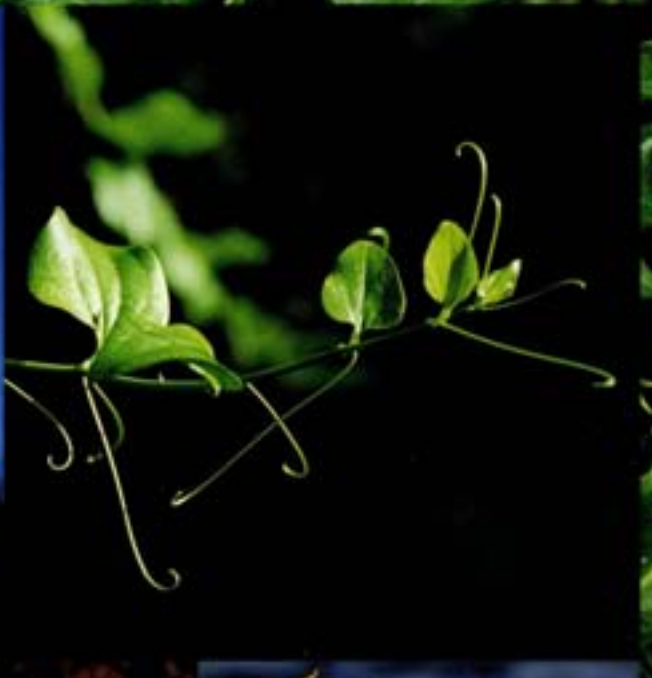
arnoldia

The Magazine of the Arnold Arboretum



arnoldia

Volume 62 • Number 2 • 2003

Arnoldia (ISSN 004–2633; USPS 866–100) is published quarterly by the Arnold Arboretum of Harvard University. Periodicals postage paid at Boston, Massachusetts.

Subscriptions are $20.00 per calendar year domestic, $25.00 foreign, payable in advance. Single copies of most issues are $5.00; the exceptions are 58/4–59/1 *(Metasequoia After Fifty Years)* and 54/4 *(A Sourcebook of Cultivar Names)*, which are $10.00. Remittances may be made in U S. dollars, by check drawn on a U S. bank, by international money order; or by Visa or Mastercard. Send orders, remittances, change-of-address notices, and all other subscription-related communications to. Circulation Manager, *Arnoldia*, The Arnold Arboretum, 125 Arborway, Jamaica Plain, Massachusetts 02130–3500. Telephone 617 524.1718; facsimile 617.524.1418; e-mail arnoldia@arnarb.harvard.edu

Postmaster: Send address changes to
Arnoldia Circulation Manager
The Arnold Arboretum
125 Arborway
Jamaica Plain, MA 02130–3500

Karen Madsen, *Editor*
Mary Jane Kaplan, *Copyeditor*
Andy Winther, *Designer*

Front Cover Clockwise from the upper left, *Lonicera sempervirens* (trumpet honeysuckle), *Smilax* spp. (briar), both photographed by Peter Del Tredici; *Hamamelis mollis* (Chinese witch hazel); and *Viburnum furcatum* (forked viburnum), both by Robert G. Mayer. The background, *Ilex cornuta*, is also by Peter Del Tredici.

Inside front cover: Malus prunifolia var. *xanthocarpa* on the left; *M* 'Wyema' on the right.

Inside back cover Inside a crabapple canopy looking out: it is a very good year for crabapples.

Back cover: The center greensward of the M. Victor and Frances Leventritt Garden, photographed by Karen Madsen, as were the inside covers.

Erratum. In volume 62, number 1, our last issue, the photographs of the Leventritt Garden on both front and back covers were not credited; they are the work of Alan Ward, author of *American Designed Landscapes: A Photographic Interpretation.*

Shrubs and Vines at the Arnold Arboretum: A History

Sheila Connor

In the Arboretum every effort has been made to foster the natural beauty of the landscapes and add to them wherever possible, but it has not been able to overcome the disadvantage of being a public garden. In the arrangement of the collection of shrubs the aesthetic has had to give way to the practical. Even in the matter of place there was no option since a considerable flat area of land was necessary and there is but one in the Arboretum.

