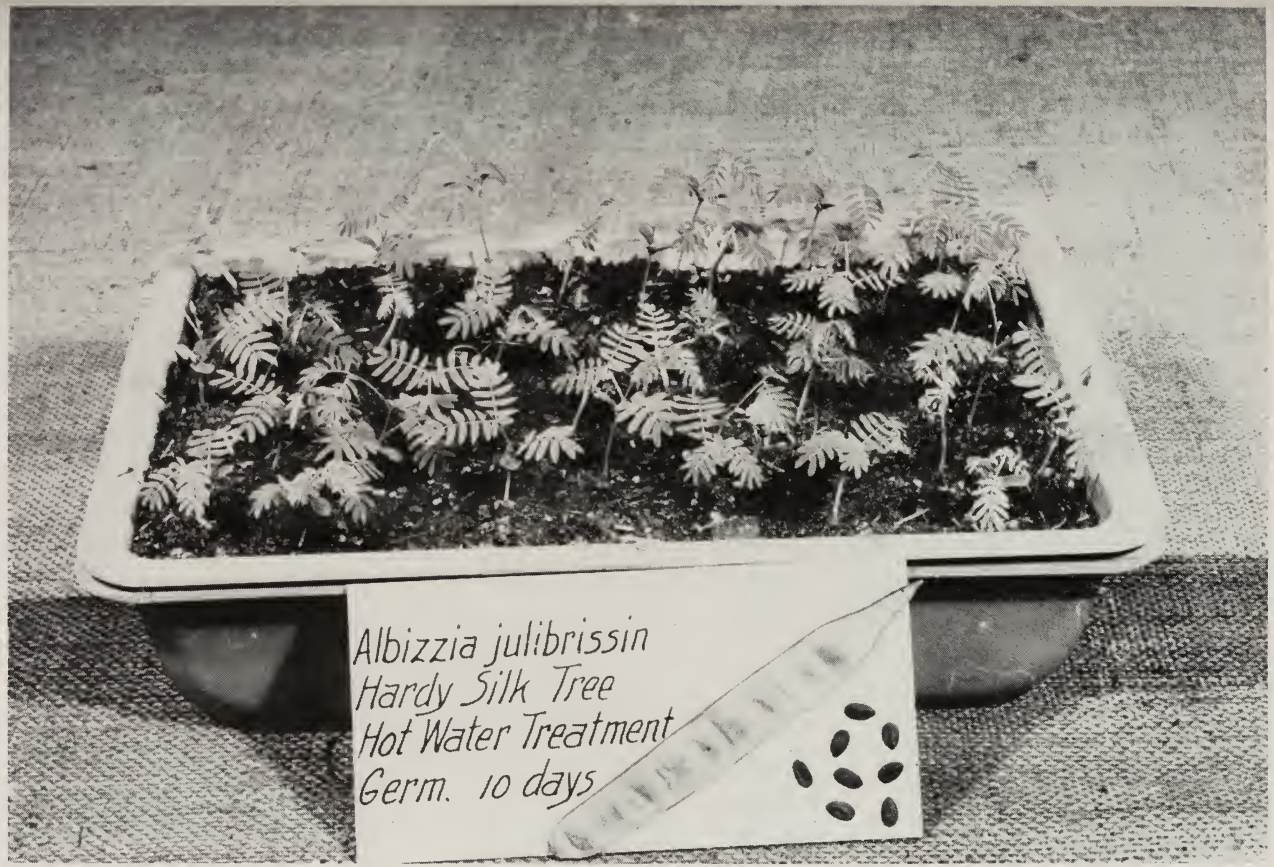

PLATE XII

Seed coats of *Albizia julibrissin* can be modified enough to permit germination by treating the seeds with water heated to 190° F. Resulting germination is shown.

Sulfuric acid treatment. Sulfuric acid treatment consists of placing the seeds in a glass container and carefully pouring concentrated sulfuric acid over them until they are covered. After a set period of time, the seeds are rinsed very thoroughly in running water for several minutes and then sown.

When the germination requirements of *Albizia julibrissin* seeds were being investigated at the Arnold Arboretum several years ago, sulfuric acid treatments of $\frac{1}{2}$ hour, 1 hour, and 2 hours produced similar results, the longer treatments being neither beneficial nor detrimental. Each produced uniform germination in about 10 days.

Hot water treatment. Seed coats can be modified enough to permit germination by placing the seeds in a container and pouring water heated to a temperature of about 190° F. over them (Plate XI). It is important that the volume of water be at least 5 or 6 times the volume of seeds, for too small a quantity would cool before it had the desired effect. Seeds are left in the water overnight and then sown at once. A somewhat less effective method is to sow the seeds and pour boiling water over the seed pan or flat. In our tests hot water and acid treatments produced similar results, but with hot water the precautions necessary when working with acid were avoided.

Vegetative Propagation

By 1966 the Arnold Arboretum's 47-year-old type specimen of *Albizia julibrissin* 'Ernest Wilson' showed signs of senescence and its propagation became necessary, In order to perpetuate the clone, asexual or vegetative propagations had to be made. Seedling propagants would have been unsatisfactory, for seedlings are genetic individuals and therefore could have characteristics differing from those of the parent plant. They might, for example, lack the inherent hardiness that is the principle attribute of this clone.

Albizia julibrissin does not propagate from ordinary stem cuttings but can be reproduced from root cuttings taken in late winter or early spring. Commercial nursery practice is to take root pieces in spring and line them out in nursery rows. To propagate *A. julibrissin* 'Ernest Wilson', root pieces about $\frac{1}{2}$ inch in diameter and 3 inches long were placed vertically in pots using a loose medium composed of sand and peat moss. This was done on March 11 and by May 23 shoots began to appear. In most cases multiple shoots developed. As propagators know, shoots that arise from roots are physiologically juvenile, even though the parent plant may have lost its juvenility years earlier. These will frequently root despite the fact that stem cuttings from the same plant will not. With this in mind, the excess shoots were removed and inserted as cuttings. In eleven days all were well rooted. This success led to an experimental project intended to test the feasibility of producing juvenile shoots from roots in quantity.

Root sections of larger size were placed horizontally in flats of sandy soil. This

PLATE XIII

Root sections of *Albizia julibrissin* placed horizontally in sandy soil give rise to juvenile shoots (top) that can be removed and will root quickly. If left attached to the root pieces, these shoots will root in place (bottom).

procedure worked well — three root pieces, one inch in diameter and from 5 to 12 inches long, led to a crop of 52 shoots (Plate XII). After the first shoots were removed, the root pieces were returned to the flat and a second but smaller crop developed. These were left in place and eventually produced roots of their own while still attached to the root piece. Use of large root sections to produce rootable cuttings provides a method by which desirable *Albizia julibrissin* clones can be propagated quickly. Included among these would be cultivars selected for resistance to the mimosa wilt disease that has been troublesome in the South in recent years.

ALFRED J. FORDHAM

ARNOLDIA

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SOME HORTICULTURAL ACTIVITIES OF JUSTIN SMITH MORRILL

JUSTIN S. MORRILL is best known as the founder of the land-grant university system in the United States, through his authorship in Congress of the Land Grant Act of 1862. The immense significance of this act, which laid the foundation for the growth of our state university system, has overshadowed many of his activities, among them adaptability trials of a variety of trees and shrubs at his home in Strafford, Vermont. The trials were very small by comparison with many present efforts, but were done before the establishment of any public arboretums in the United States, and at a time when relatively few private landholders in this country were doing this sort of thing. Because of this early information (however limited) that they provide about adaptability of certain species, and the light that they shed on Morrill's personality and interests, the available facts on Morrill's horticultural activities are presented here.

Justin Smith Morrill was born in Strafford, Vermont in 1810. Fifteen years later his formal education ended, for financial reasons, and he went to work as a clerk in the general store in Strafford. Biographers have suggested that his disappointment at having to leave school so early may have intensified his interest in books and education—a preoccupation, as it turned out, with great significance for the future of higher education in the United States. Nine years after starting to work in the store, he became part-owner of it. After 14 more years he had accumulated enough wealth to enable him to sell his interest in the store and retire from business. With the expanded leisure time now available to him, he was able to become more active in local affairs, including politics. This activity culminated in his being persuaded to run for election to the U.S. House of Representatives in 1854. He was elected and spent the next 44 years in Congress: 12 in the House of Representatives and 32 more in the Senate. Morrill's activities while in Congress have been well documented in the *Congressional Record*, his own writings, a biographical address by George W. Atherton, entitled "The

Legislative Career of Justin S. Morrill"[1] and the biography *The Life and Public Services of Justin Smith Morrill* by William Belmont Parker (Houghton-Mifflin, Boston and New York, 1924).

At the time of his first "retirement" in 1848 he started to build his homestead in Strafford. Morrill was a serious student of architecture and landscape architecture, as evidenced by his collection of books on these subjects[2], and he personally prepared the plans for his house and supervised its construction. Upon its completion in 1851, he prepared a plan of the grounds surrounding it[3] and assembled lists of plants for trial. Both the plan and the selection of plants appear to have been influenced strongly by the book *The Villa Gardener*, by J. C. Loudon (Wm. S. Orr & Co., London, 1850)—Morrill's copy bears notes in his handwriting.

From similar notes in another of his gardening books, *Cottage Residences* by A. J. Downing (Wiley and Putnam, New York and London, 1844), we can guess that his first plantings were made in the fall of 1852. In this same book is a list of plants that Morrill planned to obtain for planting in the spring of 1853. He also prepared a larger list of plants in the margins of the plan of his grounds and showed the locations of some of these plants on the property. Apparently this was a master list of plants that he planned to add to the grounds as he was able to. Unfortunately, we know which of the plants on this list were actually planted on his grounds only from the earlier-mentioned planting lists and by seeing those that remain there today. Morrill's election to the U.S. House of Representatives in 1854 apparently interrupted his planting program after only a year or two of activity, and it seems likely that it never was resumed. At least there was no evidence that it was continued in the systematic fashion in which it had been started.

The Homestead and Plantings Today

After Morrill's death in 1898, the homestead remained in the Morrill family for 40 years, then was owned by others for the next 24 years. In 1962, the centennial year after the signing of the Land Grant Act, the homestead was purchased by the Justin Smith Morrill Foundation, Inc. and was designated a Registered National Historic Landmark by the National Park Service, U.S. Department of the Interior. By that time both building and grounds had undergone considerable deterioration. Essential repairs to the roof and structural timbers

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[1] Delivered at New Haven, Connecticut, November 14, 1900, at the request of the Executive Committee of the American Association of Agricultural Colleges and Experiment Stations. Text published by J. Horace McFarland Co.

[2] This collection was presented by Morrill to the Justin Smith Morrill Memorial Library in Strafford, Vermont, and is now shelved there.

[3] Morrill's plan of his home grounds is now on loan to the Wilbur Library of the University of Vermont, and is displayed in its Special Collections Room.

PLATE XIV

The Justin S. Morrill home in Strafford, Vermont, as it appeared around 1920 (top), and in its immediate surroundings in 1967 (bottom).

were undertaken immediately, and further restoration is proceeding slowly as funds are available. It has not yet been possible to restore the grounds to anything resembling their original condition (Plates XIV, XV), and it may never be, but the few plant species apparently surviving from Morrill's plantings are in no immediate danger. Some of the more interesting specimens presently on the grounds are:

Magnolia kobus (Plate XVI). This one tree has been badly crowded by larger trees, was broken almost to the ground 30 or more years ago but has returned to a height of about 18 feet. It flowers and fruits only sparsely, because it is growing in the shade of much larger trees.

Mahonia aquifolium (Plate XVII). This forms a low thicket some 15 feet across, apparently the result of spreading of a single plant. It flowers well and shows little sign of winter damage, probably because it is usually covered by snow during the winter and is growing in a partly-shaded site.

Pinus nigra (Plate XV). This is a 60-foot tree, with a trunk 27 inches in diameter at eye-level. It has developed a picturesque habit with a tendency to be flat-topped.

Syringa persica alba. This is a graceful shrub, very old, yet not over 6 feet in height.

Thuja occidentalis. There are large specimens on the grounds, obviously planted. The largest was planted at one of four corners of a garden house, long since gone. This tree has five trunks averaging 12 inches in diameter at eye level. The bole, where all trunks have joined, measures between 3 and 4 feet in diameter. Even though this species is native to the area, specimens of this size are almost never seen in the wild.

All of these but the native *Thuja occidentalis* are rarely cultivated in this part of Vermont, but all except *Magnolia kobus* would have been available to Morrill in 1850. This species was introduced into the U.S. in 1865, so the tree must have been planted later in Morrill's life or afterward. This explains its absence in Morrill's planting lists.

In addition, several large specimens of native species of *Acer*, *Fraxinus*, *Larix*, *Picea* and *Pinus* remain on the grounds. Some were undoubtedly planted there by Morrill.

Without greater financial support than the Justin Smith Morrill Foundation has yet been able to muster (for all the dedication of its trustees and members) restoration of the house itself will proceed slowly. Any restoration of the grounds must come about more slowly still. If and when improvements on the grounds are possible, it will be most important that they are carried out with great care. The few remaining plant specimens that can (with reasonable confidence) be

PLATE XV

Barns and shops on the Morrill property as they appeared in 1967 (top). Overhanging branch against the sky at right is from a tree of *Pinus nigra*, probably planted by Morrill. This tree is shown (bottom, left) growing close to a large specimen of *Thuja occidentalis* beside the Morrill home.

traced back to Morrill could be lost or damaged in the process, breaking the last tangible links with this side of the Morrill personality.

Meanwhile these remaining specimens appear to be holding their own against nature, as they have done for many years. They await plant-interested visitors to the Justin Smith Morrill Homestead.

Plants Listed by Justin S. Morrill on the Plan of His Estate Grounds

KEY

* Plants that appear to have been actually planted by Morrill (not necessarily to exclude others that may have been planted without record).

** Plants that can be found on the Morrill property today (not necessarily the same ones planted by Morrill but probably so, except for some of the native species).

Trees and shrubs (probable identity)	Names as noted by J.S.M. on plan
***Abies balsamea*	Fir Balsam – Abies balsamifera
Acer negundo	Ash-leaved Negundo
Acer platanoides	Norway Maple
***Acer saccharum* or *A. rubrum*	Maple
**Aesculus hippocastanum*	Horse Chestnut
**Alnus glutinosa*	European Alder
Artemisia abrotanum	Southern Wood
Berberis macracantha	Violet Fruited Barberry
**Berberis vulgaris*	Barberry – Berberis vulgaris
Berberis vulgaris var. *atropurpurea*	Barberry, Purple Leaved – Berberis vulgaris
Boussingaultia sp.	Madeira Vine
Calycanthus floridus	Sweet Scented Shrub – Calycanthus florida
**Campsis radicans*	Scarlet Trumpet Flower – Bignonia radicans
Caragana microphylla	Pea Tree, Altagana
**Castanea sativa*	Spanish Chestnut – Castanea visca
**Chaenomeles japonica*	Japan Quince – Pyrus japonica
Colutea arborescens	Yellow Bladder Senna – Colutea arborescens
Convolvulus japonicus	Calistegia pubescens
Cornus florida	Cornus florida

PLATE XVI

Tree of *Magnolia kobus* growing in the shade of larger trees on the Morrill property in Strafford, Vermont. It flowers and fruits only sparsely, for lack of adequate sunlight.

Cornus sanguinea	Cornus sanguinea – Bloodytwig Dogwood
Cotinus coggygria	Venetian Fringe Tree – Rhus cotinus
Crataegus sp.	Crataegus rigida
Crataegus chrysocarpa var. *phoenicea*	Crataegus coccinea
Crataegus crus-galli var. *pyracanthifolia*	Crataegus crus-galli pyracanthifolia
Crataegus eriocarpa	Crataegus eriocarpa
**Crataegus oxyacantha*	Hawthorn – Crataegus oxyacantha
Crataegus oxyacantha var. *aurea*	Crataegus oxyacantha aurea
**Crataegus oxyacantha* var. *rosea-plena*	Hawthorn – double pink
Crataegus oxyacantha cv.	Crataegus Double Scarlet
Crataegus oxyacantha cv.	Crataegus Double White
Crataegus prunifolia	Crataegus ovalifolia
Cytisus scoparius	Scotch Broom
Daphne mezereum	Pink Mezereum
Deutzia scabra	Deutzia scabra
Euonymus americanus	Strawberry Tree – Euonymus americanus
**Euonymus americanus*	Euonymus americana
**Fagus sylvatica* 'Atropunicea'	Purple Beech
Forsythia viridissima	Forsythia viridissima
***Fraxinus americana*	Ash – Fraxinus americana
Fraxinus excelsior	European Ash
**Fraxinus excelsior* 'Pendula'	Weeping Ash
**Ginkgo biloba*	Ginkgo Tree
Gleditsia triacanthos	Three-thorned Acacia
**Halesia carolina*	Silver Bell Tree – Halesia tetraptera
**Hibiscus syriacus* or *Althaea officinalis*	Althea
Indigofera sp.	Indigo Shrub
Jasminum sp.	Jasmine
**Juniperus communis* var. *suecica*	Swedish Juniper
Juniperus virginiana	Red Cedar
Kalmia latifolia	Mountain Laurel – Kalmia latifolia
Kerria japonica	Japan Globe Flower – Kerria japonica

PLATE XVII

Mahonia aquifolium growing in a mass toward the front of the Morrill property. It appears to have grown from a single plant, likely planted there by Morrill himself.

Koelreuteria paniculata	Japan Koelreuteria – Koelreuteria paniculata
**Laburnum alpinum*	Scotch Laburnum
**Larix decidua*	European Larch
***Larix laricina*	Larch – Pinus micro
Ligustrum lucidum or *L. japonicum*	Privet, Evergreen
Ligustrum vulgare	Privet, Common
**Lonicera flava*	Yellow Trumpet Honeysuckle – Lonicera flava var. fraseri
**Lonicera sempervirens*	Evergreen Honeysuckle
Lonicera sp.	Honeysuckle
Lonicera tatarica	Upright Honeysuckle (red tart.)
Magnolia virginiana	Swamp Magnolia – Magnolia glauca
***Mahonia aquifolium*	Holly-leaved Mahonia
**Mahonia pinnata*	Mahonia fascicularis
Parthenocissus quinquefolia	Virginia Creeper
Parthenocissus tricuspidata	American Ivy
***Philadelphus coronarius*	Syringa, Common – Philadelphus coronarius
**Philadelphus grandiflorus*	Syringa, Large Flowering – Philadelphus grandiflora
***Picea abies*	Norway Spruce
***Picea glauca* or *P. rubens*	Spruce
***Pinus nigra*	Austrian Pine
***Pinus strobus*	Weymouth (White) Pine – Pinus strobus
**Pinus wallichiana* (*P. griffithii*)	Bhutan (Lofty) Pine
**Platanus acerifolia*	English Sycamore
**Populus alba*	Silver Leaf Poplar (white) – Populus alba
Populus nigra italica	Lombardy Poplar
**Prunus glandulosa*	Almond, Double Flowering – Amygdalus pumila
**Prunus serotina pendula*	Weeping Cherry
**Prunus* sp.	Double Flowering Cherry
Prunus sp.	Perfumed Cherry
**Quercus coccinea*	Scarlet Oak
Quercus lyrata	Overcup Oak

**Quercus robur*	English Royal Oak
***Rhamnus cathartica*	Buckthorn (Hedge)
Rhododendron nudiflorum	Pink Azalea – Azalea nudiflora
**Rhododendron viscosum*	Swamp Pink Azalea
**Rhus typhina*	Sumac – Rhus typhina
Ribes aureum	Missouri Currant – Ribes aureum
Ribes gordonianum	Beaton's Currant – Ribes Beatonii
Ribes sanguineum	Red Flowering Currant – Ribes sanguinea
Robinia hispida	Rose Acacia
**Robinia pseudoacacia*	Honey Locust – Robinia pseudoacacia
Rosa moschata	Musk Rose
**Salix* sp.	Comerville or Cornwall Willow? (not fully legible)
**Salix babylonica*	Napoleon Weeping Willow
**Salix repens rosmarinifolia*	Rose-mary Leaved Willow
Sophora japonica	Sophora japonica
**Sorbus americana*	Mountain Ash – Pyrus aucuparia
**Sorbus aucuparia*	European Mountain Ash
Spiraea alba	Spirea lanceolata
Spiraea sp. or cv.	Spirea (Col. Bissell)
Spiraea cantoniensis	Spirea reevesii
Spiraea media	Spirea daurica
Spiraea prunifolia	Spirea prunifolia plena
Spiraea salicifolia	Spirea salicifolia
Spiraea salicifolia or *S. rubra*	Spirea salicifolia rubra
Spiraea sibiraea	Spirea levigata
Spiraea tomentosa	Spirea tomentosa
Symphoricarpos albus	Snowdrop – Symphora racemosa
**Syringa* 'Charles X'	Lilac, Charles X
**Syringa josikaea*	Lilac, Josikea
Syringa persica	Lilac, Persian Purple – Syringa persica
***Syringa persica* var. *alba*	Lilac, Persian White – Syringa persica
Syringa sp. or cv.	Lilac, Blue

***Syringa vulgaris*	Lilac (common) – Syringa vulgaris
Tamarix africans	African Tamarisk
**Taxus baccata*	English Yew
Taxus baccata 'Fastigiata'	Irish Yew
***Thuja occidentalis*	Arbor Vitae – Thuja occidentalis
Thuja orientalis	Chinese Arborvitae
Tilia sp.	European Linden
***Tsuga canadensis*	Hemlock – Abies canadensis
***Ulmus americana*	Elm – Ulmus americana
**Viburnum opulus* var. *roseum*	Snow Ball – Viburnum opulus roseum
**Viburnum trilobum* or *V. opulus*	Cranberry Tree
Weigela rosea	Weigela rosea
Wisteria sinensis	Wistaria (Chinese)
Yucca filamentosa	Yucca filamentosa

Garden roses

49 cultivars: 40 hybrid perpetual, 5 hybrid damask, and 4 climbing roses.