—E. H. Wilson, *America's Greatest Garden* (1925)

For almost one hundred years, gardeners, homeowners, and students who wanted to learn about shrubs made their way to a gently sloping plot of land just inside and to the right of the Arboretum's Forest Hills gate. Bounded by the Arborway and Forest Hills Road on the north and east and by the ponds, natural woods, and maple collection on the south and west, the linear arrangement of the three-acre shrub collection made it easy to identify. Today the site hosts the Bradley Collection of Rosaceous Plants, but—as directors' reports and archival records document—before this transformation began in 1981, it had been home to the oldest continually maintained collection in the Arboretum's landscape.

Visually, it was perhaps also the most distinctive. Completely different from the rest of the Arboretum, where the picturesque reigns supreme despite the collection's taxonomic arrangement, the shrub collection's rows of formal, parallel beds probably confounded most visitors. The very existence of a separate shrub collection is a reminder of the difficulty of accommodating in a single design the disparate requirements of a scientific collection and a public park. It also reminds us of the sometimes opposing views held by the two men who accomplished that task, Charles Sprague Sargent and Frederick Law Olmsted.

In 1874, when he first approached Olmsted with the notion that an arboretum would be a valuable addition to the plan for the Boston park system, Sargent was 33 and although he had only "a modest reputation as gentleman landscape gardener," his professional standing was impressive and growing. In May of 1872 he was appointed professor of horticulture at the Bussey Institution (founded 1869; closed 1940s), a position first held by his friend, neighbor, and mentor Francis Parkman. (Sargent resigned this position at Harvard's school of scientific agriculture, which abutted on the Arboretum's land, in 1877.) In November of 1873 he became director of Harvard's botanic garden in Cambridge, working under Asa Gray, the father of American botany, and at the same time, he was named director of Harvard's newly established Arnold Arboretum in Jamaica Plain; it was in hopes of linking the new arboretum to the Boston park system that he addressed his proposal to Olmsted.

Olmsted, then 55 and still working in New York—on Central Park, among other projects—had a national reputation in landscape architecture and had been a proponent of arboreta since

The Arboretum's shrub and vine collection as photographed from a helicoptor by Massachusetts State Department of Public Works aerial photographers in June 1969, the year horticulturist Donald Wyman retired. The trellis, overwhelmed in places by vines, can be seen at right. From the Archives of the Arnold Arboretum

the beginning of his career. Sargent's proposal may have appealed to him because an arboretum had been included, though never realized, in the Olmsted and Vaux 1858 plan for Central Park.

SARGENT, OLMSTED, AND THE SHRUB GARDEN

The collaboration between the novice botanist and well-established landscape designer worked. Under Asa Gray's tutelage, Sargent had learned the importance of the individual elements within a landscape, and he valued the ability to recognize, identify, and compare each plant to all others. Olmsted, by contrast, looked beyond individual plants; for him, they were subordinate to the overall design and composition. But the two men agreed that the design for the Arboretum's landscape would have to satisfy both scientific and aesthetic requirements. And as Ida Hay writes in her preface to *Science in the Pleasure Ground* (1995) "the dynamic tension between science and aesthetics turned out to be one of the most interesting themes of Arboretum history."

Early in the planning process, Sargent insisted on accommodating "a working or experimental collection" within the otherwise wooded and naturalistic design. The idea may in fact have begun as a practical method for dealing with the abundance of shrubby plant material already on hand soon after the Arboretum's founding. Months before Olmsted's involvement and before any work had been done on the design, the future site of the shrub collection served as a nursery and a holding area for the thousands of plants intended for the rest of the grounds. Establishing a nursery and making an inventory of plants on hand were among the few projects that Sargent could undertake with "the very limited means at the disposal of the Director" during 1873, the first year of the Arboretum's existence.

The nursery site was possibly one of the most fertile areas of what an elderly Sargent much later recalled as the "worn-out farmland" on which the Arboretum was established. Described in 1692 as upland and meadow by its first recorded owner, Samuel Gore, the land became part of the farm of Joseph Weld in 1718 and remained in the Weld family until purchased by Benjamin Bussey in 1810. It was also conveniently adjacent to the Bussey Institution, where Sargent had established an office for himself and commandeered space in the greenhouses that were now to be "devoted to the raising of forest and ornamental trees and shrubs for future plantations" at the Arboretum. Seed for the new arboretum was pouring in from other institutions throughout the world, and Jackson Dawson, the Arboretum's first propagator (originally the Bussey's), was making ambitious collections of native plants. Within just three years, Sargent would report that "to relieve the overcrowded nurseries, 3,181 forest trees have been planted out."

Taken from the hillside just above the lilac and forsythia collections, this is one of the earliest known images of the Arboretum. The upland in the middle distance became the site of the shrub collection, and the treeline represents the future route of the Arborway, constructed in the early 1890s. Putting Olmsted's design into effect transformed the standing water of the low-lying, wet meadow into three distinct ponds, two of which were bisected by Meadow Road. This image is from the Lantern Slide Collection at the Harvard Design School, an especially comprehensive assemblage of images of early American landscape design. They were taken between 1850 and 1920 and digitized in 1996 through a Library of Congress-sponsored competition. The 2,800 lantern slides can be accessed through the American Memory Page of the Library of Congress (http://memory.loc.gov/ammem/award97/mhsdhtml/aladhome.html).

Published in the October 1898 issue of New England Magazine, *this image shows an early version of the collection's layout when the rows of "young shrubs" extended right up to the edge of the roadbed. Each plant's identity was painted on a wooden stake as the signage had not evolved to the "boldly lettered stand labels" that became the norm for the collection. Taken just inside the Forest Hills gate, the long view shows the remnant flora of "Woodland Hill," Benjamin Bussey's estate Several of the mature trees at the crest of the hill have the characteristic shape of American elms, while the conifers on the right appear to be white pines The group of trees in the middle distance occupies the present site of the ash collection just above the lilacs*

By 1878, when Frederick Law Olmsted began to work on a planting arrangement for the Arboretum, the nursery area had been under cultivation for five years and occupied much of the open land near the present-day ponds. Although one of his early studies suggests that Olmsted had considered a formal "greeting," or promenade, for this location, it is only in the last design, dated August 29, 1885, and signed by John Charles Olmsted, nephew and stepson of F. L. Olmsted, that the first reference to a plan for the area appears.

In the Bentham and Hooker plant classification sequence, which was used to arrange plant families within the Arboretum's landscape, the rose family should have been placed where it is today, near the ponds. Surprisingly, however, the plan calls for orchard-like rows of plants at that location. A likely explanation for this anomaly is that not only a nursery, but a collection of shrubs—arranged in rows—already occupied the site.

While at the botanic garden in Cambridge, Sargent had completed a successful and handsome renovation of the systematic beds. He had weeded duplicate specimens, increased the number of species, reordered the collection to correspond with the organization of specimens in the herbarium, and added grass paths to provide easy and attractive access to the plants. In Sargent's estimation he had "brought order out of Chaos." Faced with a "large and rich collection of shrubs located in the nursery" at the Arboretum, it is no wonder that he proposed in 1884 "to arrange this collection . . . in systematic order . . . until the completion of roads by

the city on the east side of the grounds make it possible to permanently group the different shrubs upon a [more] picturesque and natural plan than can now be adopted."

Although doing so required draining the ground below the nursery and relocating all the shrubs, within a single year he could claim that the "provisional or tentative arrangement of the shrub collections referred to in my last report has been completed. These now occupy thirty-seven parallel beds, each ten feet wide and three hundred feet long. This collection now contains about eleven hundred species and varieties arranged in botanical sequence, with provisions for a considerable further increase." Thus came into being the shrub collection whose design would simultaneously please botanists and horticulturists, irritate directors and superintendents, challenge landscape architects and students, and mystify many visitors throughout its century-long lifetime.