Miscellaneous ornamentals (number of kinds)

Amaryllis	(1)	Dictamnus	(1)	Lupinus	(1)	Phlox	(6)
Antirrhinum	(1)	Geranium	(1)	Lychnis	(1)	Primula	(2)
Asparagus	(1)	Gladiolus	(6)	Narcissus	(?)	Ranunculus	(1)
Aquilegia	(1)	Hibiscus	(1)	Ornithogalum	(1)	Tulipa	(12)
Convallaria	(1)	Hyacinth	(2)	Oxalis	(1)	Valeriana	(1)
Coreopsis	(1)	Iris	(4)	Paeonia	(7)	Verbena	(7)
Corylus	(1)	Lathyrus	(1)	Papaver	(1)	Viola	(3)
Delphinium	(3)	Lilium	(5)	Petunia	(2)		

Fruits, berries, and nuts (number of kinds)

Apples	(18)	Blackberries	(3)
Cherries	(9)	Currants and gooseberries	(17)
Filbert	(1)	Raspberries	(5)
Pears	(15)	Rhubarb	(1)
Plums	(9)	Strawberries	(2)
Quince	(1)		

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SOME WAYS PLANTS CLIMB

CLIMBING plants often show adaptations that facilitate their climbing. These involve easily observed modifications of different plant parts, accompanied by internal modifications, particularly in the details of stem anatomy. In this note we shall consider only the external modifications.

For convenience in discussing them, climbing plants can be grouped in five general classes: 1) twiners, in which the main stem twines about a supporting agent; 2) branch climbers, having the side branches variously modified; 3) inflorescence climbers, with part or all of the inflorescence converted into climbing organs; 4) leaf climbers, with all or portions of the leaf modified; and 5) root climbers, in which special roots for climbing have been developed. These five classes will be discussed and illustrated by listing some examples suitable for growing in the greenhouse or out-of-doors. The lists include the scientific name of each plant, the name of the family to which it belongs, and a common name when available.

Twiners

Plants move. One simple plant movement is performed by the actively growing stem tip, which describes a circle or ellipse in the air. This phenomenon (technically called circumnutation), is a relatively basic act of plant growth, but is generally overlooked as it cannot easily be observed.

The magnitude of this movement may be measured in parts of a millimeter (about 1/25 of an inch) to as much as a meter (almost 40 inches). The circular movement of the stem tip is caused by differential elongation of plant cells, which in turn is controlled by differential distribution of plant hormones. For example, if the cells on one side of a stem elongate more than those on the opposite side, the stem bends in the direction of the side with less elongation. This type of movement is similar to that which causes plants to bend toward light in a darkened room. The time required for the stem tip to complete a revolution varies from a half hour to a day or more, so that observation at regular intervals will

allow one to see the progress of this phenomenon. A simple way to do this is to place a paper collar loosely around an actively growing shoot (a morning-glory is a good subject). Place a light directly above the pot containing the plant, so that the stem apex throws a shadow on the paper collar. Mark the position of the shadow on the paper collar with a pencil and make a note of the time. As the shoot apex moves, the shadow moves, and a time sequence can be established.

The twining habit, I believe, results from an exaggeration of the basic movement of circumnutation. It is relatively easy to understand how a plant with considerable apical movement twines — it merely has to have its free movement interrupted by an object smaller in diameter than the radius of its growing circle. Approximately half of all twiners have developed the supplementary mechanism of a sensitive stem (that is, there is a positive reaction to a contact stimulus) which increases differential cellular elongation and enhances the twining process. Other adaptations that facilitate twining are all geared to the reduction of weight of the stem tip. These include thin stems, strong apical dominance with little or no development of side branches, and delayed expansion of the leaf blade. Shoots that combine all of these features and circumnutate at a rapid rate are often called "searcher shoots," and their function is self-evident.

Much has been made of the direction in which plants twine, i.e. left *vs* right-handed or clockwise *vs* counter-clockwise. There is some common belief that the direction of twining is dependent on whether a particular plant is grown in the southern or northern hemisphere. Actually, few plants can be relied upon to maintain a definite twining direction, and most reverse direction from time to time. One notable exception is found in some species of *Dioscorea* (the true yams) in which the direction of twining is consistent enough to be helpful in the classification of members of the group.

In the following plant lists, herbaceous and woody twiners are listed separately. Care must be exercised in the placement of woody twiners in an outdoor situation, as the more robust ones such as *Celastrus* can cause severe damage or death to trees. Obviously, these powerful twiners should be grown on strong trellises or poles.

Herbaceous Twiners:

Scientific name	Family	Common name
Anredera cordifolia	Basellaceae	Madeira-vine
*Argyreia speciosa**	Convolvulaceae	
Bomarea spp.*	Amaryllidaceae	
*Dioscorea villosa**	Dioscoreaceae	
Hoya spp.*	Asclepiadaceae	Waxplant
Humulus japonicus	Moraceae	Japanese Hop

Herbaceous Twiners (cont.)

Ipomoea spp.	Convolvulaceae	Morning-glory
*Lapageria rosea**	Liliaceae	
Menispermum canadense	Menispermaceae	Moonseed
Polygonum aubertii	Polygonaceae	Silver Fleece Vine
*Senecio confusus**	Compositae	Mexical Flame Vine
Thunbergia spp.	Acanthaceae	Clockvine

Woody Twiners:

Scientific name	Family	Common name
Actinidia spp.	Dilleniaceae	Chinese Gooseberry
Akebia spp.	Lardizabalaceae	
*Araujia sericifera**	Asclepiadaceae	Cruelvine
Aristolochia durior	Aristolochiaceae	Dutchman's Pipe
*Beaumontia grandiflora**	Apocynaceae	Herald's Trumpet
Celastrus species (Plate XVIII)	Celastraceae	Bittersweet
*Kadsura japonica**	Schisandraceae	Scarlet Kadsura
Lonicera japonica‡	Caprifoliaceae	Japanese Honeysuckle
*Petraea volubilis**	Verbenaceae	Sandpaper-vine
Pueraria lobata	Leguminosae	Kudzu-vine
Schisandra chinensis	Schisandraceae	Chinese Magnolia-vine
*Stephanotis floribunda**	Asclepiadaceae	
Wisteria floribunda	Leguminosae	

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* Suitable only for greenhouse use in our northern climate. Some of these tropical species may be grown as annuals out-of-doors.

‡ Although Japanese honeysuckle generally grows within bounds in more northern areas it has become a dangerous weed in the south and care must be taken to see that it does not get out of hand.

Branch Climbers

The use of branches as climbing devices seems to be a more sophisticated method than simple twining. A complete range of modification can be found from

branches borne at right angles to the main stem, to those that have become hook-like structures, to those developing tendrils. In some plants these modifications occur spontaneously, but in others stimulation by contact is required. Oddly, this category of climber is most often associated with plant groups possessing opposite leaves.

Tendrils are slender, wire-like climbing organs which are highly sensitive to contact stimuli. The following remarks apply in general regardless of the origin of the tendrils (which can be modified stems, leaves, or inflorescences), as they all behave in essentially the same way. Tendrils circumnutate just as stem tips do, and they seem to be under a similar hormonal control. Most frequently the young tendril extends beyond the circumnutating stem tip and revolves independently of it. This double movement does not present difficulties to the plants, but when circumnutation of the tendril continues after that of the main axis has ceased, a new regime must be established; either the tendril curtails its circumscription by one half and straightens to pass the stem, or the main stem is engaged by it. On engagement the stem usually is released by the tendril and circumnutation is resumed (the mechanism for this action is not understood). Tendrils are extremely sensitive and are able to detect very small degrees of resistance to their free movement. The sensitivity of the tendril to touch may be general or restricted to very precise areas, depending on the species. The time span in which a tendril is active varies with the species and may be as long as a month. If not stimulated within its active period it often withers.

In the family Cucurbitaceae (gourds, cucumbers, squashes, etc.) tendrils are more highly specialized than in most other groups. In addition to the twining action already described, they have developed a secondary modification to increase their holding efficiency. After a tendril has twined about its support and is securely fastened it begins a double coiling action from a central point on the tendril. The structure formed resembles a spring and seems to function in the same manner.

Branch Climbers (variously reflexed branches):

Scientific name	Family	Common name
Combretum spp.*	Combretaceae	Bottlebrush
*Hippocratea volubilis**	Hippocrateaceae	
Lycium halimifolium	Solanaceae	Matrimony-vine
*Periploca gracea**	Asclepiadaceae	Silkvine
Plumbago spp.*	Plumbaginaceae	Leadplant

Branch Climbers (tendrils of branch origin):

Bryonopsis laciniosa	Cucurbitaceae	Marblevine

PLATE XVIII

(Top) *Celastrus orbiculatus*, a commonly grown woody twiner valued for its colorful fruits in autumn. (Bottom) *Congea tomentosa* (Verbenaceae), a typical non-sensitive branch climber. Its special modifications are stems with long internodes and well developed opposite branches borne at right angles to the main stem.

Branch Climbers (tendrils of branch origin): (cont.)

Cucurbita pepo var. *ovifera*	Cucurbitaceae	Gourds
Luffa cylindrica	Cucurbitaceae	Vegetable Sponge
Momordica spp.	Cucurbitaceae	Balsamapple
Sicyos angulata	Cucurbitaceae	Bur-cucumber

Inflorescence Climbers

Employing all or part of an inflorescence as a climbing mechanism is efficient only in terms of climbing, since flower production must necessarily be curtailed. In many species belonging to this class of climbers, flower production is completely suppressed, making it difficult sometimes to separate this class from the preceding one. In these instances precise determination requires detailed anatomical and developmental studies. Functionally the inflorescence climbers employ techniques similar to those described for the branch climbers. The modification of the inflorescence is most commonly in the form of either a tendril or a reflexed hook.

Inflorescence Climbers

Scientific name	Family	Common name
*Bougainvillea spectabilis**	Nyctaginaceae	
Inflorescence parts converted to simple reflexed hooks which become woody with age.		
*Antigonon leptopus**	Polygonaceae	Coral Vine
Tip of inflorescence converted into tendrils.		
*Cardiospermum halicacabum**	Sapindaceae	Balloon-vine
Lower portion of inflorescence base converted to watch spring-like tendril.		
Cissus spp.*	Vitaceae	Ivy Treebine, Grape Ivy
Entire inflorescence converted to twining tendrils.		
Parthenocissus quinquefolia	Vitaceae	Virginia Creeper
Whole inflorescences converted to branched tendrils with sucker-discs at tips.		
Parthenocissus tricuspidata	Vitaceae	Boston Ivy
As preceding species.		
Passiflora spp.* (Plate XIX)	Passifloraceae	Passion Flowers
Entire inflorescence or a portion of it converted to tendril.		
Paullinia spp.*	Sapindaceae	
Lower portion of inflorescence converted to tendril.		
Securidaca spp.*	Polygalaceae	Easter-vine
All parts of inflorescence sensitive and tendril-like in action but no special tendrils.		

PLATE XIX

(Top) *Dalbergia* sp. (Leguminosae), a climber with lateral branches modified into tendril-like structures. (Bottom) A passion flower, *Passiflora coccinea*, climbing by simple, sensitive tendrils which are highly modified inflorescences.

Leaf Climbers

Some of the most highly evolved climbing mechanisms are found among the leaf climbers. This category may be subdivided on the basis of the part of the leaf modified: 1) the entire leaf, 2) the petiole and stipules, 3) the midrib, and 4) the apex. The modifications (Plate XX) are often so unique that in some instances comments within the plant lists are again necessary.

Entire Leaf Modified:

Scientific name	Family	Common name
Asparagus plumosus	Liliaceae	
Entire leaf converted to horny reflexed hook.		
*Anisostichus capreolata**	Bignoniaceae	Crossvine
Compound leaves converted into compound twining tendrils.		
*Doxanthus unguis-cati**	Bignoniaceae	
Has opposite compound leaves each composed of three leaflets. Leaflets of one leaf of each pair converted into three hooks (appearing like bird's feet). When tips of the hooks secure a hold they produce additional tissue and grow into the irregularities of the substrate surface.		
Rubus cissoides	Rosaceae	
Leaf blade becomes very much reduced with three main veins developing many retrorse thorns.		
*Ruscus androgynus**	Liliaceae	Climbing Butcher's Broom
Entire leaf converted into a reflexed hook.		

Petiole and Stipule Modifications:

Clematis spp.	Ranunculaceae	
Leaves are divided into leaflets and the petiolule of each leaflet is sensitive and somewhat tendril-like.		
*Quisqualis indica**	Combretaceae	Rangoon Creeper
As leaf matures, the petiole reflexes and becomes hook-like. The hook is persistent and becomes woody long after the leaf blade is shed.		
*Rhodochiton volubile**	Scrophulariaceae	
Combination petiole twiner and stem twiner.		
Smilax hispida	Liliaceae	Greenbrier
A pair of twining tendrils found near the junction of blade and petiole.		
Tropaeolum majus	Tropaeolaceae	Nasturtium
Petiole sensitive and tendril-like.		

PLATE XX

Diagram of various modifications of leaf parts to form climbing organs. ***a,*** *Calamus* sp. (Palmae) frond apex modified into retrorse hooks. ***b,*** *Gloriosa rothschildiana* (Liliaceae) leaf apex modified into tendril. ***c,*** *Asparagus plumosus* (Liliaceae) entire leaf converted into reflexed hook. ***d,*** *Nepenthes* sp. (Nepenthaceae) midrib acts as tendril during development. ***e,*** *Tropaeolum* sp. (Tropaeolaceae) petiole sensitive and twining. ***f,*** *Smilax* sp. (Liliaceae) stipules modified into tendrils. ***g,*** stylized drawing of unmodified leaf.

Midrib Modified:

Nepenthes spp.	Nepenthaceae	Climbing Pitcher-plant

As leaf develops a blade is formed. The tip continues growth and becomes a sensitive twining tendril. Further growth produces an elaborate and characteristic pitcher at the apex of the tendril.

Apex Modified (tendrils):

Adlumia fungosa	Papaveraceae	Climbing Fumitory
*Cobaea scandens** (Plate XXI)	Polemoniaceae	Cup and Saucer-vine
Flagellaria spp.*	Flagellariaceae	
Gloriosa rothschildiana	Liliaceae	Gloriosa Lily
Lathyrus odoratus	Leguminosae	Sweet Pea
*Mutisia latifolia**	Compositae	
*Stylidium scandens**	Stylidiaceae	

Apex Modified (hooks):

Calamus ornatus	Palmae
Desmoncus major	Palmae

Root Climbers

At least 30 percent of all the flowering plant families that have climbing members include some root-climbers among them. Since roots used in climbing have their origin in stems rather than in other roots, they are called "adventitious" roots. They may be restricted to the nodes (points of leaf attachment), or may arise anywhere along the climbing shoot. Usually adventitious roots arise only on the side of the shoot towards the surface being climbed, where the humidity may be slightly higher and the light less intense. Specialized climbing roots are short in length and life duration. They have an increased sensitivity to contact stimuli and an accompanying loss of positive geotropism. Very often the shoot that gives rise to adventitious roots is restricted to the function of climbing and the side branches from it perform the photosynthetic and reproductive functions. In this case the climbing shoot often bears leaves of smaller size and sometimes different shape from those of the lateral branches. The incorrect terms "juvenile shoots" and "adult shoots" are often applied in these instances to differentiate the two types of shoots. Climbing shoots of some length climb either in a very open spiral or the shoots are noticeably zig-zag to make full use of mechanical advantage inherent in such a system.

PLATE XXI

Cobaea scandens (Polemoniaceae). A leaf climber with compound leaves, the terminal leaflets of which are converted into sensitive tendrils.

Root Climbers:

Scientific name	Family	Common name
Campsis radicans	Bignoniaceae	Trumpet-creeper
Epiphyllum spp.*	Cactaceae	Orchid Cactus
Euonymus spp.	Celastraceae	
*Ficus pumila**	Moraceae	Creeping Fig
Hedera helix	Araliaceae	English Ivy
Hydrangea anomala	Saxifragaceae	Climbing Hydrangea
Monstera spp.*	Araceae	
Philodendron spp.* (Plate XXII)	Araceae	
*Piper nigrum**	Piperaceae	Black Pepper
*Rhaphidophora aurea**	Araceae	
Rhus radicans	Anacardiaceae	Poison Ivy
Schizophragma hydrangeoides	Saxifragaceae	
*Vanilla planifolia** (Plate XXII)	Orchidaceae	Vanilla

A sixth class of climbers may be needed to include a number of plants that climb but in which an obvious adaptative mechanism is not present. These plants sometimes are called "weavers." A good example is the climbing roses where the only adaptation seems to be the production of long canes with thorns. As non-climbing roses also possess thorns there is a legitimate question of whether or not the thorns are evolved specifically as a climbing adaptation. The term weavers implies that these plants climb by forming a large mass of inter-twined branches. Such plants usually are planted in conjunction with a trellis or other support.

Finally, there are a few plants that are often mistaken for climbers. Some species of *Clusia* and *Ficus* fall into this category. Seed germination often takes place in a tree crotch or axil of a leaf (palms are particularly favored habitats) sometimes high above ground level. As the seedling develops (Plate XXIII), specialized roots hold it to the substrate while others grow toward and eventually reach to the ground and provide the water and minerals necessary to insure continued growth. As the seedling develops in size the substrate tree may be destroyed and as its decomposition takes place the former climber (which by this time may be quite large) becomes free-standing.

PLATE XXII

(Left) *Vanilla planifolia* (Orchidaceae) climbing the stem of a tree fern by adventitious roots, produced singly at each node. (Right) A root climber, *Philodendron* sp. (Araceae), with horizontal holding roots which secure the plant to the tree and vertical nourishing roots which descend to the ground.

Climbers are especially rewarding for the gardener, for their potential interest is not limited solely to the flowering period. In addition, they can be employed to brighten difficult-to-handle locations such as walls, fences, and tree trunks. Some of them are a bit particular about exposure, soil, etc., and consultation with one of the excellent available reference books will prove helpful. Many plant and seed catalogs also offer useful cultural directions. The plants listed above are only a sampling of the climbers available; others will no doubt come to mind displaying additional climbing mechanisms or variations on those previously mentioned. One or more of these climbers deserves a favored spot in your garden or greenhouse.

LORIN I. NEVLING, JR.

REFERENCES

Bean, W.J. *Wall Shrubs and Hardy Climbers.* Putnam, London. 1939.

Hottes, A.C. *Climbers and Ground Covers.* A.T. De La Mare Co., New York. 1947.

——. *A Little Book of Climbing Plants.* A.T. De La Mare Co., New York. 1924.

Howard, F. *Landscaping with Vines.* Macmillan Co., New York. 1959.

Jenkins, D.H. *Vines for Every Garden.* Doubleday, Doran & Co., Inc., Garden City, N.Y. 1937.

McCollom, W.C. *Vines and How to Grow Them.* Doubleday, Page & Co., Garden City, N.Y. 1911.

Pal, B.P. *Beautiful Climbers of India.* Indian Council of Agricultural Research, New Delhi. 1960.

Pearce, S.A. *Climbing and Trailing Plants.* W.H. & L. Collingridge Ltd., London; Tranatlantic Arts, Inc., New York. 1957.

Perkins, H.O. *Espaliers and Vines for the Home Gardener.* Van Nostrand Co., Inc. Princeton. 1964.

Terres, J.K. *Songbirds in Your Garden.* Crowell Co., New York. 1953.

Wyman, D. *Shrubs and Vines for American Gardens.* Macmillan Co., New York. 1949.

PLATE XXIII

Clusia rosea (Guttiferae). Not a climbing plant but one which has germinated on the palm plant and has formed horizontal holding roots and vertical nourishing roots which have reached the ground. The vertical roots eventually become stem-like.

Krussmann, Gerd, *Die Bäume Europas, ein Taschenbuch fur Naturfreunde.* Verlag Paul Parey, Berlin und Hamburg, Germany, 1968.

140 S. mit 379 Abb. im Text u. auf 80 Tafeln, davon 8 farbig und 114 Arealkarten. Ln. DM 24, —

For those who read German, this is an excellent little book by the director of the botanical gardens in Dortmund-Brunninghausen, Germany, who is also the author of that authoritative publication *Handbuch der Laub Geholze.* The author is thoroughly familiar with the subject about which he writes, having worked with plants throughout his adult life, and having traveled extensively in Europe and the British Isles. He is an excellent photographer and has a talent for sketching and making leaf prints. Every time I have been on a trip with him he has energetically been taking notes and photographing plants in order to increase his knowledge and to be better able to augment his numerous articles and books.

Approximately 180 trees are described with drawings or black and white leaf prints of the leaves (sometimes the fruits also) of every one. Also included are 108 small scale maps of Europe showing the distribution of the majority. Some 197 black and white pictures are included showing habits or close-ups of fruit or flower of many. Common names are given in German, French, Italian and English. All this is in a small book, 4 1/2 × 7 5/16 inches, suitable for carrying in one's pocket in the field. It should be excellent for aiding in field identifications.

A serviceable little book by one who has worked with ornamental plants all his life, it is hoped that some day this might be translated into English and so enlarge the group in America who can use it. Published May 27, 1968.

Donald Wyman

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NOTES ON MAKING AN HERBARIUM

FROM TIME TO TIME the Arnold Arboretum receives inquiries from people who either want to send plant material for identification or to prepare a reference collection for their own use. While many discussions of the techniques and accompanying problems can be found in the botanical literature, few are readily available in this country for the layman. For this reason these notes have been prepared. For those who desire more detail about specific groups of plants, or about specific problems or specific techniques, an Appendix and Bibliography will be found at the end of the text.

Let it be said at the outset that the best (but far from the most convenient) way to preserve plant material for study is to place the material in jars of preserving fluid. Such a collection, however, is not an herbarium. Liquid preservation has several disadvantages: 1) It is bulky; 2) the liquid tends to evaporate through the best-sealed lid, and in time must be replaced with fresh liquid; 3) to use the specimens for comparison, they must be removed from the jars and spread out in a pan of the liquid; 4) because of the fragility of glass containers it is not easy to transport specimens so preserved or to send them through the mails for identification or study. For special purposes, such as class teaching or preserving material in its natural shape for illustration, liquid preservation can scarcely be improved upon. But for most purposes of reference and identification, drying the plant material under pressure and mounting it on sheets of paper is more convenient and economical.

Herbaria and Their Use

An herbarium specimen is a pressed and dried plant or portion of a plant, accompanied by notes stating at the very least where it grew, when it was collected, and by whom. It is evidence that a particular plant, exhibiting particular charac-

teristics, grew in a particular place at a particular time. Incidentally, when identified, it exemplifies more or less completely the characteristics of the particular taxon [1] of which it is a member.

An herbarium is a collection of pressed and dried plant specimens arranged in some systematic order that facilitates examination of all of the material of a particular taxon. The aim of an herbarium is to accumulate in one place all possible information about the habits, habitats, variations and uses of all the plants with which it may be concerned. An herbarium may be concerned with a particular local area, such as a township, county, or state, or it may attempt to cover a nation, a continent or the world. It may attempt to accumulate all information available about a single taxon, such as a species, or about a few taxa, such as those included in a genus or a family, or it may attempt to contain information about all of the kinds of plants. It may deal with cultivated plants, wild plants, or both. However big or small it may be, it is a repository of information and a research tool of considerable value.

The usefulness of an herbarium or of an isolated herbarium specimen is determined by, and dependent upon, the completeness of the actual specimen(s) and the notes which accompany it(them).

Making an herbarium is the only economical way in which examples of many different kinds of plants, growing naturally in many different places, differing in their environmental requirements, and going through their life cycles at different rates, can be brought together at one time and in one place so that a student can compare simultaneously many different plants at any given stage of their life cycle. Such a situation is essential for identification of plants and for the production of written works that will allow subsequent students to identify other plants without the labor of comparing them with all of the material that was used for the original identification.

Historical Background

Sometime in the 1530's Luca Ghini, who was at that time Professor of Botany in the University of Bologna, Italy, discovered that plants dried under pressure and pasted on sheets of paper could be preserved almost indefinitely — and could be transported easily. It is on record that he had a collection of some 300 sheets so prepared. Unfortunately, it appears that this collection no longer exists. Several of Ghini's students and colleagues recognized the value of this technique and the collections of at least two of them survive. Andrea Cesalpini, the author of *De Plantis Libri XVI*, which is the basis for our consideration of flowers and fruits as the prime structures on which to base identification and classification, formed about 1563 a collection of some 768 specimens of Italian plants. This collection

[1] *Taxon*, pl. *taxa*, is a neutral and/or inclusive term devised to signify a taxonomic group of any rank, i.e. variety, species, genus, etc. In the present example, a second collection might represent a different variety of the species, or a different species in the same genus, or perhaps a different species in a different genus. The term taxon allows for any or all of these possibilities.

PLATE XXIV

An herbarium in use. Note steel cases for mounted specimens and mounted specimens enclosed in heavy manila folders.

is still preserved at the Instituto Botanico of the University of Florence. Ulisse Aldrovandi, who succeeded Ghini as Professor of Botany at Bologna and who taught a number of the most prominent botanists of the next generation, attempted to form an herbarium that was world-wide in scope. About 4,368 specimens of this collection are preserved at the Instituto Orto Botanico in Bologna. The herbarium technique proved so useful that it was quickly adopted by botanists throughout Europe. Arber (10) records that more than 20 collections formed or begun before 1600 are still extant in various European herbaria.

Originally, the individual sheets with plants mounted on them were bound and treated as books. Aldrovandi's herbarium, for example, is preserved as 17 bound volumes. This was the general technique until about 1700. Linnaeus (1707–1778) did not use this technique, preferring to keep the sheets separate and storing them (probably in cases) horizontally. Stearn (182) thinks that Linnaeus' example and teaching led to the spread of this technique — which is the one generally used today.

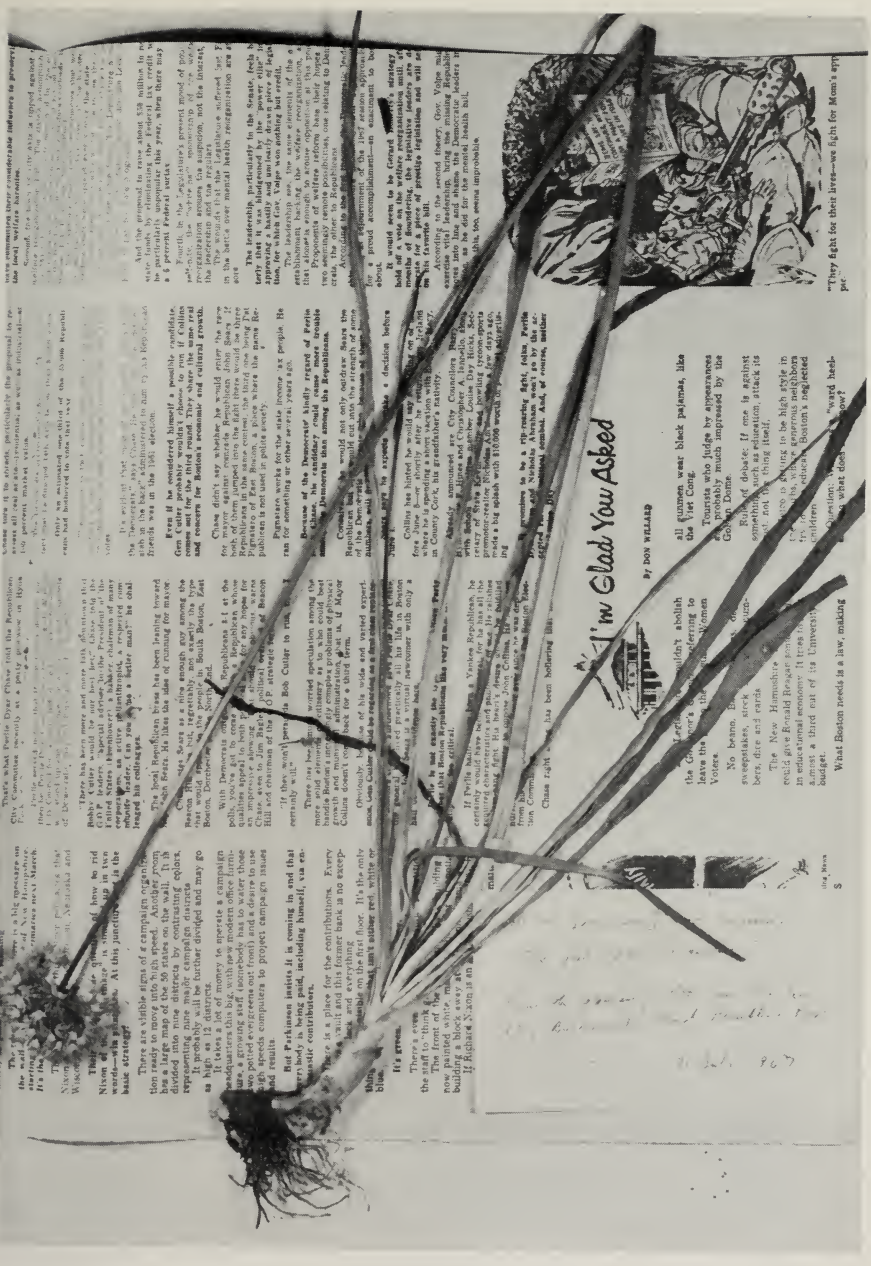
Binding the single sheets into books had the disadvantage of making any changes or additions to that part of the collection difficult if not practically impossible. This led to the use of portfolios, in which several unattached single sheets could be kept in a book-like fashion, a compromise between bound volumes and single sheets filed in cases. The advantage of portfolios was that they could be stored on shelves like books. The disadvantages were that the specimens were joggled every time the portfolios were moved and could be severely damaged by crushing if shelved too tightly. There was also always the risk of insect infestation, unless the specimens were poisoned — a messy and unpleasant, if not risky, business. However, as late as 1833, Asa Gray was selling bound volumes of mounted grass and sedge specimens entitled *North American Graminae and Cyperaceae.* And even today biological supply houses sell portfolios in which to keep herbarium specimens. Old techniques die slowly.

Preparation of Specimens for the Herbarium

Collecting — What to Collect

The herbaria of the world contain many scrappy specimens. It is not necessary to collect more scrappy specimens. As nearly as possible, an herbarium specimen with its accompanying notes should give a representation of the whole plant. Herbs and small shrubs up to 2 ft.–3 ft. tall should be collected entire (Plate XXV). Lateral branches may be trimmed off, if necessary, as may also some of the remaining leaves, to reduce bulk. The specimen should represent all parts of the root system (the plant should be dug, not pulled), as well as rhizomes, stolons, or tubers, if any (Plate XXVI), basal leaves, cauline (stem) leaves, any leaves or bracts in the inflorescence, and of course flowers and/or fruits.

Large shrubs and trees should be represented by a twig or small branch bearing three or more adjacent leaves, or at least leaf bases, so as to show their arrangement (Plate XXVII). It should, of course, bear flowers and/or fruits. If it is not possible to press the flowers or fruits while attached to the stem, then an explicit



I'm Glad You Asked

By DON WILLARD

PLATE XXV

Specimen on the folded newspaper in which it was pressed. Note rhizome, and inflorescence bent to fit the folded paper.

statement as to how they are attached should be made in the notes which accompany the specimens. Particular attention should be paid to different forms and sizes of leaves on the same plant. Shade-grown leaves and leaves on sucker shoots of trees or shrubs are frequently different in size or shape or texture from the leaves on twigs bearing flowers and/or fruits. Such variations should be collected and explicitly noted. Material without flowers or fruits should be collected only if it has some unusual value or significance (See Appendix).

Some plants have distinct male and female flowers. In some cases flowers of both sexes may be found in a single inflorescence (poinsettia) or, at least, on the same plant (Indian corn). This is termed monoecism. In other cases, individual plants will produce flowers of only one sex (e.g. willows). This is termed dioecism. In all these cases, it is important to collect both male and female flowers.

Each specimen should be composed of material to fit within the dimensions of a standard herbarium sheet, 11½ x 16½ in. When collecting small herbs, several should be collected, so as to fill a folded sheet of newspaper, and later a standard herbarium sheet. A larger herb or shrub may have its main axis variously bent into a "V", "N", or even an "M" to fit a fold of paper (Plate XXV). The bent stem may be held in place during drying by slipping a small piece of cardboard with a slit in the middle over the bend in the stem (Fig. 1). Alternately, 16 in.

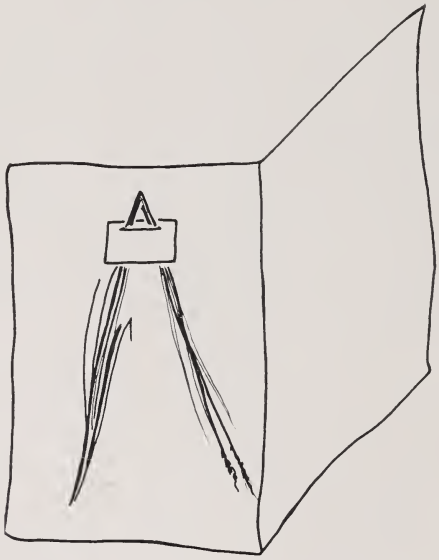


Figure 1

sections of axis with leaves or other appendages may be pressed in sequential folds of paper forming a series of specimens which should be numbered serially (185a, 185b, 185c, etc.) (Plate XXVI). If leaves are too large to be pressed flat, they may be folded or split lengthwise just off center so that the portion of leaf

PLATE XXVI

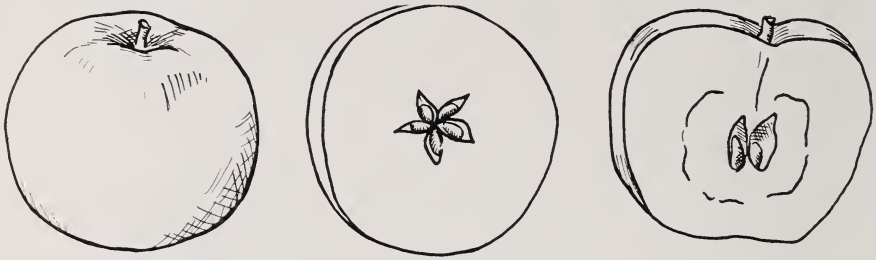
Lilium 'Black Beauty'. This specimen, which includes an entire plant, will be mounted on 3 separate herbarium sheets. The base of the stem and bulb has been split to facilitate drying.

which is pressed includes both the leaf apex and the leaf base, and the entire petiole. If possible the leaf or leaves should be arranged so that both surfaces will show (Plate XXVII).

Flowers that open for only a short time or that shed their petals readily are best put directly into a field press as they are collected, and then kept under pressure until dry.

Flowers composed of very thin tissues may become attached to the pressing paper and be almost impossible to remove when dry without breaking or tearing. Such flowers should be placed between a fold of tissue paper, or a piece of tissue paper and a piece of waxed paper or polyethylene film.

Bulky structures such as large fruits may be placed whole in a cloth bag with a numbered tag and dried entire (Fig. 2a). It is wise, however, to press a thin median cross section (Fig. 2b) and a median longitudinal section (Fig. 2c) to



a b c

FIGURE 2

demonstrate the size and shape of the structure. It is preferable, if possible, to preserve fleshy structures in liquid. Dry fruits may be stored in cardboard boxes. Special care should be taken that the specimen number always accompanies such material — and that the notes with the rest of the specimen give reference to any separate parts. Additional notes about specific groups of plants will be found in the Appendix.

In general, each collection should consist of at least two specimens — one to be kept by the collector in his own herbarium, and the other(s) to be used for exchange with other collectors or herbaria, or to send to a specialist for identification.

Collecting — How to Collect

Collecting equipment is bulky and awkward to transport. For best results, plant collecting should not be combined with other activities: psychologically, because one can do only one job well at a time; physically, because the results do not warrant the expenditure of energy if collecting is only desultory; factually because specimens snatched in passing do not have the notes on habit, habitat, location, etc. that are necessary to make this kind of specimen most useful. However, there are times when collecting must be a secondary function. When this is the case, the field press method, described below, is the best. If a field press is

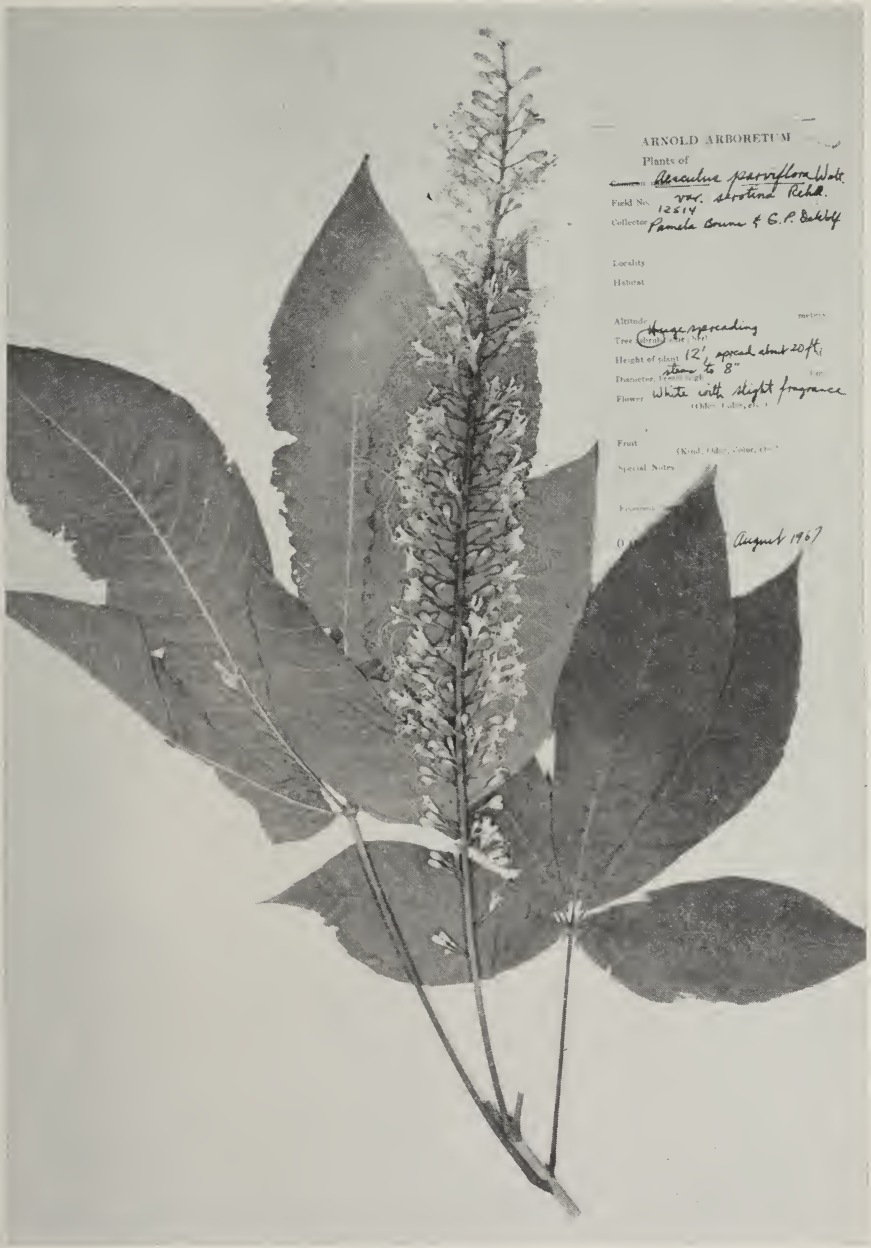


PLATE XXVII

Aesculus parviflora flowering twig, showing arrangement of leaves: one leaf turned to show upper surface, one leaf removed (note petiole base) to reduce bulk.

not available, then a book or magazine, as large as possible, printed on unglazed paper may be used. The specimens should be placed one to a page and copious notes taken, for the value of such snippets and scraps is in direct proportion to the amount of information which accompanies them.

There are, in general, two techniques of collecting — one utilizes a collecting box or vasculum, the other uses the so-called field press. A vasculum is an oblong metal box with a hinged and fastenable door occupying most of one side. It should be provided with a handle and with eyelets so that a carrying strap may be used. A vasculum about 8 x 8 x 24 in. is about the right size. Vascula sold by supply houses are generally smaller — and far too expensive. A metalsmith can easily produce an acceptable article from lightweight sheet steel or aluminum (Fig. 3).

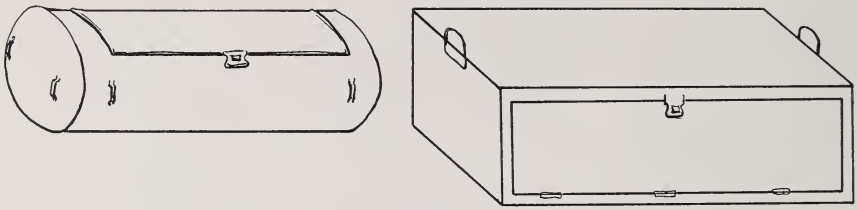


Figure 3

It may be circular, elliptical or rectangular in cross section. The vasculum should be painted white, both to reflect the heat of the sun and so keep the interior cool, and to make it more conspicuous when set down on the ground. A large heavy-weight polyethylene bag may be used as a substitute for a vasculum — and some collectors use a large canvas sack. Plant material is collected directly into the vasculum and carried back to the base of operations, where it is sorted and put into the drying press. Care must be taken to insure that the vasculum does not become too hot — or the specimens will be cooked.