That year, 1885, was in general a momentous one for Sargent, with several projects begun during the previous decade now coming to culmination. In 1879, on the recommendation of Asa Gray, Sargent had been appointed to manage the nation's tenth forest census, and the results of that study had just been published as *The Report of the Forests of North America.* At the same time, an exhibit of over 500 samples of wood, amassed by Sargent for Morris K. Jesup, was about to open at the American Museum of Natural History in New York; the exhibit, called "The Woods of the United States," displayed Sargent's notes on each species' structure, qualities, and uses. Lobbying for the Arboretum to be included in the Boston park system had succeeded, and the indenture between the city and Harvard had been signed three years earlier. And, most significant of all for the Arboretum, the city had finally built enough roads so that the systematic planting of the "permanent" collection could begin.

At the end of the year, a confident Sargent described his vision for a public arboretum in the 1884–1885 *Annual Report of the Director of the Arnold Arboretum to the President and Fellows of Harvard College;* he had formally accepted the Olmsted firm's final plan for the planting arrangement and declared the first of the Arboretum's collections—the shrubs—completed. By this time he had decided that two distinct collections should be maintained within the Arboretum: the first, or "permanent collection for display, [would consist] of a selection of species intended to illustrate . . . the most important types of arborescent vegetation"; while the second, a "collection for investigation, which need not necessarily be permanent . . . should be arranged in a manner to permit the admission of . . . new forms and the removal of others which have served their purpose. To this second collection would naturally be joined all minor collections like that of shrubs and other plants of less enduring character than trees."

Olmsted's feelings about the displacement of Rosaceae by Sargent's shrub collection are unknown. Little correspondence between the two men survives—perhaps because, as Sargent testified many years later at a Park Department hearing, the two "spoke daily." The conversations between Olmsted and Sargent about the placement of shrubs must have been interesting. One letter, written by Sargent to Olmsted on April 22, 1888, when the tree groups were being set out on the hillside above the ponds, suggests that discussions about plant placement continued for years after Olmsted's final plans had been accepted. Of today's much beloved lilac collection and its bright yellow companions and fellow harbingers of spring, Sargent wrote, "Isn't it a mistake to plant forsythia, syringa [lilacs] and other showy flowered garden shrubs on the Arboretum Hill? I should be afraid that they would not harmonize with the general scheme of planting . . . How will a mass of bright colored garden flowers look rising above the softer first tints seen everywhere else in the Arboretum?"

Four months later the debate about the use of "showy" exotic shrubbery spilled over into the pages of Sargent's newly founded *Garden and Forest, a Journal of Horticulture, Landscape Art, and Forestry.* The first sally in the debate, appearing in the issue of August 1, 1888, was an unsigned note placed among the editorial articles. The sentiments may have come from the journal's knowledgeable New York editor, Williams Stiles, but they are as likely to have

originated with the journal's "conductor," Charles Sprague Sargent:

> It is not easy to explain why certain plants look distinctly in place in certain situations and why other plants look as distinctly out of place in the same situations. This is a matter which nature perhaps has settled for us. It is certain at any rate that combinations of plants other than those which nature makes or adopts inevitably possess inharmonious elements which no amount of familiarity can ever quite reconcile to the educated eye. Examples of what we wish to explain abound in all our public parks, and especially in Prospect Park in Brooklyn . . . where along the borders of some of the natural woods and in connection with native shrubbery great masses of garden shrubs, Diervillas, Philadelphus, Deutzias, Forsythias and Lilacs, have been inserted. These are all beautiful plants. They never seem out of place in a garden; but the moment they are placed in contact with our wild plants growing naturally as they do, fortunately, in the Brooklyn park, they look not only out of place, but are a positive injury to the scene.

As the designers of Prospect Park had been Olmsted and Calvert Vaux, it is not surprising that the editorial elicited a prompt reply from Mr. Olmsted.