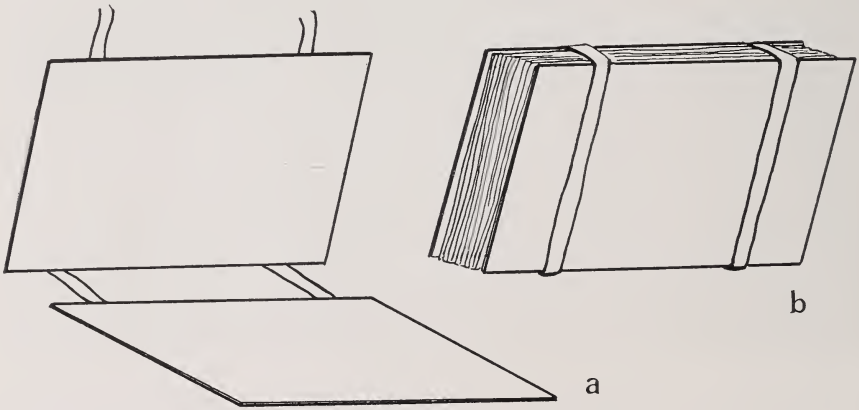


Figure 4

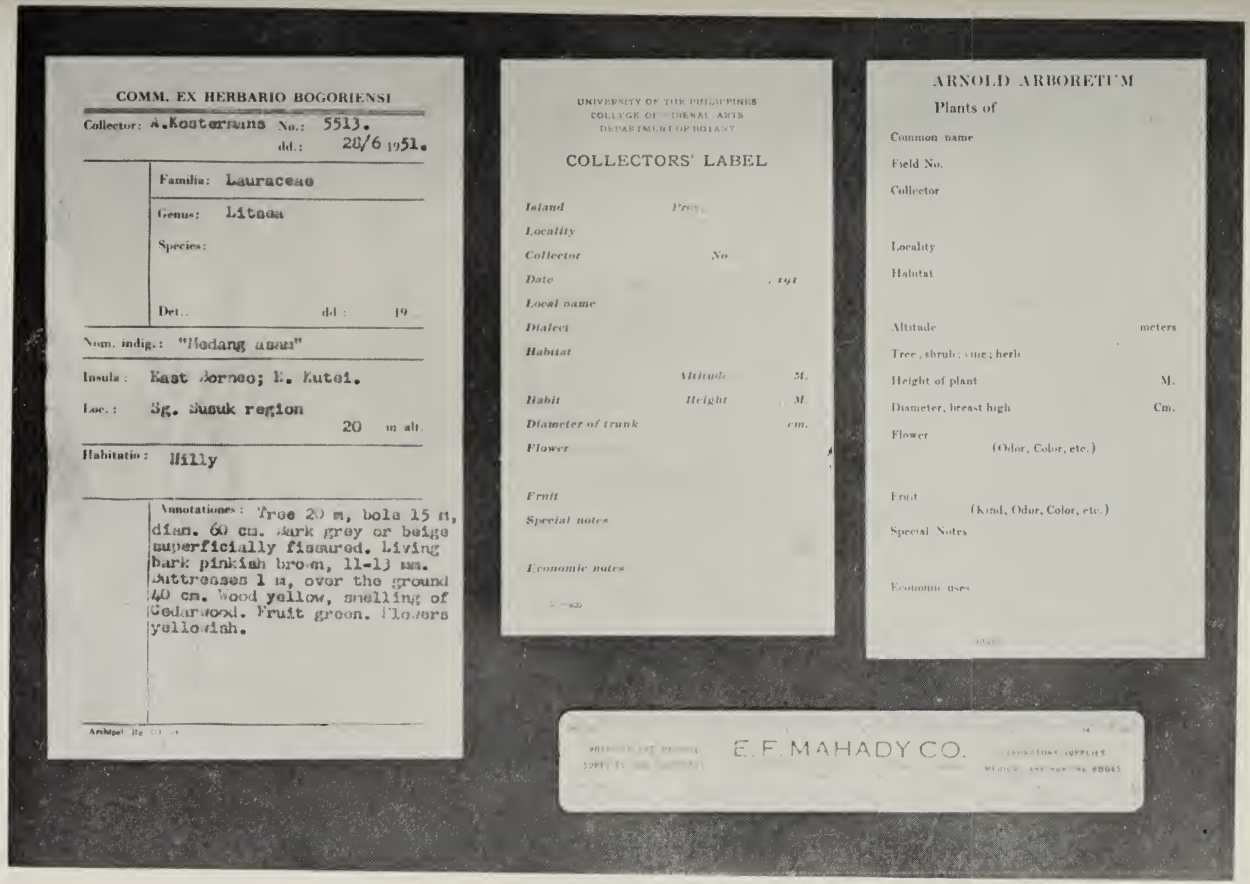


PLATE XXVIII

Field labels. From left to right: the label currently used at the Bogor (Indonesia) Botanic Garden, a label used at the University of the Philippines, the label used at the Arnold Arboretum, Jamaica Plain.

A field press consists of two lightweight press frames, hinged along one side with two short straps and at least one strap around the body of the press to keep it closed and apply some pressure to the contents (Fig. 4a). It may be carried under the arm or it may be fitted with a handle or a carrying strap so that it may be carried in the hand or slung over the shoulder. The frames may be of thin, weatherproof ¼-inch plywood, treated hardboard, or corrugated cardboard or strawboard covered with some waterproof material. The press is filled with folded unglazed paper (Fig. 4b) and the specimens are inserted directly into the folds in the field. On returning to the base, the folded papers with their enclosed plants are put directly into the drying press.

With either technique, a note-book of some sort should be carried into the field and notes taken on the spot when collections are made. It is not safe to trust to memory. Every collector should number all the collections he makes, beginning with number one for the first one. For any given collection the data in the field note-book should include at least the number of the collection, the date, the precise location — sufficiently detailed so that someone else could find the place — and any information about the plant itself that will not show in the pressed specimen. Many people find a pad of printed or mimeographed "field labels" with spaces to be filled in very useful (Plate XXVIII). These are especially advisable for the non-professional taxonomist. Particularly when using the vasculum, it is advisable to correlate notes and specimens by attaching a numbered tag-label to the specimen, the number corresponding to the number assigned in the notes.

Each collection from a particular individual or colony of individuals made at a particular time receives the same number. This number should be written in lead or wax pencil on each folded sheet that holds a specimen from that particular individual or colony. Each collector should maintain a single series of collection numbers throughout his lifetime. Such numbers serve to correlate duplicates of the collections that may be filed in different herbaria. Whatever the identification of the individual collection may be and whatever changes may be made from time to time in that identification, the collector's name and number serve to identify the particular collection for all time.

Drying Specimens

The plant specimen is placed in the fold of a sheet of unglazed paper about 24 x 18 in. which has been folded to give a sheet of 12 x 18 in. This may be newspaper, or it may be unprinted stock specially purchased for the purpose. This folded paper with the included plant specimen is placed between two sheets of blotting paper or other thick absorbent paper — several sheets of newspaper will do (Fig. 5). In American practice, the "sandwich" of collecting paper and blotters is then placed between two 12 x 18 in. sheets of corrugated cardboard or corrugated aluminum (often called ventilators) in which the corrugations run the short direction. All these sheets are placed between two wooden frames and pressed tightly together by two straps. The filled frames are then placed over a gentle source of heat in such a way that the warm, dry air passes through the ventilators (Fig. 6). During drying, the water in the specimen passes by diffusion into the dry paper, then the blotting paper, then to the dry air passing through the

corrugations and is carried off. The specimen decreases in volume as it dries, and it will shrivel unless the press is regularly tightened during drying. If constant pressure is maintained, the decrease in thickness in the specimen will be accompanied by a similar, regular decrease in length and breadth, resulting in a flat, relatively undistorted mummy of the original. Of course, the sandwiches of specimens, papers and corrugated ventilators may be piled together within one set of press frames to any practical size. In general, however, 25–30 individual specimens with blotters and ventilators make a bundle of sufficient size.

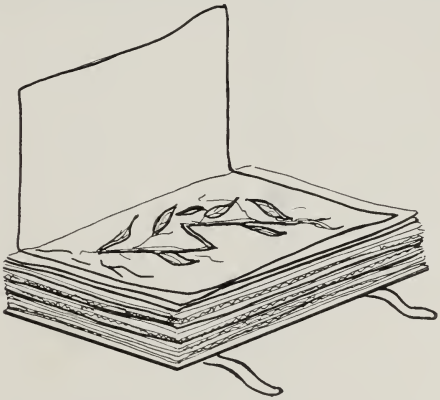


Figure 5

In British and older American practice, ventilation is not used but the wet absorbent papers are regularly changed for dry ones until the specimens are dry. This is a laborious and time-consuming technique and does not seem to yield results superior to the previous method.

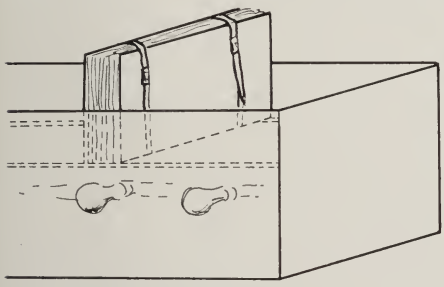


Figure 6

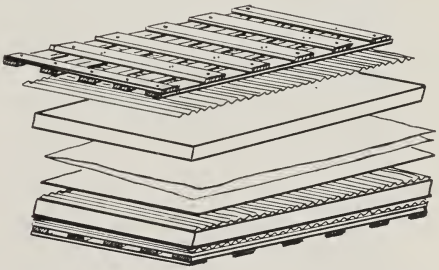


Figure 7

For bulky material, a sheet of polyurethane foam (available in thickness between ⅝ in. and 1 in.) may be substituted for one of the blotters. This will fit itself to the specimen and help to prevent shrivelling of parts due to inadequate or unequally distributed pressure (Fig. 7).

The source of heat and the method of holding the press over it vary considerably. In the most elaborate modern installations a closed cupboard or case is fitted

with a heat source at the bottom (an electric heating unit or steam pipes), shelves of expanded metal mesh are arranged about 24 in. apart, and an exhaust fan is fitted at the top. The presses are placed on the shelves, with the corrugations running vertically.

A simple home installation consists of a wooden box without top or bottom and with the two long sides 18 in. apart in outside measurement (Fig. 8). The inside of the box may be painted with aluminum paint. The box is raised from the floor about 1½ in. to allow for ventilation and some heat source such as a series of incandescent lightbulbs or a small electric heater (preferably with a fan), is set in-

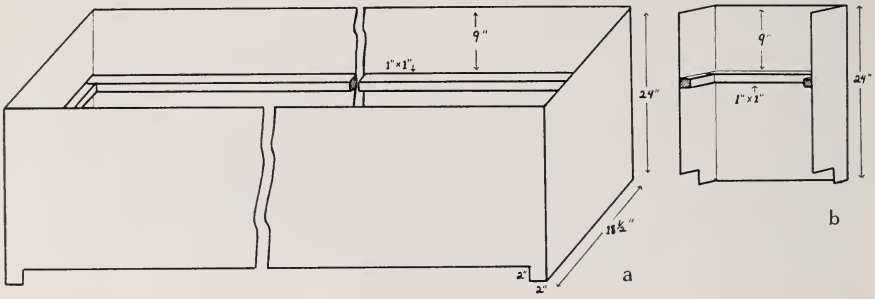


FIGURE 8

side. The presses are set on edge on top of the box with the corrugations running vertically. Such a box and heat source can be constructed so as to be portable. It is not recommended that the heat source be a naked flame.

Mounting Specimens

Two considerations govern the storage of botanical specimens once they are dried. The first is their usefulness as objects of record or study. The second is their preservation for the future. To an extent these two functions are incompatible so the storage methods adopted must involve a compromise between them.

For maximum ease of study, the dried specimen lying loose in the paper in which it was pressed and dried is best. But dried specimens are extremely brittle and when they are kept loose in the folded pressing papers they are easily damaged by handling. Also, the flimsiness and fragility of the individual sheets of paper make the specimens awkward to consult.

The object of "mounting" botanical specimens is to give them a firm physical support that will allow a reasonable amount of handling with a minimum of damage. The kind of paper on which specimens are mounted and the methods used to attach them to the paper are governed by cost, effectiveness, and personal prejudice.

Mounting Paper

Paper used for mounting specimens should be of 100% rag content. So far as a botanist is concerned, an herbarium specimen is a piece of scientific information

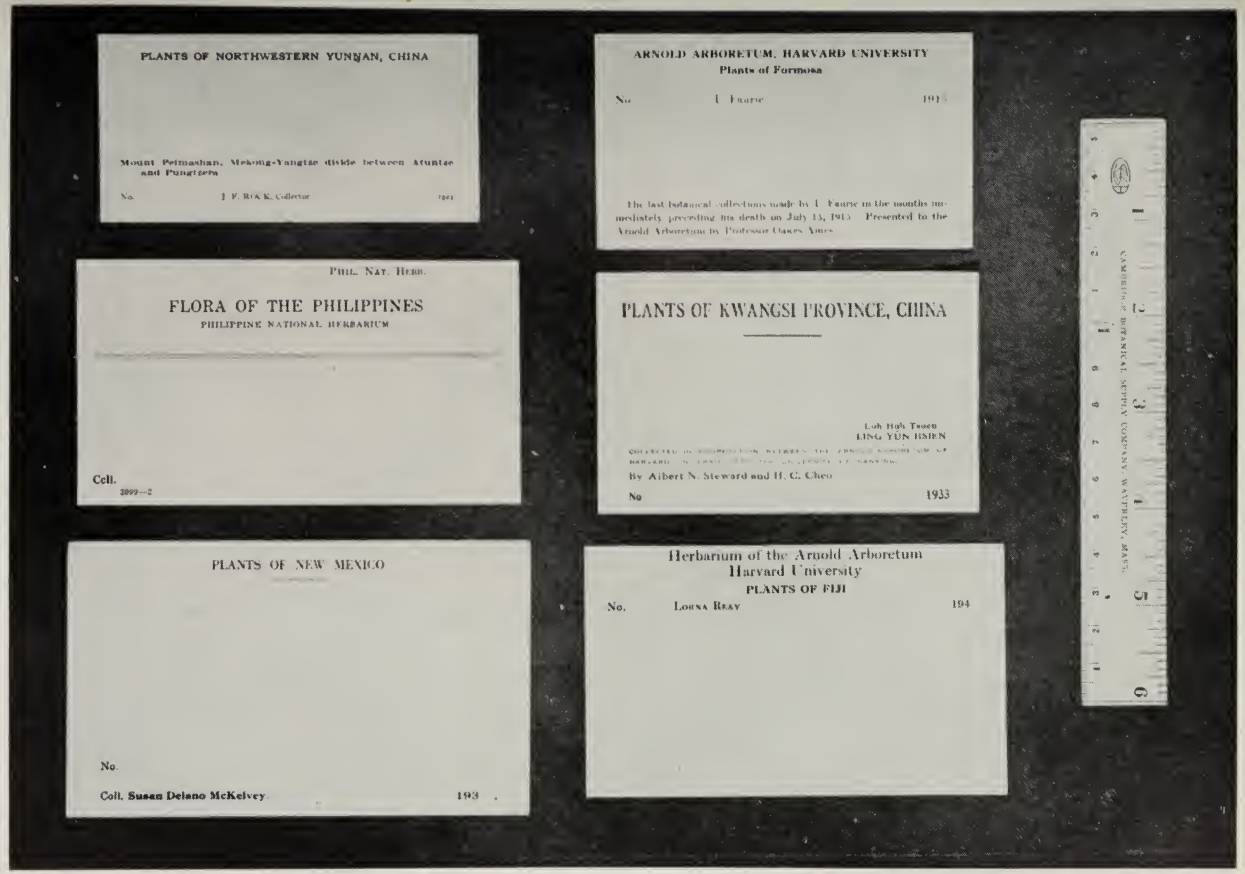


PLATE XXIX

Herbarium labels, of the sizes usually used in the United States at the present time.

to be preserved for all time. Papers made from wood pulp or mixtures of wood pulp and rags tend to deteriorate, yellow, soften, and tear — sometimes within a matter of a few months.

The thickness or weight of the paper to be used depends upon the amount of use the specimens will have, the amount of space available and money available. Where money or space is a prime consideration, the lightest paper that can be used safely is so-called 36 pound stock. Paper of this weight is not very stiff. Consequently the specimens must be glued or fastened over their entire area in order to reinforce the paper. So-called 56 pound stock is a heavier, stiffer paper which should be used wherever the specimens are likely to get much use. Because it is stiffer, the specimens are better protected — and need not be so tightly and completely fastened to the paper.

The size of the paper on which the specimens are mounted varies considerably. In the United States and in most herbaria in the Western Hemisphere, the standard size is 16½ x 11½ in. Linnaeus mounted his specimens on sheets of paper about 12½ x 8 in. The sheets in the herbarium of the British Museum (Natural History) are about 17½ x 11½ in. At the Royal Botanic Gardens, Kew, the sheets are about 16½ x 10½ in. Some continental European herbaria use the size 17 x 11½ in., others use sheets 19½ x 13¾ in. Leningrad uses 15¾ x 11 11/16 in. (74) and Copenhagen uses 15¼ x 8 11/16 in. While the size of the sheet is obviously not important *per se* except that the larger sheets allow larger and more complete specimens), all commercially available herbarium paper in the United States is pre-cut to the standard size of 16½ x 11½ in. Also, commercially available cabinets and boxes are made to hold this size paper. Thus, economics dictate the size of the paper on which the specimens are mounted and, indirectly, the size of the specimens collected.

Mounting Labels

Almost every botanist has very strong if not violent opinions about the size, shape and typography of herbarium labels. Actually the form of the label is not important — the thing that is important is that the label should be so designed and of such a size that all the information from the field label can be transcribed onto it.

Traditionally, collectors have supplied little information beyond laconic notes on date and locality with their specimens. This could be readily transcribed on relatively small labels, for many years labels as small as 2 x 4 in. were used. Even today, labels larger than 3½ x 4½ in. are not common (Plate XXIX). Over the past 75 years we have come to realize that we need to know much more about our plants. In most areas it seems to have been the foresters who have led the way in designing field labels that provide space for abundant information. Herbarium botanists have tended to be conservative in this matter, and to reject large labels and field labels as aesthetically or professionally offensive.

Gradually tradition is changing — and petite labels are now being abandoned for practical labels. Perhaps the best solution is the one used at Brussels where a field-type label, 4⅜ x 6¾ in., is printed on good quality paper and used as the herbarium label.

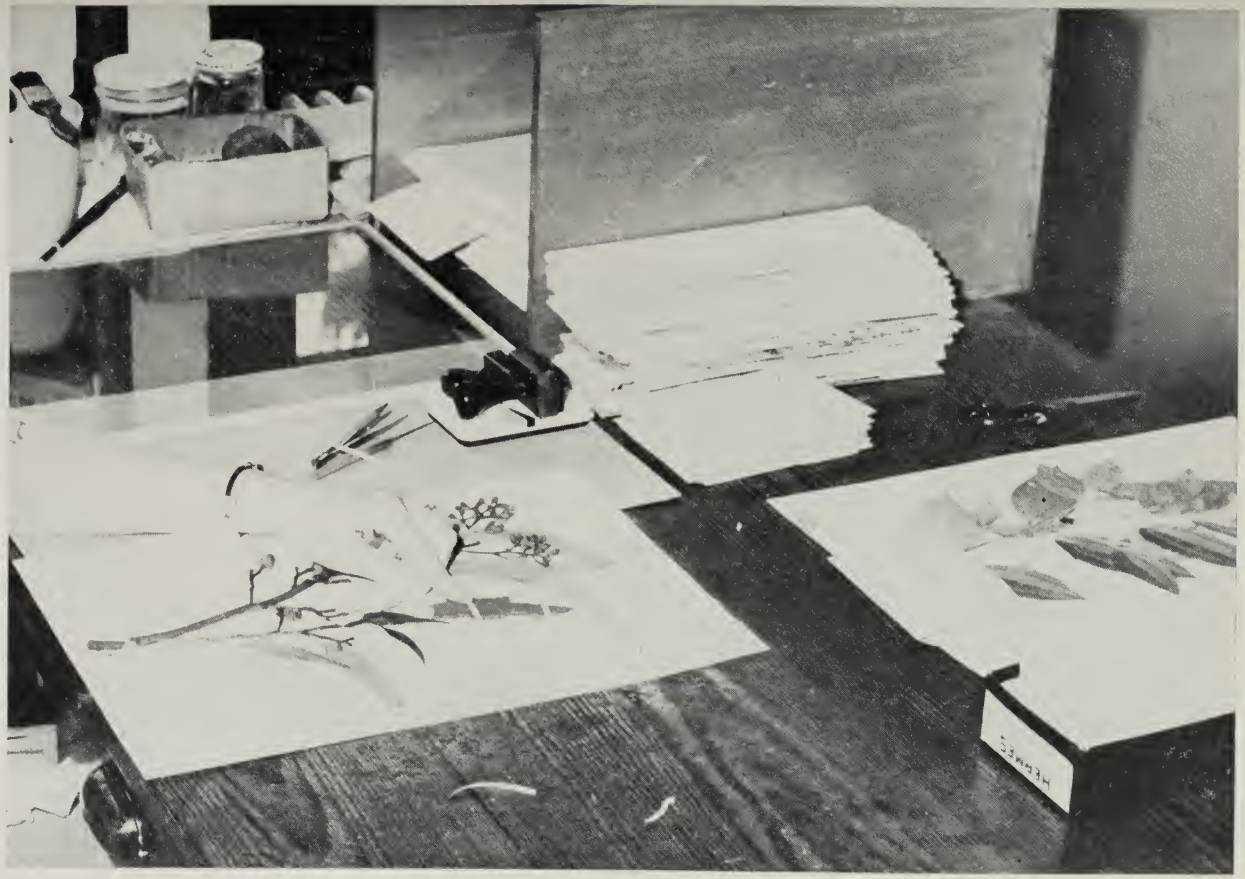


PLATE XXX

Mounting botanical specimens. Attaching the specimen with linen strips.

Laying-Out

Before mounting commences, the dried specimen and its label should be laid on the mounting paper. The label should be placed in the lower right-hand corner where it will be attached (it may be glued to the sheet at this stage). The specimen is moved about until one finds the position where it is best displayed. It is in this position that it should be attached. Specimens should be so arranged that bulky portions do not all come at one general position on the sheets. This allows the sheets to lie more evenly in the cabinet. Detached pieces of the specimen: leaves, flowers, seeds, small fruits, etc., should be placed in small envelopes (such as coin envelopes) or folded paper packets (Fig. 9), which are then pasted to the sheet.

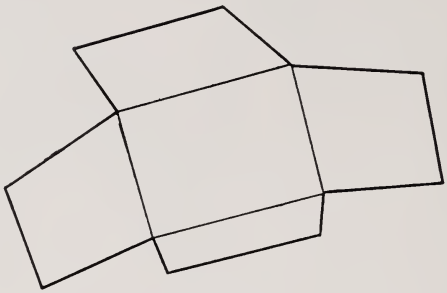


FIGURE 9

It is practical to lay out several specimens at one time so that several mountings may proceed more rapidly. Great care should be taken at this stage (and all others) that specimens and labels are not inadvertently mixed.

Experience, a severe teacher, has taught us that it is not wise to mount more than one collection on a single sheet of paper. Each collection is basically a single piece of information. As such, it stands by itself. Addition of a second collection to the same sheet can lead to confusion. In the first place, the second collection may not represent the same taxon as the first. Even experienced taxonomists have made this kind of mistake! Secondly, with a minimum of two specimens and two labels there is the possibility of confusion as to which label represents which collection.

This is not a theoretical problem but one which arises again and again when dealing with old herbaria in which this practice was followed.

Attaching Specimens to Mounting Paper

1. **Sewing or taping.** Specimens may be attached to the herbarium sheets by passing a heavy cotton or linen thread, about the weight of "carpet thread" around the stems and through the paper. The ends of the thread are tied on the reverse side of the sheet and a sheet of paper or cloth tape is pasted over the knot and loose ends.

   Alternately, or additionally, narrow ⅛–¼ in. wide strips of gummed white cloth tape may be pasted across the surface of the specimen to hold it in

PLATE XXXI

Materials for mounting botanical specimens. (Top) Container for glue with paint-brush for applying it to the glass plate. (Bottom, left to right) Glass plate coated with glue, small paint-brush for "touching up" the glue on the specimens, scissors, scalpel, needle, tweezers, gun-type oil can for dispensing plastic glue, paper packet for loose pieces of specimen, pruning shears for trimming woody specimens, and wooden blocks (See Plate XXXIII).

place (Plate XXX). "Scotch" tape or similar materials should not be used as they deteriorate quickly and are difficult and messy to remove from the specimen when (as inevitably happens with these materials) it must be remounted.

2. **Gluing with a glass plate.** (Plates XXXI, XXXII). In this technique, a glass plate (which may be a sheet of double-strength window glass cut to the size of the herbarium sheet) is covered with a thin layer of glue. The glue should be applied to the plate with a paint brush (Plate XXXI). Linnaeus used "Fish Glue" to fasten his specimens to the paper. This glue (a by-product of the fish-packing industry) is liquid at ordinary temperatures, and was used extensively until the 2nd World War (LePage's Liquid Glue). More recently synthetic, water-soluble, white glue (such as "Elmer's Glue-all") has been used.

   After the surface of the plate has been covered with glue, the specimen is laid on the glued surface, right side up (Plate XXXII, top). It is immediately removed (gently) and laid on the mounting sheet, glued side to the paper. The label is treated in the same way and placed in the lower, right-hand corner of the paper. The specimen is then covered with a piece of waxed paper, over which is placed a blotter, and the whole is placed under a weighted board the size of the herbarium paper (Plate XXXII, bottom). Some institutions use a bag of dry sand as a weight. Several specimens, each with its waxed paper and blotter, may be piled one on top of another. The mounted specimens are left overnight to dry.

3. **Mounting with plastic glue.** This method is either used alone or in conjunction with the glass plate method. In recent years a plastic glue of a special formula has been used increasingly (12, 160). It may be obtained commercially from Carolina Biological Supply Company (See Appendix).

   The plastic glue is dispensed from some sort of a small container — usually a plastic dispenser such as is used for catsup or mustard in restaurants. "Gun" type oil cans may be used — but great care must be taken that the glue does not harden in the spout (Plate XXXIII, top).

   The specimen is laid out on a paper and thin strips of plastic cement are applied over the stems and leaves (Plate XXXIII, top). Metal washers or heavy nails may be used to weight down portions of the specimen that do not lie flat on the paper (Plate XXXIII, bottom). When the glue has hardened one has a plastic strip holding the specimen to the sheet in the same way that a cloth tape would. Both ends of the strip must be in contact with the paper. After plastic glue has been applied, it must be allowed to harden in the air for 3 to 4 hours or overnight. To save space, the mounted specimens can be laid on sheets of cardboard (cardboard ventilators are excellent) and stacked, using small pieces of wood at each corner for spacers (Plate XXXIII, bottom).

   The plastic cement technique has the great advantage that the whole specimen is not attached to the paper over its entire surface. Therefore, flowers or leaves can be detached easily for study. The stiffest, heavyweight

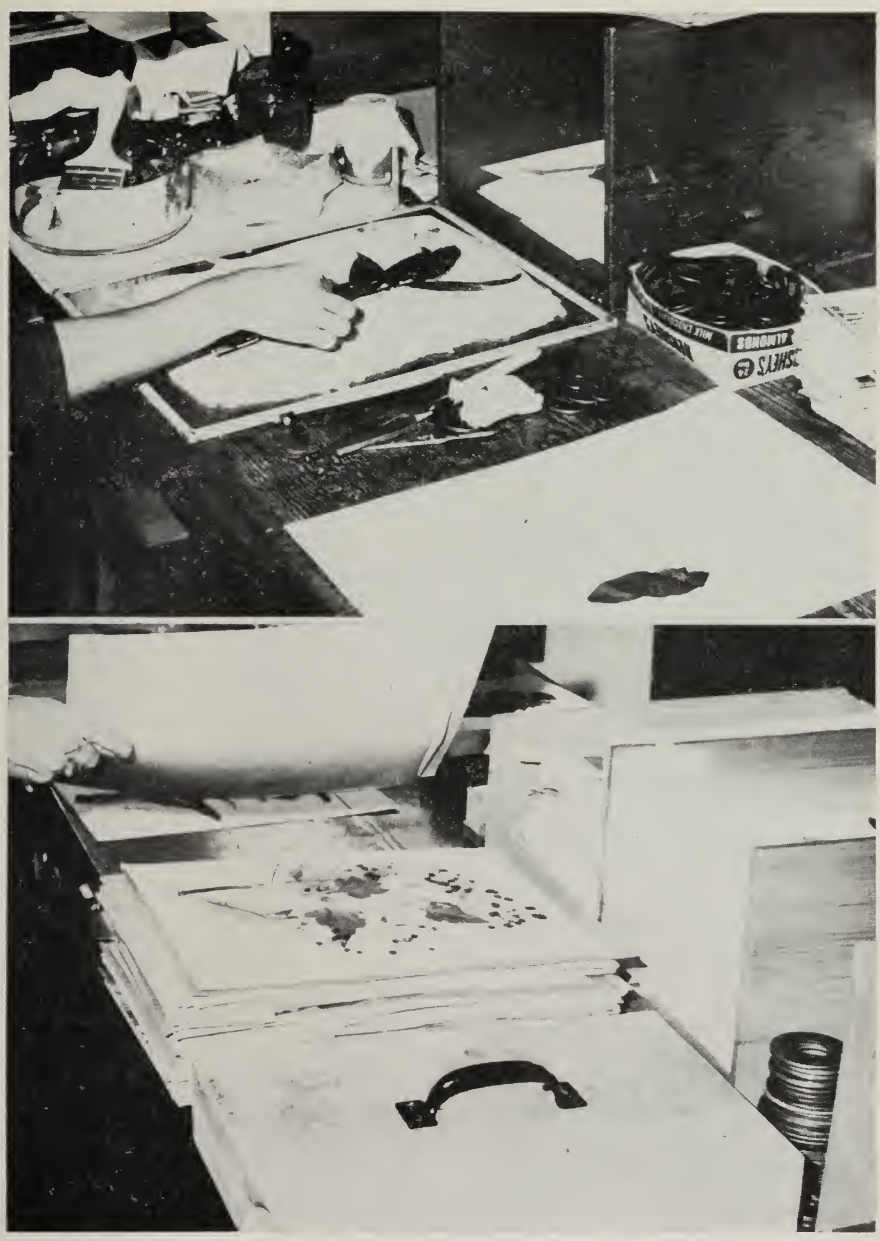


PLATE XXXII

Mounting botanical specimens with a glass plate. (Top) Placing the specimen on the glue-covered plate. (Bottom) The glued specimen on mounting paper, about to be placed under pressure while drying.

paper (56 pounds) should be used for this technique. In addition to making the specimen more readily available for study, this technique allows for very rapid mounting. In many cases, as many specimens can be mounted in an hour as can be done in a day by the other techniques.

Preservation of Specimens

Dried specimens are quite attractive to larvae of various beetles. In many herbaria specimens are kept in airtight steel cases. The specimens are fumigated before they are put in the cases and a little paradichlorobenzene (moth repellent) is kept in each case as a repellent. In the home, the specimens may be kept in a tight cardboard or wooden box, and a stick or ring of paradichlorobenzene, such as is sold to repel moths in closets, placed in the box.

It has been found that when the temperature of the air-hardened plastic glue rises above 90°F., the fumes of paradichlorobenzene will cause the plastic to soften and become viscid. The change is reversible and the glue solidifies again as the temperature of the glue goes below 90°F. This would indicate that mounted specimens ought not to be stored in boxes or closed containers that are exposed to the summer sun — nor stored in an attic or other area subject to excessively high temperatures. Under normal temperature conditions tolerable to human beings this problem should not arise.

Until fairly recently it was standard practice in many herbaria to "poison" all specimens by dipping them before mounting in a 2% solution of mercuric chloride (corrosive sublimate) in 95% ethyl alcohol. *This solution is intensely poisonous and is not recommended.*

If an insect infestation is found in the specimens, the specimens should be placed in an airtight box or large polyethylene bag heavily dusted with paradichlorobenzene crystals, and left for about two weeks.

Arrangement of Herbaria

After the plants have been mounted on herbarium sheets, some arrangement must be devised so that an individual sheet and the information that it provides can be easily located again. The standard practice, which works very well, is to place all of the specimens of one particular kind of plant, species or variety, in a folder of good quality, lightwight paper. The fold is placed on the left-hand side and the name of the species, and variety if applicable, is written in the lower right-hand corner. All species of one genus of plants are placed in a folder of heavy manila paper. The fold is again placed on the left-hand side and the name of the genus is written in the lower left-hand corner. All of the genus folders belonging to one plant family are kept together. For example, the genus *Rhododendron* consists of a large number of species: *Rhododendron maximum*, *Rhododendron catawbiense*, *Rhododendron calendulaceum* (frequently called *Azalea calendulacea*), etc., and a large number of cultivated varieties (cultivars) such as 'Old Port,' 'Cunningham's White', etc. All of these forms can conveniently be filed in one alphabetical sequence within the genus folder. *Rhododendron* is a

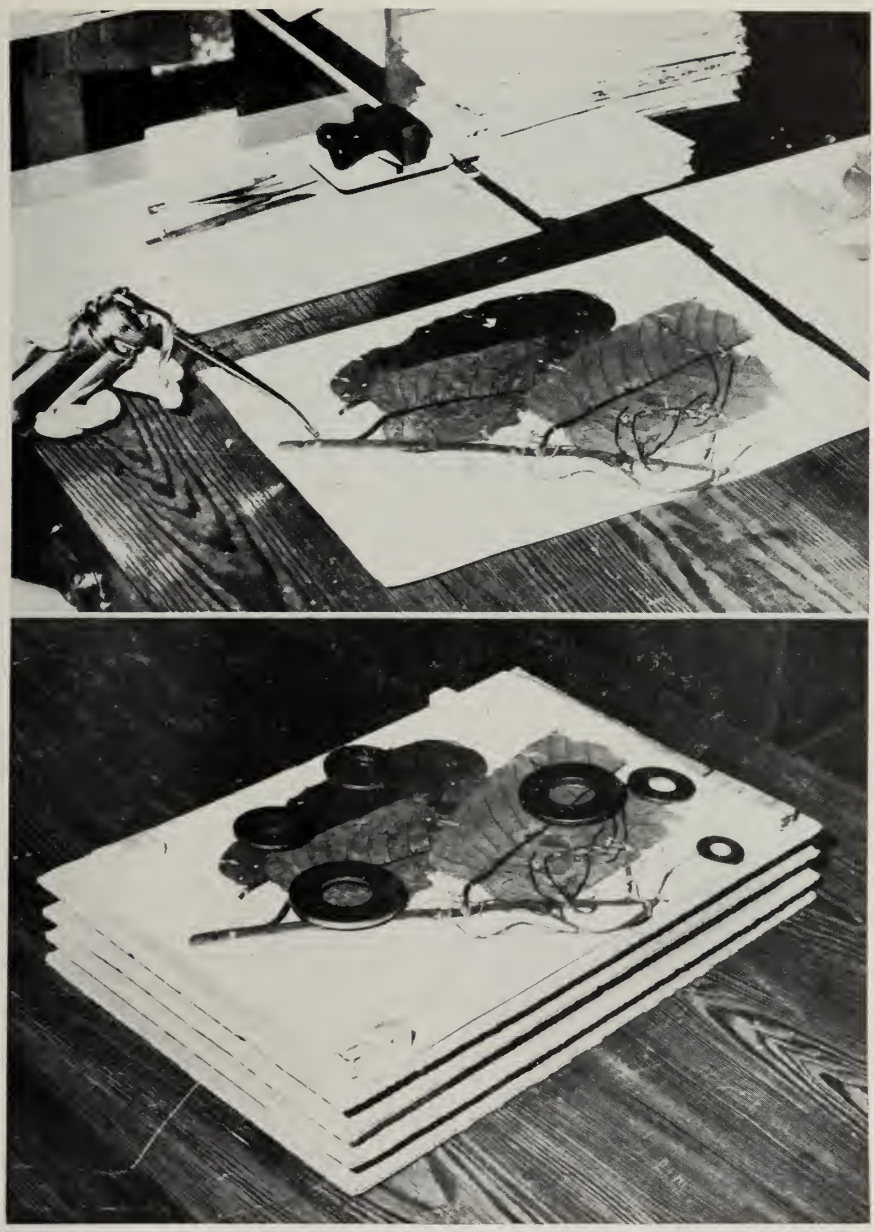


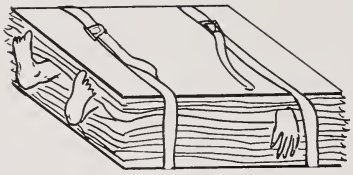
PLATE XXXIII

Mounting botanical specimens with plastic glue. (Top) The glue being applied with a gun-type oil can. (Bottom) The specimen weighted down to the mounting paper while the glue dries. Note the wooden blocks at each corner (see text for explanation).

member of a family of plants, the **Ericaceae,** which includes the blueberries (*Vaccinium*) the heaths (*Erica* and *Calluna*), and many more. The folders containing these genera also can be conveniently filed alphabetically. Finally, the various plant families can be arranged alphabetically. This alphabetical arrangement is not the method used in the great herbaria, in which the plant families are generally arranged according to some system of presumed relationship of the plants, but it is a convenient arrangement.

Storage Containers

A small number of specimens can be stored in portfolios or in cardboard boxes of appropriate size. However, when more than a few hundred specimens are involved, one should consider the purchase of a proper herbarium case. These are made of wood, composition board, or sheet metal. They contain a series of compartments, about 5¾ in. high x 12¼ in. wide x 16¾ in. deep, into which the genus folders are inserted, and the whole case is closed by an airtight door (Plate XXIV). They have the advantages that they are compact and protect the specimens from dust and dirt and insect infestation.



APPENDIX

The following notes on methods for collecting and pressing special groups of plants have been assembled from a number of sources. The list is particularly indebted to lists published by van Steenis (183) and by Fogg (67). Notes included in the manual by Fosberg and Sachet (73) have also been consulted.

Suggestions for Collecting Particular Kinds of Plants

As mentioned earlier, an herbarium specimen should attempt to record, as closely as possible, the exact appearance of the entire plant. On the field label or in the field notes should be noted anything that will not show in the dried specimen, i.e. flower color or fragrance, color of leaves, the presence of a waxy "bloom" on the surface of fruits, etc. In the case of any plant that cannot be preserved entire, a sketch or photograph which will show the branching pattern is very useful.

It is recognized that it is not always possible to obtain a specimen with flowers or fruits particularly when dealing with horticultural material for which identification is needed. In this case, it is very important to supply with the specimen as much additional information as is possible. This should include: 1) the place from which the plant was obtained, 2) the place where the plant is growing, 3) the use to which the plant is being put (hedge, shrubbery, specimen tree, herbaceous border, summer bedding, house plant) 4) what the plant is supposed to do or what the flowers or other ornamental parts are supposed to be like, 5) if possible, a photograph of the plant. Even with all of this it is not always possible to identify the plant but the chances are that some part of the information or the specimen will allow a fairly confident identification to be made.

In general, except for special purposes, as indicated above, a *specimen without flowers or fruit is difficult, if not impossible, to identify.* The following list, compiled from several sources, indicates items to be kept in mind when collecting various kinds of plants. In all cases, it is assumed that the basic specimen will be one that is in flower or fruit.

Acanthaceae — Flowers often detach easily after collecting. Fruits are important.

Agrimonia — Underground parts are useful.

Allium — Underground parts essential, especially the bulb coats. Note if the leaves are flat or rounded.

Amaranthaceae — Ripe fruits are almost essential.

Amaryllidaceae — Do not forget underground parts.

Amelanchier — Flowers and fruits (and leaves) from the same plant. Note habit (erect or stoloniferous).

Annonaceae — Fruiting material alone is of little value. Flowers may open precociously and then grow considerably before and during anthesis.

Araceae — Fruiting material alone of little value. Flowers, inflorescences, and underground parts of great value. Cf. Nicolson, D.N. in Fosberg and Sachet (73).

Araliaceae — Both flowers and fruits should be collected.

Asclepiadaceae — Fruit should be collected to supplement the flowers, but fruit alone is not of much use.

Balanophoraceae — Sometimes dioecious. Tuber surface is important.

Balsaminaceae — Fruit is desirable. Flowers are very fragile and have a tendency to agglutinate on drying under pressure. Preservation of flowers and fruits in liquid is desirable. Notes on flower color and markings very valuable.

Bamboos — Flowers and fruits seldom found but very much desired. Should be accompanied by a complete internode at medium height of culm, including a complete culm sheath (with tip). Cf. McClure, F. A. in Fosberg and Sachet (73).

Begoniaceae — Ripe fruit desirable. Male and female flowers essential.

Betula — Fruiting catkins essential. Bark collection or notes on bark desirable.

Burseraceae — Fruit important.

Cactaceae — Photographs almost essential. Some flowers should be detached, split, and dried separately. Stems may be split, the "flesh" scooped out, and the outer "rind" dried. Cross section of the stem to show arrangement of ribs. Handle with heavy leather gloves and use extreme care. Stems may be dipped into boiling water to kill the tissues and to remove the waxy coating which will allow more rapid drying.

Campanulaceae — Shape of the corolla is essential — corolla may be split and spread out, or a sketch made on the field label, or both.

Capparidaceae — Fruiting material is of limited usefulness. Flowers may open precociously and then grow considerably before and during anthesis.

Caprifoliaceae — Ripe fruit desirable.

Casuarinaceae — Dioecious or monoecious. Male and female flowers and ripe fruit desirable.

Celtis — Color and shape of ripe fruit desirable.

Coccoloba — Leaves from adventitious shoots and leaves from mature twigs; male and female inflorescences and fruits all desirable for accurate identification.

Commelinaceae — Color of petals and anthers should be noted. Flowers may be pressed by placing them between a sheet of waxed paper and a sheet of tissue paper. Alternatively flowers should be preserved in liquid.

Compositae — Flowering heads should be pressed so that some show the upper, others the lower surface of the head. Note the color of the rays and the disk florets. Ripe fruits, basal leaves when produced, median cauline leaves, and underground parts are all highly desirable.

Convolvulaceae — Some flowers should be split open and dried flat. Ripe fruit desirable.

Cornus — Note color of branchlets and mature fruit. Note color of pith of branchlets.

Crataegus — Flowers and fruit from the same tree. Note color of anthers.

Cruciferae — Ripe fruit desirable.

Cucurbitaceae — Dioecious or monoecious. Flowers of both sexes and ripe fruit desirable.

Cyperaceae — Ripe fruit and underground parts desirable. Very young inflorescences alone of little value.

Dahlia — Median leaves, branches from flowering portions, and notes on ray color needed.

Dilleniaceae — Ripe fruits desirable.

Dioscoreaceae — Male and female inflorescences, also axillary bulbils. Underground parts and base of aerial stem. Mature fruits if possible. Notes on direction of twining of stems, i.e. clockwise or counterclockwise.

Dipterocarpaceae — Ripe fruits desirable.

Ebenaceae — Dioecious. Male and female flowers desired — also ripe fruits with calyx attached.

Elaeocarpaceae — Ripe fruits desirable.

Epacridaceae — Ripe fruits desirable.

Ericaceae — Useless without flowers — but ripe fruits desirable in addition. Check for waxy "bloom" on fleshy fruits.

Euphorbiaceae — Dioecious or monoecious — male and female flowers needed. Ripe fruits also desirable. Sap may cause severe dermatitis.

Fagaceae — Male and female flowers — and ripe fruits.

Ferns — see Pteridophyta

Fraxinus — May be dioecious. Both male and female flowers desirable — ripe fruit nearly essential.

Gesneriaceae — Fruits desirable in addition to flowers.

Gnetaceae — Dioecious or monoecious. Male and female flowers and ripe fruit desired.

Gramineae — Underground parts and stolons. Inflorescences should not be too young. Stalks should be pressed to show leaf sheaths and ligules.

Iridaceae — Press flowers between a sheet of waxed paper and a sheet of tissue paper. Fruits are almost essential.

Labiatae — If large enough, some flowers should be split open and pressed flat. Base of aerial stem and underground parts essential. Mature nutlets desirable.

Leguminosae — Flowers and fruits essential.

Liliaceae — Underground parts most desirable. Fruits alone useless.

Loranthaceae — Fruits alone useless. Note host plant.

Malvaceae — Flowers and fruits desirable.

Melastomataceae — Flowers and fruits desired. Petals may drop very quickly.

Menispermaceae — Dioecious. Male and female flowers if possible. Fruiting materials desirable.

Moraceae — Frequently dioecious. Fruits desirable.

Musaceae — Collect axis of inflorescence. Ripe fruits desirable. Photograph of whole plant desirable.

Myristicaceae — Dioecious. Ripe fruits desirable.

Myrtaceae — Fruits very much desired.

Nepenthaceae — Flowers not very important. Pitchers at base of aerial stem not essential — pitchers of full grown cauline leaves essential.

Nymphaeaceae — Ripe fruit desired. Note if leaves are floating on surface of the water or erect.

Orchidaceae — Note color of flowers and markings. Preserve flowers in liquid if possible. Fruits useless by themselves.

Orobanchaceae — Ripe fruits desirable. Note host plant if possible.

Palmae — cf. Bailey, L. H. — The Palm Herbarium . . . Gentes Herbarum 7(2): 151–180, 1946. Tomlinson, P. B. in Fosberg and Sachet (73).

Pandanaceae — Dioecious. Male plants rare. Ripe fruit more desirable than flowers. Stem diameter and leaf tips important. Habit sketch or photograph most desirable.

Piperaceae — Fruit.

Polemoniaceae — Some flowers should be split and pressed flat. Underground parts most desirable.

Polygonaceae — Fruits essential.