> To the Editor of GARDEN AND FOREST:
>
> Sir.— In GARDEN AND FOREST of August 1st, page 266, the law seems to me to have been laid down that the introduction of foreign plants in our scenery is destructive of landscape repose and harmony. No exception was suggested, and the word harmony was used, if I am not mistaken, as it commonly is in criticism of landscape painting, not of matters of scientific interest.
>
> The question, as we understand it, is essentially this: Would all of the trees and bushes that had come of a foreign ancestry be noted before any of the old native stock?
>
> It appears to us . . . that the American Chionanthus, Angelica, Cercis, Ptelia, Sumachs, Flowering Dogwood, Pipevine and Rhododendrons would be placed before some of the foreign Barberries, Privets, Spireas, Loniceras, Forsythias, Diervillas or even Lilacs. We doubt if the stranger, seeing some of these latter bushes forming groups spontaneously with the natives, would suspect them to be of foreign origin . . .
>
> Frederick Law Olmsted,
> Brookline, September 1888

Perhaps the debate had ranged too widely—or come too close—for at this point the editor stepped in:

> Mr. Olmsted's letter should be read with the greatest care and attention. No man now living has created so much and such admirable landscape, and no man is better equipped to discuss all that relates to his art. The position which GARDEN AND FOREST has taken upon the question of composition in plantations made with the view of landscape effect is embraced in the following sentence, extracted from the article to which Mr. Olmsted refers: "It is certain, at any rate, that combinations of plants, other than those which nature makes or adopts, inevitably possess inharmonious elements which no amount of familiarity can ever quite reconcile to the educated eye." This sentence was written with special reference to the fact that in Prospect Park, in Brooklyn, various showy flowered garden-shrubs of foreign origin had been massed among native shrubs growing apparently spontaneously along the borders of a natural wood in the most sylvan part of the park. The effect which this combination produced appeared to us inharmonious, and therefore less pleasing than if the plantation had been confined to such shrubs as may be found growing naturally on Long Island in similar situations. How far the idea of harmony in composition in landscape is dependent upon association it is hard to say.
>
> The truth is that great masters of landscape construction can combine material drawn from many climates and many countries into one harmonious whole, but the masters of the art are not many, and the planter who is not sure of his genius can wisely follow nature in her teachings of harmony in composition. Had this reservation been made in the article referred to, our statement that "all attempts to force Nature, so to speak, by bringing in alien elements from remote continents and climates, must inevitably produce inharmonious results," would, perhaps, have been less open to criticism. —ED.

But by then the Arboretum's *Diervilla*, *Philadelphus*, and *Deutzia* (though not the large collections of *Syringa* and *Forsythia*) had been relegated to the shrub collection, away from the more "naturalistic" and "permanent" plantations. But this disposition may only have brought more trouble for Sargent. In almost every succeeding annual report he showed his

Although undated, this photograph from the J. Horace McFarland Collection was probably taken during the winter of 1905–1906, shortly after the construction of the vine trellis that enclosed the shrub garden on three sides McFarland (1859–1948), a lifelong friend of Charles Sprague Sargent and a well-known author, publisher, horticulturist, and rosarian, wrote as floridly on the Arboretum as he did on roses In "A Tree Garden to Last a Thousand Years," an article published in the first volume of "The Country Calendar" in 1905, he emphasized that "Even in the 'Order,' which is the name of the amphitheater of single specimens of shrubs, arranged in botanical order for easy comparison and study, there is informal formality and continuous beauty "

Part of the Smithsonian Institution Archives of American Gardens, which hold approximately 80,000 photographic images and records documenting historic and contemporary American gardens (available online at http://gardens.si edu/horticulture/res_ed/AAG/coll-mcf htm) the McFarland Collection includes over 3,100 black-and-white mounted photographs and 445 glass lantern slides of gardens throughout the United States and dates from 1900 to 1962.