Pteridophyta — Spore-bearing fronds should be collected attached to the rootstalk. Sterile fronds may be different from fertile fronds — both should be collected. Scales and hairs on the fronds and on the rhizome or rootstalk are important. Tree ferns — entire petiole should be collected, also a section of the stem showing the leaf scars or leaf bases.

Quercus — Leaves and mature fruits desirable. Flowering material of little value.

Ranunculaceae — Collect underground parts. Fruits very important.

Ribes — Note color of mature fruit.

Rosaceae — Fruits needed.

Rosa — Note habit of plant. Sterile twigs from vigorous new shoots should be collected along with the flowering shoots — the leaves are likely to be different.

Rubiaceae — Fruits very much to be desired.

Rubus — Note habit — canes arching or not, rooting at the tip or not. Collect sections of vegetative shoots as well as flowering shoots, to show differences in leaves.

Salix — Dioecious. Mature male and female catkins and leafy material collected from the same plants essential.

Sapindaceae — Fruits desirable.

Sapotaceae — Fruits desirable.

Schrophulariceae — Some flowers should be split and pressed flat. Note corolla color and markings. Note appendages (if present) on petals. Flowers of some genera drop very quickly. Many forms blacken on drying.

Smilax — If specimen is from a lateral axis, note if main axis is smooth or prickly, particularly at the base. Note fruit color.

Solanaceae — Some flowers should be split and pressed flat. Fruits are desirable.

Styracaceae — Fruits are desirable.

Sympetalae — Collect extra flowers of tubular-flowered forms. Some should be split open and pressed flat to show attachment of stamens and styles, glands, nectaries, etc. (Plate XXXIV).

Symplocaceae — Ripe fruits desired. Note color.

Umbelliferae — Ripe fruits essential. Basal leaves and underground parts very desirable.

Vaccinium — Flowers and fruit essential. Note if fruit is glaucous. Note habit of plant.

Viburnum — Ripe fruit desirable.

Zingiberaceae — Underground parts most desirable. Inflorescences should be in liquid.

Preserving Succulent or Fleshy Plants

Many woody plants growing in dry regions by the sea, or in the tropics, have rather stiff, thick leaves, which dry very slowly in the press. In many cases the slowness in drying is caused by a thick waxy coating on the surfaces of the leaf. Immersing such specimens in boiling water for about 30 seconds or until the leaves become limp will materially increase the speed of drying. Notes should be made on the original appearance of the plant.

Plants with thick, succulent stems, such as cacti and the succulent Euphorbias, may require more drastic treatment. The stems can be cut lengthwise and any soft material scraped out. Here again, immersion in boiling water will likely help.

When handling cacti it is advisable to wear heavy leather gloves. If worse comes to worst, spines can be removed from the fingers by pulling carefully with a pair of tweezers. Care should be taken that the tip is not broken off in the flesh. The tiny, hairlike spines of cacti (glochids) can be removed by running one's fingers through one's hair. This seems rather improbable, but it works!

Care must be taken when handling members of the Euphorbiaceae. The juice of many is extremely caustic. It may cause a severe dermatitis on the skin, or blindness if it gets into the eyes.

Filmy water-plants should be floated out in a pan of water. A sheet of good paper, such as writing paper, can be slid into the water under them and then raised, lifting the plant out on the paper. This should be covered with a sheet of waxed paper and put in the press.

Miscellaneous Notes

Preserving Fluid

The standard botanical preserving fluid is Formol-Acetic-Alcohol (FAA), made by mixing:

Commercial Formalin	5 parts
Glacial (Pure) Acetic Acid	5 parts
50% Alcohol	90 parts

For field work, 70% alcohol alone will do. This may be denatured ethyl alcohol or rubbing alcohol (iso-propyl alcohol) such as can be readily obtained in drug-stores or supermarkets. Great care should be taken to make sure that the covers of all containers holding preserving fluid are tight.

Sources of Supplies

Cambosco Scientific Co., Inc 37 Antwerp Street Brighton Station Boston, Mass. 02135	Plant presses Ventilators (cardboard) Botanical driers (blotters) Mounting supplies
Carolina Biological Supply Co. Elon College, North Carolina and Powell Laboratories Division Gladstone, Oregon	Plant presses Ventilators (cardboard) Botanical driers (blotters) Mounting supplies
General Biological Supply House, Inc. 8200 South Hoyne Avenue Chicago, Ill. 60620	Plant presses Ventilators (aluminum & cardboard) Botanical driers (blotters) Herbarium storage boxes
Ward's Natural Science Estab. Inc. P. O. Box 1712 Rochester, N. Y. 14603 and Ward's of California P. O. Box 1749 Monterey, Cal. 93942	Plant presses Ventilators (cardboard) Botanical driers (blotters) Mounting supplies Herbarium cabinet
Bio Metal Associates P. O. Box 61 Santa Monica California 90406	Plant presses Ventilators (cardboard & plastic) Botanical driers (blotters) Mounting supplies Herbarium cabinet

PLATE XXXIV

Solandra hartwegii, flower slit and spread out to show stamens. Note also the bud, showing aestivation of the corolla, and the detached calyx showing lobing.

BIBLIOGRAPHY

There is no pretense that the list of titles below constitutes anything like a complete bibliography of the published articles that deal with the art of collecting and mounting plants for study. It consists primarily of those articles which have come to the compiler's attention, with emphasis on the American literature. For the European literature, the reader is referred to the bibliographies in van Steenis (183) and Rehder (155). Also, with the exception of a few incidental references, the list deals almost exclusively with the vascular plants.

1. Anon. 1915. Suggestions for the collection of range plant specimens in national forests. U. S. Dept. Agr., Forest Service, Unnumbered Leaflet, 4 pp.
2. Anon. 1925. Instructions for National Forest range plant work. U. S. Dept. Agr., Forest Service, Unnumbered Circular, 4 pp.
3. Anon. 1944. A field collector's manual in natural history. Smithsonian Institution, Publ. 3766, 118 pp.
4. Anon. 1956. New protectors for herbarium specimens. Carolina Tips 19(4):13
5. Anon. 1957. Liquid adhesive for herbarium mounts. Carolina Tips 20(9):35.
6. Anon. 1960. Methods in use at the commonwealth mycological institute. Herb. I. M. I. Handbook, Commonwealth Mycological Institute, Kew, 103 pp.
7. Anon. 1965. Instructions for collectors, No. 10, Plants, 6th ed. British Museum (N. H.), Dept. of Botany, 72 pp.
8. Anon. 1965. Notes on the preparation of herbarium specimens. Carolina Tips 19(2):5–6.
9. Anon. Undated. Notes on plant-collecting. Royal Botanic Gardens, Kew, 4 pp.
10. Arber, A. 1938. Herbals, their origin and evolution, 2nd ed., University Press, Cambridge, pp. 138–143.
11. Archer, W. A. 1945. Collecting data and specimens for study of economic plants. U. S. Dept. Agr. Misc. Publ. 568, 52 pp.
12. ———, 1950. New plastic aid in mounting herbarium specimens. Rhodora 52(624):298–299.
13. ———, 1952. Aerosol for controlling herbarium pests. Science 116 (3009):233–234.
14. Bailey, J. W. 1854. On a mode of giving permanent flexibility to brittle specimens in botany and zoology. Am. Jour. Sci. and Arts (2nd Ser.) 18:100–102.
15. Bailey, L. H. 1946. The palm herbarium . . . . Gent. Herb. 7(2):151–180.

16. Bailey, W. W. 1881. The botanical collector's handbook. George A. Bates, Salem, Mass. 139 pp.

17. ———, 1899. Botanizing — A guide to field-collecting and herbarium work. Preston & Rounds, Co., Providence, R. I. 142 pp.

18. ———, 1904. Collecting plants for identification. Am. Bot. 7(1):9–11.

19. Baker, G. E. 1949. Freezing laboratory materials for plant science. Science 109(2838):525.

20. Baker, H. G. 1958. The origin of the vasculum. Proc. Bot. Soc. Br. Isles 3(1):41–43.

21. Balfour, J. H. 1854. Classbook of botany, Adam & Charles Black, Edinburgh pp. 1075–1086.

22. Ballard, F. 1938. Herbarium specimens and gas poisoning. Kew Bull. 1938(9):397–399.

23. Beal, W. J., *et al.* 1886. Arrangement of herbaria. Bot. Gaz. 11(4,5):98, 120–121

24. Beauvisage, G. 1904. Conseils aux voyageurs pour les recoltes d'enchantillons botaniques de plantes utiles, medicinales, alimentaires ou industrielles. Assoc. Fr. l'Advancem. des Sci. (Bot.) Grenoble 1904:724–731.

25. Benedict, H. M. 1913. A demonstration herbarium. Plant World 16(8):231–233.

26. Benson, L. 1939. Notes on taxonomic techniques. Torreya 39(3):73–75.

27. ———, 1957. Plant classification. D. C. Heath & Co., pp. 380–400.

28. ———, 1962. Plant taxonomy: methods and principles, Ronald Press, New York, 494 pp.

29. Ber, V. G. 1963. Protection of botanical collections from insect pests II. (in Russian). Bot. Zhur. 48:384–395.

30. Biswas, K. 1944–45. The herbarium. Sci. and Culture 10:151–154.

31. Blake, S. F. 1919. Directions for preparation of plant specimens for identification. U. S. Bur. Pl. Ind., Office Econ. and Syst. Bot. Circ. 1, 2 pp.

32. ———, 1920. Directions for collecting flowering plants and ferns. U. S. Dept. Agr. Circ. 76, 8 pp.

33. ———, 1935. Better herbarium specimens. Rhodora 37(433):19.

34. Blumer, J. C. 1907. A simple plan for collectors of ecological sets of plants. Plant World 10(2):40–42.

35. Booke, R. V. 1955. Drying plant materials for winter bouquets. Plants and Gardens 11(3):225–227.

36. Buchholz, J. T. 1931. A practical drier for botanical specimens. Trans. Ill. Acad. 24(2):103–107.

37. Burtt Davy, J. and Chalk, L. 1927. The collection and preparation of herbarium and timber specimens. Imp. For. Inst., Univ. Oxford, 22 pp.

38. Camp, W. H. 1946. On the use of artificial heat in the preparation of herbarium specimens. Bull. Torrey Club 73(3):235–243.

39. deCandolle, A. P. 1834. Instruction practique sur les collections botaniques. Bibliotheque Universelle des Sciences, Belles-Lettres, et Arts, Ser. 1, 56:169–191. Seen in reprint only.

40. Castellanos, A. 1928. Instrucciones para formar herbarios parana. Mus. Escolar Central, 12 pp.

41. Ciferri, R. 1929. The use of paradichlorobenzene in the conservation of herbaria. Science 70(1810):240.

42. Clemens, F. E. 1904. Formation and succession herbaria. Nebr. Univ. Studies 4:329–355.

43. Clute, W. N. 1904. The making of an herbarium. Roger Williams Park Museum (Providence, R. I.), Bulletin 4, 18 pp.

44. Cody, W. J. 1966. New herbarium equipment. Pl. Res. Inst., Research Branch; Canada Dept. Agr., 7 pp.

45. Coley, M. and Weatherby, C. A. 1915. Wild flower preservation, Frederick A. Stokes, Co., New York, 197 pp.

46. Collins, J. F. 1910. The use of corrugated paper boards in drying plants. Rhodora 12(144):221–224.

47. ———, 1932. Better herbarium specimens. Rhodora 34(408):247–249.

48. Corner, E. J. H. 1938. Brief note on the use of monkeys for plant collecting. Chron. Bot. 4(3):259

49. Cosson, E. 1871. Instructions sur les observations et les collections botaniques . . . . Bull. Soc. Bot. Fr. 18:66–73, 81–91, 111–122.

50. Coville, F. V. 1895. Directions for collecting specimens and information illustrating the aboriginal uses of plants. U. S. Nat. Mus. Bull. 39J:3–8.

51. Cowan, R. S. 1947. A mirror device for studying lower surface of small objects . . . . Science 105(2734):555–556.

52. Curtis, A. H. 1901. Hints on herborizing. Plant World 4(4,5):61–66, 81–87.

53. Dammer, U. 1891. Handbuch fur pflanzensammler. Verlag Ferdinand Enke, Stuttgart, 342 pp.

54. Dayton, W. A. 1931. Glossary of botanical terms commonly used in range research. U. S. Dept. Agr. Misc. Publ. 110, 40 pp.

55. Deane, W. 1895. Notes from my herbarium. III. How I mount plants. Bot. Gaz. 20:345–348.

56. Derr, H. B. and Lane, C. H. 1914. Collection and preservation of plant material for use in the study of agriculture. U. S. Dept. Agr. Farmers' Bulletin 586, 24 pp.

57. DeWolf, G. P., Jr. 1967. Identification of unknown plants. Arnoldia 27(4–5):51–52.

58. Dieterle, J. V. A. 1960. Sandbags as a technical aid in mounting plants. Rhodora 62(743):322–324.

59. Eaton, S. 1892. How to collect and preserve plants and sea-weeds. Hinds and Noble, New York, 32 pp.

60. Englemann, G., *et. al.* 1886. How to collect certain plants. Bot. Gaz. 11(6):135–150

61. Fassett, N. C. 1949. Herbarium technique. Rhodora 51(603):59–60.

62. ———, 1952. Uses of cellulose acetate in the herbarium. Rhodora 54(647):286–288.

63. ———, Uso de la aceto-celulosa en el herbario. Ciencia e Investigacion 9:89–90.

64. Fernald, M. L. 1945. Injury to herbarium specimens by extreme heat. Rhodora 47(560):258–260.

65. Fessenden, G. R. 1949. Preservation of agricultural specimens in plastics. U. S. Dept. Agr. Misc. Publ. 679, 78 pp.

66. Flint, J. M. 1881. Memoranda for collectors of drugs for the materia medica section of the National Museum. Proc. U. S. Natl. Mus. 4 (App. 8):1–2.

67. Fogg, J. M., Jr. 1940. Suggestions for collectors. Rhodora 42(497):145–157.

68. Font Quer, P. 1917. Instructions per a la recolleccio, preparacio, i conservacio de les plantes. Musei Barcinonensis Scientiarum Naturalium Opera, Ser. Bot. I, 45 pp.

69. Fosberg, F. R. 1939. Plant collecting manual for field anthropologists. American Fiber-Velope Mfg. Co., Philadelphia, 22 pp.

70. ———, 1946. The herbarium. Sci. Month. 63:429–434.

71. ———, 1947. Formaldehyde in plant collecting. Science 106(2750):250–251.

72. ———, 1960. Plant collecting as an anthropological field method. El Palacio 67(4):125–139.

73. ——— and Sachet, M. H. 1965. Manual for tropical herbaria. Regnum Vegetabile 39, 132 pp.

74. Franks, J. W. 1965. A guide to herbarium practice. The Museum Assoc. Handbook for Museum Curators, Part E, Sect. 3, 34 pp.

75. Gates, B. N. 1950. An electrical drier for herbarium specimens. Rhodora 52(618):129–134, Pl. 1162.

76. Gates, F. C. 1935. Paradichlorobenzene, an effective herbarium insecticide. Science 81(2105):438–439.

77. Gentry, H. S. 1952. The belt plant press. Bull. Torrey Club 79:84–88.

78. Gleason, H. A. 1933. Annotations on herbarium sheets. Rhodora 35(410):41–43.

79. ——— and Smith, A. C. 1930. Methods of preserving and arranging herbarium specimens. Jour. N. Y. Bot. Gard. 31(365):112–125.

80. Grassl, C. O. 1937. Visualizing our herbaria. Museums Jour. 36(9):373–384.

81. Gray, A. 1879. Gray's botanical text-book, 6th ed., Vol. I, Structural Botany. American Book Co., New York, pp. 370–384.

82. Griffiths, D. 1906. Preparation of specimens of *Opuntia*. Plant World 9(11):278–285.

83. Guillaumin, A. 1942. Formulaire technique du botaniste, preparateur et voyageur. Guides Techniques du Naturaliste, Vol. III (Savoir en Histoire Naturelle, Vol. 10), Paul Lechevalier, Paris, 139 pp.

84. Haasis, F. W. 1939. Transparent mounts for field herbaria. Madrono 5(4):121–122.

85. Harrington, H. D. 1947. Preserving plants in formaldehyde fumes. Turtox News 25(12):238.

86. ———. 1950. Preserving flowers by freezing. Turtox News 28(2):51.

87. Harrington, H. D. and Durrell, L. W. 1957. How to identify plants. Sage Books, Denver, 203 pp.

88. Hitchcock, A. S. 1900. Collecting sets of plants for exchange. Plant World 3(10):148–151.

89. ———, 1925. Methods of descriptive systematic botany. John Wiley & Sons, New York, 216 pp.

90. ———, 1931. Field work for the local botanist. Publ. by the author, Washington, D. C., 58 pp.

91. ———, and Chase, A. 1909. Directions for preparing herbarium specimens of grasses. U. S. Dept. Agr., Bur. Pl. Ind., Doc. 442, 4 pp.

92. Hodge, W. H. 1947. The use of alcohol in plant collecting. Rhodora 49(584):207–210.

93. Holmes, E. M. 1899. The arrangement of museum herbaria. Museums Assoc. of the U. K., 16 pp.

94. Hooker, J. D. 1871, 1886. Botany. *In* Herschel, J.F.W. (Ed.) A manual of scientific enquiry, prepared for the use of officers in Her Majesty's navy . . . (4th and 5th editions), John Murray (4th ed.), Eyre and Spottiswoode (5th ed.), London.

95. Hooker, W. J. 1849, 1851, 1859. Botany. *In* Herschel, J.F.W. (Ed.) A manual of scientific enquiry, prepared for the use of officers in Her Majesty's navy . . . (1st, 2nd, and 3rd editions), John Murray, London.

96. Horr, W. H. 1947. A rapid plant drier. Trans. Kansas Acad. 50(2):191–193.

97. Howard, R. A. 1947. The use of DDT in the preparation of botanical specimens. Rhodora 49(587):286–288.

98. Jackson, H. S. 1921. A convenient laboratory plant press. Proc. Ind. Acad. 1920:183–186. Reprinted in N. Y. State Museum Bull. 266:99–101, 1925.

99. Jenne, Gertrude. 1968. A portable forced air plant dryer. Taxon 17(2):184–185.

100. Johnson, A. G. 1948. Effect of formaldehyde on Picea and Tsuga herbarium specimens. Science 107(2777):294.

101. Johnston, I. M. 1939. Preparation of botanical specimens for the herbarium. Arnold Arboretum of Harvard University, Jamaica Plain, Mass., 33 pp. Reprinted in reduced format by Cambosco Scientific Co. Spanish trans. published by Inst. Miguel Lillo, Tucuman, Argentina, 1941.

102. Kirk, J. 1895. The preparation and preservation of botanical specimens. Trans. N. Z. Inst. 27:318–327.

103. Knowlton, F. H. 1891. Directions for collecting recent and fossil plants. U. S. Nat. Mus. Bull. 39B:3–46.

104. Kobuski, C. E. 1955. A revised glossary of the more common botanical and horticultural terms. Arnoldia 15(5–7):25–44.

105. ———. 1958. The horticultural herbarium. Arnoldia 18(5):25–28.

106. ———. *et al.* 1958. Report of the committee for recommendations on desirable procedures in herbarium practice and ethics. Brittonia 10(2):93–95.

107. Kuhlmann, M. 1947. Como herborizar material arboreo. Instituto de Botanica, Sec. da Agricultura, Estado de Sao Paulo, Sao Paulo, 39 pp.

108. Lawrence, G. H. M. 1951. Taxonomy of vascular plants, Macmillan Co., New York, pp. 234–262.

109. Lindley, J. 1839. An introduction to botany (3rd ed.) Longman, Orme, Brown, Green and Longmans, London, pp. 537–543.

110. Little, E. L. 1952. Preparing specimens of Picea and Tsuga. Rhodora 54(645):232–234.

111. Löfgren, A. 1914. Phytographia . . . (2nd ed.). Typographia Brazil de Rothschild, & Cia, Sao Paulo, 120 pp.

112. Lonert, A. C. 1962. Turtox silica-gel flower preservative. Turtox News 40(2):54.

113. ———. 1962. Turtox dry-flex concentrate. Turtox News 40(2):58–59.

114. Lundell, C. L. 1946. A useful method for drying plant specimens in the field. Wrightia 1(2):161–162.

115. Lunell, J. 1918. The collecting, drying, and mounting of plant specimens Am. Midl. Nat. 5(7–8):191–195.

116. MacCarthy, G. 1887. The study of local floras. Jour. Elisha Mitchell Soc. 4(2):25–30.

117. MacDaniels, L. H. 1930. A portable plant drier for tropical climates. Am. Jour. Bot. 17(7):669–670.

118. MacDougal, T. 1947. A method for pressing cactus flowers. Cactus and Succ. Jour. 19:188.

119. MacFarlane, J. M. 1894. The organization of botanical museums for schools, colleges and universities. Biological Lectures, Marine Biol. Lab., Wood's Hole, pp. 191–204.

120. McClean, A. P. D. 1930. A drying cabinet for the preparation of plant specimens for the herbarium. Bothalia 3:137–141.

121. McClintock, E. 1965. The herbarium and horticulture. Calif. Hort. Soc. Jour. 26(4):97–101.

122. Maiden, J. H. 1917. Hints for the collecting and preservation of herbarium specimens . . . . Forestry Comm., N. S. W., 8 pp.

123. Maillefer, A. 1944. Les herborisations et la dessication des plantes pour herbiers. Bull. Soc. Vaudoise Sci. Nat. 62(262):421–429.

124. Manning, W. H. & Deane, W. 1897. The making of an herbarium. Southampton, N. Y. Library Art Annex, 14 pp.

125. Mansfeld, R. 1936. Vorlinneische Sammlungen in Herbar Dahlem. Notizbl. Bot. Gart. u. Mus. Berlin-Dahlem 13(118):305–311.

126. Manton, W. P. 1882. Field Botany, A handbook for the collector, Lee & Shepard, Boston, 41 pp.

127. Martin, E. 1968. A new method for mounting plant specimens. Arboretum Leaves 7(3):28.

128. Martin, G. W. 1925. Paradichlorobenzene in the herbarium. Bot. Gaz. 79(4):450.

129. Merrill, E. D. 1916. On the utility of field labels in herbarium practice. Science (N.S.) 44(1141):664–670.

130. ———. 1926. An economical herbarium case. Torreya 26(3):50–54.

131. ———. 1926. An efficient and economical herbarium paste. Torreya 26(4):63–65.

132. Merrill, E. D. 1948. On the control of destructive insects in the herbarium. Jour. Arnold Arb. 29:103–110.

133. Michigan, Univ. of, Dept. of Botany. Instructions to Naturalists in the armed forces for botanical field work:

No. 1, The collecting of seaweeds and freshwater algae;

No. 2, The collecting of fungi and lichens;

No. 3, The collecting of mosses and liverworts;

No. 4, The collecting of ferns and fern allies;

No. 5, The collecting of flowering plants and gathering data for regional and insular floras;

No. 6, Collecting in plant groups that require special methods;

No. 7, Gathering and shipping seeds and living plants for propagation.

134. Millspaugh, C. F. 1925. Herbarium organization. Field Mus. Tech. Ser. 1(3):1–18.

135. Moll, J. W. 1894. Een Toetel om Planten voor het Herbarium te Drogen. Bot. Jaarb. 6:1–23.

136. Moore, H. E., Jr. 1950. A substitute for formaldehyde and alcohol in plant collecting. Rhodora 52(617):123–124.

137. Nichols, G. E. and St. John, H. 1918. Pressing plants with double-faced corrugated paper boards. Rhodora 20(237):153–160.

138. Nieuwland, J. A. and Savin, A. D. 1928. Preservation of *Monotropa* and similar plants without discoloration. Proc. Indiana Acad. 38:103–104.

139. Okamoto, K. 1954. Making botanical specimens with corrugated duraluminum sheets (in Japanese). Shizen Kagaku to Hakubutsukan 21:8–13.

140. Okamoto, K. 1955. Making botanical specimens with a portable electric dryer (in Japanese). Shizen Kagaku to Habubutsukan 22:28–34.

141. ———. 1957. Ventilation of electric dryer (in Japanese). Shizen Kagaku to Hakubutsukan 24:31–35.

142. O'Neil, H. 1938. Heat as an insecticide in the herbarium. Rhodora 40(469):1–4

143. Palmer, E. J. 1937. The identification of plant material at the Arnold Arboretum. Arnold Arboretum, Bulletin of Popular Information (Ser. 4) 5(3):13–16.

144. Passerini, N. and Pampini, R. 1927. La conservazione degli erbari e l'efficacia del sublimato ($HgCl_2$) nell' avvelamento delle piante. Nuovo Gior. Bot. Ital. 34(3):593–629.

145. Peebles, R. H. 1942. Preservation of cactus material. Cactus and Succ. Jour. 14(1):3–8.

146. Phillips, E. P. Undated. The collecting of botanical specimens and the making of a herbarium. Union of So. Africa, Dept. of Agric., Local Series 71, 4 pp.

147. Pierce, W. D. 1936. Retention of plant colors. Science 84(2176):253–254.

148. Pike, R. B. 1964. Plant pressing with plastic sponges. Rhodora 66(766):172–176.

149. Porter, C. L. 1967. Taxonomy of flowering plants (2nd ed.). W. H. Freeman and Co., San Francisco, pp. 42–54.

150. Purvis, M. J., Collier, D. C., and Walls, D. 1966. Laboratory techniques in botany (2nd ed.) Butterworths, London, pp. 207–218.

151. Quisumbing, E. 1931. Water glass as a medium for permanently mounting dissections of herbarium material. Torreya 31(2):45–47.

152. Reed, C. F. 1941. A method for determining and specifying locality by collectors. Science 93(2403):68.

153. Reed, H. S. 1902. Plant preparations for museum and general demonstration work. Jour. Appl. Microscopy and Lab. Methods 5(7):1885–1888.

154. Reeder, J. R. 1955. Another method for preparing herbarium specimens of Picea and Tsuga. Tropical Woods 102:46–48.

155. Rehder, A. 1911. The Bradley bibliography, Vol. 1, Riverside Press, Cambridge, pp. 35–36.

156. Richards, H. M. 1901. New methods of drying plants. Torreya 1(12):145–146.

157. Ricker, P. L. 1913. Directions for collecting plants. U. S. Dept. Agr., Bur. Pl. Ind., Circ. 126:27–35.

158. Robinson, B. L. 1903. Insecticides used at the Gray Herbarium. Rhodora 5(58):237–247.

159. Rollins, R. C. 1950. Deep-freezing flowers for laboratory instruction in systematic botany. Rhodora 52(624):289–297.

160. ———. 1955. The Archer method for mounting herbarium specimens. Rhodora 57(682):294–299.

161. Ruth, F. S. 1965. Laminating method for preservation of herbarium specimens. Turtox News 43(8):212–214.

162. Saint-Leger, J. 1885. Histoire des herbiers, J. B. Bailliere et Fils, Paris, 120 pp. (also in Lyon Soc. Bot. Ann. 13:1–120, 1886).

163. Salisbury, E. 1948. The collection, preservation, and interchange of biological material. Roy. Soc. Lond., Empire Sci. Cong., Rpt. 1946(2):206–211.

164. Sanford, S. N. F. 1936. The collection and preservation of flowering plants. Boston Soc. Nat. Hist. Bull. 79:3–17.

165. Santapau, H. 1955. Botanical collectors manual. Ministry of Nat. Resources and Sci. Res., New Delhi, 62 pp.

166. ———. 1955. Instructions for field collectors of the botanical survey of India. Ministry of Nat. Resources and Sci. Res., 16 pp.

167. Savile, D. B. O. 1962. Collection and care of botanical specimens. Research Branch, Canada Dept. Agriculture, Publ. 1113, 124 pp.

168. Schrenk, J. 1888. Schweinfurth's method of preserving plants for herbaria. Bull. Torrey Club 15(11):292–293.

169. Schultes, R. E. 1946. El uso del formol en la recoleccion de plantas. Rev. Fac. Nac. de Agron. (Medellin) 6(22):46–52.

170. ———, 1947. The use of formaldehyde in plant collecting. Rhodora 49(578):54–60.

171. Scully, F. J. 1937. Preservation of plant material in natural colors. Rhodora 39(459):16–19.

172. Sears, J. A. 1967. The preparation of botanical specimens by a simple, inexpensive method. Turtox News 45(1):36–37.

173. Sharp, A. J. 1935. An improvement in the method of preparing certain gymnosperms for the herbarium. Rhodora 37(439):267–268.

174. ———, 1964. A new method for mounting evergreen conifer twigs with deciduous leaves. Rhodora 66(766):216.

175. Shattuck, G. C. (Ed.) 1935. Handbook of travel (2nd ed.). (Linder, D. H. Botanical Collecting, pp. 319–334) Harvard Univ. Press, Cambridge.

176. Shope, P. F. 1936. Paradichlorobenzene as a herbarium insecticide. Science 83(2140):19.

177. Smith, G. G. 1946. A drying cabinet for the herbarium. Jour. S. Afr. Bot. 12:43–45.

178. Smith, J. D. *et al.* 1886. Specimens and specimen making. Bot. Gaz. 11(6)129–134.

179. Spaulding, V. M. 1907. Suggestions to plant collectors. Plant World 10(2):40.

180. Stackhouse, I. 1800. Observations on preserving specimens of plants. Trans. Linn. Soc. 5:21–23.

181. Standley, P. C. 1909. Herbarium notes. Torreya 9(4):74–77.

182. Stearn, W. T. 1957. An introduction to the Species Plantarum and cognate botanical works of Carl Linnaeus. Ray Society, London, Facsimile of 1st ed. of Carl Linnaeus, Species Plantarum.

183. van Steenis, C. G. G. J. 1950. The technique of plant collecting and preservation in the tropics. Flora Malesiana, Vol. I, pp. XLV–LXIX. Noordhoff-Kolff N. V., Djakarta.

184. Steeves, (Mrs.) H. R., Jr. 1968. Starting an herbarium. Bull. Garden Club Am. 55(1):17–20.

185. Stevens, F. L. 1926. Corrugated aluminum sheets for the botanist's press. Bot. Gaz. 82(1):104–106.

186. Stevens, O. A. 1949. A simple plastic collecting bag. Rhodora 51(612):393.

187. Steyermark, J. A. 1947. Notes on drying plants. Rhodora 49(585):220–227.

188. ———. 1968. Notes on the use of formaldehyde for the preparation of herbarium specimens. Taxon 17(1):61–64.

189. Stone, G. E. 1899. Formalin as a preservative for botanical specimens. Jour. Appl. Microscopy 2(10):537–540.

190. Sutton, S. B. 1965. The herbarium introduced. Arnoldia 25(6):37–40.

191. Svensen, H. K. 1935. The preparation of herbarium specimens. Brooklyn Bot. Gard. Leafl., Ser. 23(4):1–4.

192. Sweetser, A. R. 1906. Some botanical notes from the biological laboratory. The collecting and preserving of plants. Univ. Ore. Bull. (N.S.) 3(3):11, 13.

193. Swingle, C. F. 1930. Oxyquinoline sulphate as a preservative for plant tissues. Bot. Gaz. 90(3):333–334.

194. Tagg, H. F. 1901. Notes on museum methods in use at the Royal Botanic Garden, Edinburgh. Notes from the Roy. Bot. Gard. Edinburgh 1(5):213–246, *pl.* 3.

195. Tehon, L. R. 1949. Pleasure with plants (3rd printing). Nat. Hist. Surv. Div. Urbana, Ill. Circ. 32, 32 pp.

196. Templeton, B. C. 1932. Methods of preserving cacti for herbarium use. Desert (now Desert Plant Life) 3(11):127.

197. Thieret, J. W. and Reich, R. J. 1960. The formaldehyde method of collecting plant specimens. Turtox News 38:114–115.

198. Traub, H. P. 1950. Non-moistureproof cellophane and cellulose acetate film for preserving herbarium specimens. Phytologia 3(6):297–298.

199. ———. 1951. Further notes on drying plant specimens between sheets of moisture permeable plastic films. Phytologia 3(9):473–475.

200. ———. 1954. PDB in plastic envelopes for pest control in the small herbarium. Taxon 3:84–88.

201. Turrill, W. B. 1950. Taxonomy in the seed-bearing plants. Kew Bull. 1949(4):453–461.

202. Uhe, G. 1967. A portable and expansible drier for herbarium specimens. Turtox News 45(4):98–101.

203. Verdoorn, I. C. 1945. On the genus *Aloe*: preparation of herbarium material at Pretoria. Chron. Bot. 9(3–4):150–151.

204. Walker, E. 1942. Recording localities on specimen labels. Chron. Bot. 7(2):70–71.

205. Ward, L. F. 1881. Flora of Washington and vicinity. Appendix: Suggestions to beginners. U. S. Nat. Mus. Bull. 22:209–237.

206. Weber, W. A. 1949. A vasculum for mountaineers. Turtox News 27(9):212–213.

207. Wherry, E. T. 1949. A plastic spray coating for herbarium specimens. Bartonia 25: 86.

208. White, M. G. 1967. Pick . . . press . . . picture! Flower and Garden 11(10): 5, 45–46.

209. Wiegand, K. M. 1918. The collection and preservation of specimens of plants. Cornell Rural Science Leaflet 12(1):154–159.

210. Wilcox, E. M. 1901. Directions for collecting and preserving insects and plants. Okla. Agr. Expt. Sta. Circ. 3, 15 pp.

211. Williams, F. R. 1942. The use and methods of making an herbarium. Herb Society of America, Boston, 10 pp.

212. ———. 1943. Drying plants in three dimensions. Jour. N. Y. Bot. Gard. 44(522):138–141.

213. ———. 1948. Flowers in borax. Jour. N. Y. Bot. Gard. 49(587):251–253.

214. Withering, W. 1776. A botanical arrangement of all the British vegetables (1st ed., 2 vols.) M. Swinney, Birmingham, Vol. 1, pp. xlvii–li.

215. ———, and Stokes, J. 1792. A botanical arrangement of British plants (3 vols.) Swinney & Walker, Birmingham, Vol. 3, pp. xlv–lv.

216. Wormersley, J. 1957. Paraformaldehyde as a source of formaldehyde for use in botanical collecting. Rhodora 59(708):299–303.

217. Yuncker, T. G. 1936. New herbarium mounting forceps. Am. Midl. Nat. 17(2):569.

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ARNOLDIA

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METASEQUOIA AFTER TWENTY YEARS IN CULTIVATION

TWENTY years have passed since the Arnold Arboretum first introduced *Metasequoia glyptostroboides* to cultivation. Various articles have been written about it, plants have been propagated sexually and asexually and distributed widely since. Many individuals in the northern hemispheres who have planted it have been most interested in its speed of growth. There are trees now growing in cultivation that are 60 feet tall, grown from the first seed distributed in 1948, but records are lacking concerning its fruiting habits in cultivation since that time.

In order to help fill the gap with information on the speed of growth and fruiting habits of this tree in cultivation, we have written to many individuals in this country, Great Britain, Holland, Germany and Russia to determine what we can, and the information collected to date is meagre indeed. What little that we have learned about it is included in this bulletin, and it is hoped that others who read this will send in additional information that will be of assistance to everyone growing the tree.

Metasequoia glyptostroboides is a member of the Pine Family, closely allied to genus *Taxodium*. It bears small deciduous needles, about $\frac{3}{4}$ to $1\frac{1}{8}$ inches long that quickly drop in the fall after a severe freeze. These are borne on short branchlets which are also deciduous. It bears small female cones about an inch long and $\frac{1}{2}$ inch wide. These have been observed on many of the older cultivated trees. The staminate or male cones are formed in the late summer at the ends of some of the twigs, and like those of many coniferous plants, open to disperse their pollen in the early spring. The accompanying sketches of male and female cones illustrate these.

The tree was originally found near Wan-hsien, Szechuan, China. In 1948 it was reported that less than 1,000 trees, large and small, were still in the area and that the peasants were still cutting down the trees and using the wood for interior finishing purposes. In nearby Chungking, the lowest winter temperatures are reported to be about 32° F., with highest summer temperatures of 111° F.

The winter period is from December to March with lowest recordings about 32° to 38° F. Apparently there is a frost-free period from April through November, giving a long growing period, with an average 43 inches of rain well distributed throughout the year.

However, trees are growing in cultivation now in areas with much lower winter temperatures. In the Arnold Arboretum, where the tree is perfectly hardy the winter temperatures usually go to zero or -10° F. and sometimes lower. The tree has been growing in Wisconsin as well as at the Case Estates of the Arnold Arboretum in Weston, Massachusetts, in areas with an occasional -30° F. without apparent serious injury. More important than winter cold is the length of growing season, and the time of late spring freezes and early fall freezes. *Metasequoia glyptostroboides* was found in an area of a long growing season. It starts to grow early in the spring and frequently its growth is not fully matured until mid or late fall. Observations have been made in the Arnold Arboretum showing that when the tree is planted in low spots, late spring freezes (or early fall freezes) can kill much of the tender growth. This has also been noted in England, especially in areas with late spring frosts in late May or early June.

Metasequoia does continue to elongate in late summer and early fall, unless its growth has been retarded by summer drought. Hence it would be expected that growth would be best in those areas with a combination of plenty of rain fall and a long growing period. However, Professor Oliver Diller of the Secrest Arboretum reports plants growing in Sweden only 200 miles from the Arctic Circle.

The University of Washington Arboretum in Seattle, reported that during the precipitous November freeze of 1955 which they called "early", some of their trees 15-20 feet tall, were completely killed especially in areas of poor air drainage. Others on higher ground apparently were not injured seriously.

Another fact that has been proved many times both in America and Europe is that the dawn redwood grows best in areas with a generous supply of moisture throughout the year. It does not grow well in wet soils, nor in sandy dry soil situations, for trees originally planted in dry soil, when moved to normally moist soil, have markedly improved in growth. Rabbits, mice and deer have been reported as feeding on the bark, and Japanese beetles, where plentiful, can be a pest on the foliage during the early summer.

Flowering and Fruiting Characteristics

In all our correspondence only one institution has reported observing male cones on living cultivated specimens. Female cones have been produced on many trees, some only 3 feet tall. When trees approach 15–20 years of age, cones are produced, sometimes only a few, sometimes many as in the case of a tree in the Botanic Gardens of the University of California. Wayne L. Hansis, the manager of the Gardens, reported "hundreds" on one tree and Carleton Goff of Barrington, Rhode Island reported 200 cones on his largest tree in 1966, but no cones in

PLATE XXXV

Metasequoia glyptostroboides. ***a.*** Branch showing: male cone buds on right hand branchlet; 3 female cone buds on upper end of main branch; 2 vegetative buds on lower end of main branch—natural size. ***b.*** Female cone bud, × 3. ***c.*** Male cone bud, × 3. ***d.*** Vegetative bud, × 3. ***e.*** Unopened green female cone, × ½. ***f.*** Female cone open for seed dispersal, × ½. ***g.*** Cross section of female cone, × ½. ***h.*** Fertile scale bearing ovules, × 1½.

1967. None of the seeds was viable. Apparently Metasequoia may be alternate bearing, like so many other trees and shrubs, but some reports show that a few trees produce a few cones on large trees every year.

Female cones have been sighted by many and "seeds" have been sown by some (collected from cultivated plants). To date, however, as far as we can determine only six seeds have resulted in living seedlings in America—two at the USDA Forest Service in Berkeley, California, and four at Princeton Nurseries, Princeton, N.J. Dr. Stanley L. Krugman, of the Institute of Forest Genetics, U.S. Dept. of Agriculture Service, Berkeley, California, wrote that very few male cones were seen on their trees in 1967 but in 1968, a sufficient number were collected to supply a small amount of pollen for some controlled pollinations. Broekhuizen and Zwart reported in November 1967, that "As yet Metasequoia did not produce fertile seed in Europe." However, a most interesting letter from the Batumi Botanical Garden in Batumi, Russia indicates that this botanical garden has had fruiting plants since 1964, and that in 1967 seeds distributed from their own trees had 25–30% germination. The concensus of opinion in most other areas is that the seed is not viable because it has not been properly fertilized. Apparently then, male cones are not produced as early in the life of these trees as are the female, or if they are produced as early, the climate is such that they may be subject to winter injury. More observations along this line are needed to clear up this point.

The observations here recorded have been made by many individuals, some trained in the study of plants, others untrained. When an individual reports that no fruits have been borne on his trees, he may be correct or he may have been simply unobserving. Many individuals reporting fruits did not take the trouble to ascertain whether or not the seeds were viable, and those sowing seed collected from the fruits may have cared for them properly or improperly. Admittedly we are saddled with these observations, good and bad, and offer them here for what they are worth.

The drawing on page 115 is of interest to show the young male cone. This was made from a specimen collected by C.T. Hwa in the vicinity of Wan-hsien, Szechuan, China during September–October 1947. These are present on the tree all winter, opening in the early spring to shed their pollen. They are subjected to winter cold which, in some areas may cause injury—the reason why many trees have not yet produced pollen on cultivated plants. The male cones are probably borne high up in the tree and the author will welcome correspondence with anyone who can find them on plants this fall. One should observe this carefully, using field glasses on the higher trees. Apparently, if our many observers are correct, some 20 year old trees may still not be old enough to produce male cones. Further careful observations on this point are greatly needed.

PLATE XXXVI

Metasequoia glyptostroboides in the Arnold Arboretum grown from seed sown July 1948. When transplanted to this spot in the nursery, Spring 1951, it was at the height pointed to by the young lady. During the 1951 growing season it grew 4′4″, doubling its height in this better soil in the one season.

Growth Rates

We can rely more on the measurements of heights of these trees, and knowing that a 60 foot specimen can be produced in 20 years from seed is obvious proof that the species is a fast growing one. The largest trees observed in China were about 115 feet tall with a trunk diameter of about 7 feet but it is estimated that the tree can grow to about 150 feet. The trunk is very buttressed so that trunk diameter measurements can be misleading. To show how fast the tree can grow, the University of Washington Arboretum, Seattle, Washington reported that one of its 10 year old trees grown from cuttings was 44 feet tall. One of the seedlings in the Arnold Arboretum, the seed being sown in January 1948, was transplanted from poor, dry soil to a good soil situation in 1951 when it was 4′ 4″ tall (Plate XXXVI). That growing season, it actually doubled its height, thus showing the effect of good soil on growth.

Several clones have been named including 'National' [3], 'Moerheim' [1], and 'Vada' [1]. 'National' was named in 1963 by the National Arboretum, Washington, D.C., the tree selected from a seedling lot grown from the original seed importation sent by the Arnold Arboretum. The tree is narrow-pyramidal in growth. 'Moerheim' has branches more or less upright and is columnar in habit; 'Vada' has horizontal branches and is densely pyramidal, both originating in Holland from the original seed sent by the Arnold Arboretum. Both were named by Broekhuizen and Zwart, collaborators of the Institute of Forestry Research at Wageningen, Holland. It is apparent then that the original seedlings in cultivation have shown variable habit characteristics.

A trunk section from a 12 year old tree growing in Cambridge, Mass., near water (taken just a few inches above the ground level) measured $16\frac{1}{4}$ inches in diameter at its widest parts. Annual increase in trunk diameter for the 12 year period was:

Age in years	*Increment*
1	$\frac{1}{2}''$
2	$\frac{5}{8}''$
3	$\frac{3}{8}''$
4	$1''$
5	$1''$
6	$1\frac{3}{4}''$
7	$2''$
8	$2''$
9	$1\frac{3}{4}''$
10	$2''$
11	$1\frac{1}{2}''$
12	$1\frac{1}{2}''$

PLATE XXXVII

Metasequoia trees in America. Upper left: 20 year old tree at Winterthur, Delaware, 58′ tall in 1967. Upper right: 19 year old tree of Carleton Goff, Barrington, R.I., photographed in November 1966. The tree was 50′ tall in 1967. Lower left: a 20 year old tree growing in the open in the Arnold Arboretum, showing a wide pyramidal habit. It is 30′ tall and 24′ wide. Lower right: the original 'National' growing in the National Arboretum, Washington, D.C., photographed in 1968, measured 46′6″ when 20 years old.