obsession with the collection's ongoing needs and with his pursuit of the perfect design. If he was not "improving its arrangement," he was "devoting more time to studying and improving" it, or had to "extend and rearrange" it by "lifting every plant and rearranging the beds." One design revision—presumably made to accommodate more plants—changed the arrangement from 37 seven-foot beds to 15 eleven-foot beds, achieving an increase of only five feet (from 8,325 to 8,330). The collection was clearly "suffering from the want of proper space," and he worried how it would be "adequately provided for in the future." By 1906, the collection had undergone three complete rearrangements, and Sargent admitted that although it was a principal feature of the Arboretum and its most complete collection, "the arrangement has not, however, proved entirely satisfactory."

After one last attempt at redesign, this time with the plants displayed in 19 beds, each ten feet wide, and occupying a total of only 7,765

linear feet, Sargent conceded defeat. In 1907, he reports that it has been necessary to plant genera formerly accommodated in the shrub collection along the drives and in other parts of the arboretum. The "excluded" groups include the rhododendrons, azaleas, kalmias, and viburnum and dogwood collections. Mention of the shrub collection subsequently disappears from his annual reports.

He does, however, introduce a new element into the design. A ten-foot tall, 1,280-foot-long vine trellis was erected to provide shelter for the beds along the northern and eastern sides of the collection. Made of concrete posts strung with galvanized wire, it was the Arboretum's first attempt to bring together a collection of vines and other climbers. The trellis itself, not unlike the layout of the shrub collection, would be modified and rebuilt, but the two collections would soon be thought of as one: the shrub and vine collection.

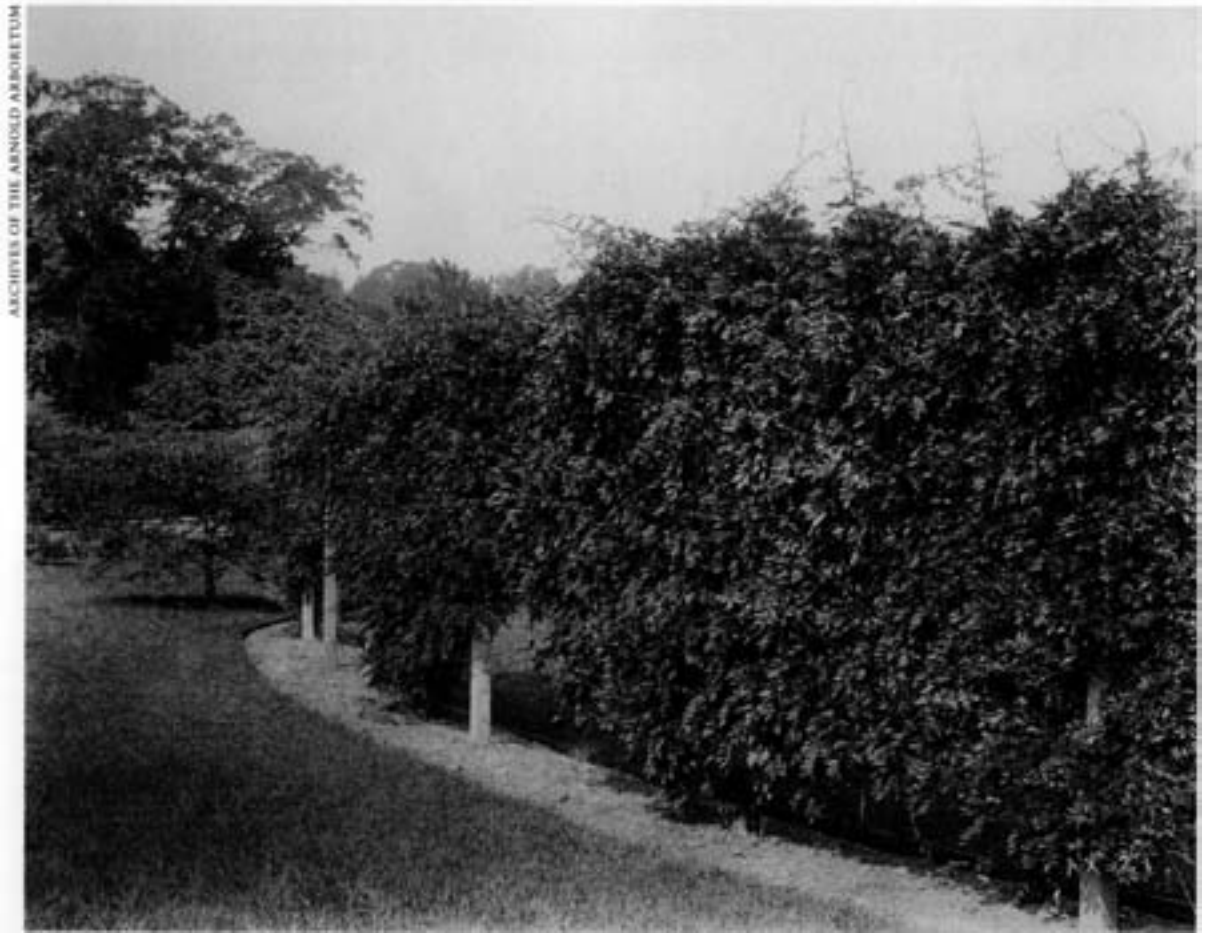
As for those conspicuous plantings on Bussey Hill, by the 1920s Sargent appears to have had a change of heart. Writing in *The Bulletin of Popular Information*, a seasonal guide to plants made available to Arboretum visitors for a dollar a year, he notes, "Forsythias are often badly planted; they require space in which to spread