Possible Use for Paper Pulp and Lumber

Professor Oliver Diller of the Secrest Arboretum, Wooster, Ohio reports the following from the Champion Papers Company of Knightsbridge, Hamilton, Ohio: the dawn redwood sample sent "did appear to react very similarly to our present source of long fiber (in making paper pulp) — southern pine — as far as pulping and bleaching are concerned. The pulp was somewhat stronger than what we normally experience with southern pine." Apparently, then it may have some potentials as a source of fiber for the paper industry, primarily because of the possibility of its yielding a very strong pulp. No information is available on the pulping qualities of dawn redwood from the U.S.D.A. Forest Products Laboratory in Madison, Wisconsin. The U.S. Forest Products Laboratory has found the wood of dawn redwood to be too light in weight, too weak, limber and soft to have economic value as a solid wood product. Its bending strength, crushing strength and hardness are only about two thirds those of second growth California redwood. This, according to the Forest Products Laboratory is in agreement with findings published sometime ago by the National Central University Forestry Institute in China. Many modern species yield wood far superior for lumber, plywood, furniture and other solid wood products. Apparently then, this tree holds little promise of bringing a new era in timber growing although the possibilities for its use in paper pulp might be investigated further.

Some of the taller Metasequoias in Cultivation

The following trees were measured in 1967; only the tallest tree at a single location is listed. Trees noted as 19–20 years old were undoubtedly grown from the first seed lot introduced from China by the Arnold Arboretum. Measurements for some of the English trees were supplied by Mr. A.F. Mitchell of the Forestry Commission Research Station, Wrecclesham, England and this data is greatly appreciated. Mr. Mitchell has been measuring the taller trees of this species in England for several years and supplied measurements of other 30–40 foot trees (8) but since the measurements were taken prior to 1967, they are not included here. Other measurements have been taken at the author's request, by various individuals responsible for growing the trees in question. It would have been more accurate if all measurements had been taken carefully by one individual, but such is not the case. We have the records of many other trees but those offered below are sufficient to show how this species has been growing in cultivation since 1948.

Some of the taller Metasequoias in Cultivation as of January 1, 1968

	Height in feet	*Age*	*Cones Produced*	*Age when Produced*
Princeton University, Princeton, N.J.	60′	20	Yes	15 4 sds.germ.and still alive

	Height in feet	*Age*	*Cones Produced*	*Age when Produced*
University of California Botanical Garden, Los Angeles, Calif.	59′ (1966)	20	Yes	10
Arnold Arboretum, Jamaica Plain, Mass.	58′	20	Yes	15
Henry F. Dupont, Winterthur, Del.	58′	20	?	
Willowwood Arboretum, Gladstone, N.J.	58′	20	Yes	10
Dr. J.J. Willaman, Plymouth Meeting, Penn.	57′	17	Yes	13
Missouri Botanical Garden, St. Louis, Mo.	55′	20	Yes	15
Frank Bailey Est., Locust Valley, N.Y.	55′	20?	Yes	15
Lacy Park, San Marino, Calif.	55′	15	Yes	15
Batumi Botanical Garden, Batumi, Georgian S.S.R., U.S.S.R.	55′	15	Yes	12
Leonardslee, Sussex, England	54′	—	?	
Windsor Great Park, Windsor, England	51′	20	Yes	
County of Los Angeles, Arcadia, Calif.	50′	19	Yes	15
Morris Arboretum, Philadelphia, Pa.	50′	20	Yes	20
Carleton Goff, Barrington, R.I.	50′	20	Yes	18
Smith College, Botanical Garden	50′	20	Yes	18
Arthur Hoyt Scott Foundation, Swarthmore, Pa.	50′	20	No	
Longwood Gardens, Kennett Square, Pa.	50′	20	Yes	10
Royal Botanical Gardens, Wisley, England	49′	?	No	
U.S. National Arboretum, Washington, D.C.	46′6″	20	Yes	15
Ladham House, Goudhurst, Kent, England	46′	17	?	
Brooklyn Botanic Garden, Brooklyn, N.Y.	45′	20	No	
Mrs. Donovan, 870 Regal Rd., Berkeley, Calif.	45′	?	?	
University Botanic Gardens, Cambridge, Eng.	43′6″	20	Yes	6
Robin Hill Arboretum, Lyndonville, N.Y.	43′	19	No	
Hoyt Arboretum, Portland, Oregon	40′	20	Yes	4
Secrest Arboretum, Wooster, Ohio	39′8″	19	Yes	19
Chiddingly, Sussex, England	39′	18	?	
Nymans, Sussex, England	37′	?	?	
Hungerdown Ho., Chippenham, Wilts, England	35′6″	?		

	Height in feet	*Age*	*Cones Produced*	*Age when Produced*
Alice Holt Lodge, Hants, England	35′	17	?	
Kennington Nursery, Oxford, England	34′	18	?	
Wayferd Manor, Somerset, England	33′	?	?	
Belmonte Arboretum, Wageningen, Holland 'Vada'	33′	19	No	
N.J. State Exp. Station, Rutgers, N.J.	30′	?	Yes	on a 3′ tree
Univ. of Washington Arboretum, Seattle, Wash.	30′	20	Yes	grown fr. sd.
	44′	10	?	prop. by cutts.
Mrs. Wm. McCoy Jr., Chagrin Falls, Ohio	30′	15	No	
San Diego Botanical Garden, San Diego, Cal.	30′	?	No	
Michigan State Univ. Bot. Garden, East Lansing, Michigan	30′	17	Yes	12
U.S.D.A. Forest Service, Berkeley, Calif.	28′	20	Yes	19 (3 viable sds.)
Morton Arboretum, Lisle. Illinois	25′6″	14	No	
Dawes Arboretum, Newark. Ohio	25′	?	No	
Callaway Gardens. Pine Mt.. Georgia	25′	9	No	
Belmonte Arboretum, Wageningen. Holland 'Moerheim'	25′	15	No	
Cole Nursery Co., Painesville, Ohio	25′	20	Yes	
Botanischer Garten. Dortmund. Germany	25′	16	?	Has 100 trees
Mr. Charles Platt. Allanby Farm. New Hope, Pa.	25′	13	Yes	10
Strybing Arboretum, San Francisco. Calif.	22′	20	Yes	19
Royal Botanical Garden, Edinburgh, Scotland	21′6″	20	No	

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BIBLIOGRAPHY

Just a few references are given here for those interested in further pursuing the interesting articles written about this tree since 1948.

1. Broekhuizen, J.T.M. and F.N. Zwart. Een Bijdrage tot de Kennis Van Metasequoia glyptostroboides. Communication #10, pp. 439–463. Nov. 1967. Institute of Forestry Research, Division of Silviculture, Agricultural University, Wageningen, Holland. (This includes 20 excellent references.)

2. Chaney, Ralph W. A revision of fossil Sequoia and Taxodium in western North America based on the recent discovery of Metasequoia. Trans. Am. Phil. Soc. 40 (3) 169–263; 1950.

3. De Vos, Francis. Metasequoia glyptostroboides 'National'. Am. Hort. Mag. 42 (3) 174–177. July 1963.

4. Florin, R. Botaniska notiser, (1) 1952 (1–29). (This contains a complete story and bibliography on subject of 137 titles from 18 countries in 14 different languages, all but 5 published after 1948.)

5. Hu, H.H. How Metasequoia, the "Living Fossil" was discovered in China. Jour. N.Y. Bot. Gard. 49: (585) 201–207. September 1948.

6. Li, Hiu-Lin. The Discovery and Cultivation of Metasequoia. Morris Arb. Bull. 8 (4) 49–53. Sept. 1957.

7. Merrill, E.D. Metasequoia—another "Living Fossil." Arnoldia 8: (1) 1–8. March 5, 1948.

8. Mitchell, A.F. The growth of Metasequoia. Jour. Roy. Hort. Soc. 89 (11) 468–469; Nov. 1964.

9. Wyman, D. Metasequoia brought up to date. Arnoldia 11: (3) 25–28. April 27, 1951.

1968 FALL COURSES OF THE ARNOLD ARBORETUM

Propagation of Woody Plants by Seeds Instructor: Alfred J. Fordham

A discussion of methods used to collect, clean, and pretreat seeds to prepare them for germination. Seeds to take home will be provided from the Arboretum collection. Suitable footgear should be worn, as part of the session will involve walking around the grounds.

Friday morning 10–12 o'clock. September 27, 1968

Free—but open only to * Friends of the Arnold Arboretum. Meet at the Dana Greenhouse.

Plants in Autumn at the Case Estates Instructor: Dr. Paul D. Sorenson

A series of informal talks and discussions about cultivated and native plants. The Case Estates in Weston will serve as an outdoor laboratory as long as weather conditions permit. The purposes are to familiarize one with our many decorative plants, their names, how to identify them, their use, and their cultivation. While no single text will be used, students will be introduced to certain sources in botanical literature which deal with plant families in general and more specifically with individual plants studied.

Suitable footgear for walking is recommended. Parking is available near barn at 135 Wellesley Street. All classes will meet first in the Little Red Schoolhouse at 133 Wellesley Street.

5 sessions Wednesday afternoons 2–4 o'clock. October 2 to 30

Registration fee for * Friends of the Arnold Arboretum $2.50; others $5.00

Fall Field Course in Ornamental Plants Instructor: Dr. Donald Wyman

Informal outdoor talks and field trips on the Arboretum grounds under the supervision of Dr. Wyman and the horticultural staff make up the Fall Field Class. Different plant groups are studied on each trip. The class sessions will consider the berried trees and shrubs, autumn color, the evergreens, and similar topics. Opportunities are afforded for questions and answers relating to the identification and culture of ornamental plants as seen in the Arboretum or as suitable for culture in New England. In case of rain or cold weather, meetings are held indoors.

4 sessions. Friday mornings 10–12 o'clock. October 4 to 25

Registration fee for * Friends of the Arnold Arboretum $2.50; others $5.00

Meet the Staff — A series of talks by members of the staff of the Arnold Arboretum of Harvard University.

Tuesday evenings, 8 o'clock. October 29 to December 3

The Red Schoolhouse, 133 Wellesley Street, Weston.

Watch for the listing of very interesting talks that will be given these evenings. The next *Arnoldia* will give full details.

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* Information on how to become a "Friend of the Arnold Arboretum" can be obtained by writing or calling the Arnold Arboretum, Arborway, Jamaica Plain, Mass. 02130.

ARNOLDIA

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POTENTILLA FRUTICOSA VARIETIES IN THE ARNOLD ARBORETUM

AT THE present time there are 46 named varieties or cultivars of *Potentilla fruticosa* growing in the nurseries and collections of the Arnold Arboretum. The species itself is native over both northern hemispheres. It has only been during the past few decades that the ornamental qualities of this species have begun to be appreciated, probably the reason why so many cultivars have been named. Alfred Rehder considered these mostly varieties of one species but H.L.J. Rhodes ("The Cultivated Shrubby Potentillas" Baileya 2: 89–96, 1954) and Wray M. Bowden (Cytotaxonomy of *Potentilla fruticosa*, allied species and cultivars, Journal of Arnold Arboretum 38: 381–388, 1957) have split these up into several species and hybrids. As far as this particular issue of Arnoldia is concerned, the plants will all be treated as varieties and cultivars of the one species, merely because that is the way we have received them from nurseries and botanical gardens throughout America and Europe as well.

The bush cinquefoil (*Potentilla fruticosa*) is one of the few woody plants native over both northern hemispheres. It can be found as a low mat of dense woody growth on top of the Olympic Mountains in Washington or high up in the Himalayas, and as three-foot shrubs in Michigan, as well as in Great Britain, Europe and China. Today, with our interest centered on planting small properties, such small shrubs should be of considerable value.

Not only are these plants valued from the standpoint of their height, but they also are in that admirable class which do not have any serious insect or disease troubles. The entire group is of interest for several months in the summer when few woody shrubs produce blooms, for their small bright yellow or white flowers begin to appear in July and are in evidence throughout the summer and well into the fall. Several varieties have originated in English gardens, some have been introduced from China and the Himalayan region, and some have originated in America.

These are not outstanding ornamental plants. They are not in the same ornamental class with roses or azaleas, but they are of value because of their interest in the summer, their low dense habit of growth, and their lack of persistent insect and disease pests. Plantsmen are usually anxious to grow shrubs and trees which require no care, and the varieties of this species are certainly in this category. One plant has been growing in the Arnold Arboretum for 60 years, and never has required any spraying.

All of the 46 varieties grown in our collections are not sufficiently different to warrant growing them in landscape plantings, for some are so similar that it is impossible for the gardener to tell them apart unless they are observed growing side by side.

First and foremost these are sun demanding plants which will not grow well in shaded situations. In order to flower profusely they must have a situation in the full sun. They seem to grow in any normal soil. Poor dry soil situations will result in slower less vigorous growth, but they do not require large amounts of moisture. The leaves are small and compound, usually with 3–7 leaflets, the single flowers having five petals are about $\frac{3}{4}$ of an inch in diameter, some varieties having white flowers but most being a creamy white to deep yellow. The fruits are dried capsules which unfortunately can remain on the plant for several years and so give it a rather untidy appearance. This can be alleviated by light pruning in the fall after the flowering period is over.

The varieties of *Potentilla fruticosa* are not susceptible to severe insect or disease pests. The species is easily propagated by seeds, and the varieties are easily propagated by soft-wood cuttings. As noted previously, these are not conspicuous landscape plants but their small size, dense habit, length of bloom, hardiness and ease of cultivation make them of increasing interest in small gardens where summer interest is desired.

The following notes were made from the plants in the Arnold Arboretum this year:

The varieties and cultivars started to bloom in late May and were first scored for flowers June 6th, then again July 17th and again August 15th. Those considered best in flower were:

'Katherine Dykes'	medium yellow
mandshurica	white
'Primrose Beauty'	pale yellow
'Longacre'	medium yellow

Those considered second best in flower were:

'Friedrichsenii'	medium yellow
'Golden Drop'	dark yellow
'Klondyke'	dark yellow

PLATE XXXVIII

Potentilla fruticosa 'Parvifolia' a variety with dark yellow flowers and narrow leaflets.

'Moonlight'	medium yellow
'Mt. Everest'	white
'Snowflake'	white

Those outstanding in foliage are:

	Leaves
'Beesii'	gray
'Elizabeth'	light green
'Gold Drop'	yellow green & feathery texture
'Klondyke'	feathery texture
mandshurica	grayish green
'Primrose Beauty'	grayish green
veitchii	light green
'Vilmoriniana'	grayish green

The tallest in our collection to date are:

	Height
davurica	5′
'Katherine Dykes'	5′
'Friedrichsenii' ('Berlin Beauty')	5′
'Mt. Everest'	5′
'Manley's'	4′
'Moonlight'	4′
'Ochroleuca'	4′
'Friesengold'	3½′
purdomii	3½′

The remainder are, at the present time, 3′ tall or lower. It should be pointed out that many of these plants are still young and their ultimate height and spread will not be known for some years to come. However, 'Beesii' seems to be as low as any, and in fact it has been listed in European catalogues under the name 'Nana Argentea'.

Varieties with the lowest habit are:

'Beesii'	1×2′	at 3 years
'Micrandra'	1×2′	at 8 years
'Sutter's Gold'	1×2′	at 8 years
'Tenuiloba'	1×3′	at 47 years
'Elizabeth'	2×4′	at 3 years

PLATE XXXIX

Potentilla fruticosa veitchii a variety with white flowers introduced by E.H. Wilson from China in 1900. The plant in the photograph is about 15 years old.

'Gold Drop'	2×3′	at 15 years
'Klondyke'	2×3′	at 10 years
'Longacre'	2×5′	at 9 years
'Woodland Gold'	2×4′	at 4 years
'Parvifolia'	2½×5′	at 45 years
'Snowflake'	2½×4′	at 7 years

The following notes were made from plants in the Arnold Arboretum or its nurseries during 1968.

	Height × Width	*Age, yrs.*	*Flowers in cms.* *Width*	*Width of petal*	*Color of Flowers*
'Arbuscula'	low	3	no fls.		
'Barnbarroch Hybrid'	1½′	12	3.4–4	1.5	medium yellow (5 lfts.)
'Beesii'	1×2′	3			yellow (5 lfts.)
'Bowle's Var.'	low	2	2.5	0.9	medium yellow (7–9 lfts.)
'Buttercup'	low	2	2.7	1.0	dark yellow (7 lfts.)
'Compacta Kornik'	low	2	2.5	0.8	white (5 lfts.)
'Coronation Triumph'	18″	2	2.7	0.9	medium yellow (5–7 lfts.)
'David Ayling'	2′	2	2.8	1.1	medium yellow (5 lfts.)
davurica	5×7′	38	3.2	1.5	white (5 lfts.)
'Elizabeth'	2×4′	3	3.5	1.4	medium yellow (5 lfts.)
'Farreri'	3×4′	29	2.0	0.6	dark yellow (7 lfts.)
'Farrer's White'	low	2	2.3	1.0	white (5 lfts.)
'Friedrichsenii' ('Berlin Beauty')	5×7′	66	3.0	1.0	medium yellow (5–7 lfts.)
'Friesengold'	3½×5′	4	3.0	1.0	medium yellow (5–7 lfts.)
'Gold Drop'	2×3′	15	2.5	0.8	dark yellow (5–7 lfts.)
'Grandiflora'	3×5′	29	3.5	1.5	dark yellow (5–7 lfts.)
'Hurstbourne'	low	3	2.0	0.9	medium yellow (7 lfts.)
'Katherine Dykes'	5×7′	17	3.0	1.2	medium yellow (5 lfts.)
'Klondyke'	2×3′	10	4.2	1.7	dark yellow (5–7 lfts.)
'Lady Daresbury'	low	8	3.5	1.5	medium yellow (5 lfts.)

	Height × Width	*Age, yrs.*	*Flowers in cms.* *Width*	*Width of petal*	*Color of Flowers*
'Logan'	low	2	3.1	1.4	dark yellow (5 lfts.)
'Longacre'	2×5′	9	3.0	1.2	medium yellow (5 lfts.)
mandshurica	3×5′	17	2.5	1.0	white (5 lfts.)
'Manley's'	4×6′	11	2.5	1.0	medium yellow (5 lfts.)
'Micrandra'	1×2′	8	2.5	0.8	dark yellow (5–7 lfts.)
'Moonlight'	4×6′	17	3.5	1.2	medium yellow (5 lfts.)
'Mt. Everest'	5×6′	8	3.0	1.3	white (5 lfts.)
'Nyewoods'	low	3	no fls.		(5 lfts.)
'Ochroleuca'	4×8′	66	3.0	1.0	pale yellow (5–7 lfts.)
'Parvifolia' ('Woodland Gold')	2½×5′	45	2.4	1.0	dark yellow (5–7 lfts.)
'Primrose Beauty'	3×4′	8	3.0	1.0	pale yellow (5–7 lfts.)
'Pumila'	2×3′	2	2.1	0.7	light yellow (5–9 lfts.)
purdomii	3½×4′	23	2.5	1.2	medium yellow (5–7 lfts.)
'Rhodocalyx'	low	1	2.5	1.0	white (5 lfts.)
'Rigida'	low, flat	2	no fls.		(5 lfts.)
'Snowflake'	2½×4′	7	3.0	1.2	white (5 lfts.)
subalbicans	2′	2	2.8	1.6	white (5 lfts.)
'Sulfuriensis'	low	2	2.1	1.0	pale yellow, almost white (5 lfts.)
'Sutter's Gold'	1×2′	8	3.5	1.5	dark yellow (5 lfts.)
'Tangerine'	low, flat	2	3.0	1.5	pale orange in shade (7 lfts.)
'Tenuiloba'	1×3′	47	2.5	1.0	dark yellow (5 lfts.)
veitchii	upright	2	3.0	1.2	white (5–9 lfts.)
'Vilmoriniana'	3′	2	2.5	1.0	light yellow (5–9 lfts.)
'Walton Park'	1×2′	3	3.5	1.3	dark yellow (5 lfts.)

Donald Wyman
Arnold Arboretum
Harvard University

"MEET THE STAFF" LECTURE SERIES

A series of talks by some members of the staff of the Arnold Arboretum of Harvard University.

Time: 8 P.M., Tuesday evenings: October 29 to December 3, 1968

Place: The Red School House, 133 Wellesley Street, Weston, Mass.

October 29: Birds, Bats and Botany: The Story of Pollination
Carroll E. Wood, Jr., Ph.D., Associate Curator

November 5: Identification of Horticultural Plants
Gordon P. DeWolfe, Ph.D., Horticultural Taxonomist

November 12: Climbing Plants, Stranglers and Whoa-Vines
Lorin I. Nevling, Jr., Ph.D., Associate Curator and Supervisor of the Herbaria

November 19: The True Yams, Their History and Uses
Bernice G. Schubert, Ph.D., Associate Curator

November 26: Exploring for Wild Dahlias in Mexico and Central America
Paul D. Sorensen, Ph.D., Assistant Horticultural Taxonomist

December 3: Around The World in 90 Days — Botanically Speaking
Richard A. Howard, Ph.D., Director, Arnold Arboretum

Refreshments will be served at 7:30 and the lecture will begin at 8:00 P.M. promptly. Please park at the areas indicated behind the barn.

The above series of talks for "Meet The Staff" requires a registration fee of $5.00 for Friends of the Arnold Arboretum*; $10.00 fee for others.

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* Information on how to become a "Friend of the Arnold Arboretum" can be obtained by writing or calling the Arnold Arboretum, Arborway, Jamaica Plain, Mass. 02130.

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