G. R. KING, 1916. ARCHIVES OF THE ARNOLD ARBORETUM

"The shrubs are brought together in their respective genera and natural orders and there is only a single row of plants down the centre of the border This allows each plant to stand on its own ground without interference from its neighbor, and the convenience of the student is further aided by each specimen having a label on either side The general idea is somewhat similar to that of the arrangement of the herbaceous plants at Kew. Considered as part of the landscape this system is not beautiful, especially in the early stages, when the plants are not fully grown and bare spaces yet await their destined occupants. But for purposes of botanical study no other arrangement is so convenient." So wrote W J. Bean, Curator at the Royal Botanic Gardens, Kew, and author of Trees and Shrubs Hardy in the British Isles, *in the* Bulletin of Miscellaneous Information of the Royal Garden, Kew, *in October 1910, after his visit to the Arnold Arboretum.*

their long, gracefully arching branches and are not suitable for small gardens. To be most effective they should be planted as in the Arboretum, in a great mass on a bank or hillside."

The lilacs were also given their due by Sargent in the *Bulletin*, "The flowers of no other plant bring so many visitors to the Arboretum." Beginning in 1915, in what surely gave rise to the now famous Sunday celebration, Sargent began predicting when the lilacs would attain their fullest bloom. In 1920 he forecast that "Most of the varieties of the common lilac will be in flower when this Bulletin reaches its readers living near Boston." In May of 1920, he wrote, "The plants will be in full bloom by Saturday, the 29th," and when the spring of 1924 proved to be slow in coming, he commented that "They are late blooming this year but are now fast opening their flowers, and it is possible that Sunday, the 25th, will bring the largest number of visitors of the year to the Arboretum."



ARCHIVES OF THE ARNOLD ARBORETUM

The first trellis, constructed of ten-foot high posts of reinforced concrete set fifteen feet apart, provided seven parallel strands of wire for the vines to climb. According to E. H. Wilson, with this layout, all that was needed to keep the shrubs from interfering with their neighbors was the use of "a knife in late winter." Apparently some did overstep their bounds. Beginning in the mid 1930s, many of the most "aggressive" were removed and grown on the stone walls. While working on the rearrangement of the shrubs in 1950, Farrand proposed letting "delicate creepers" such as species clematis and single roses scramble over the rock walls or climb trees. She thought that "loose growing crabapples, small cherries, or pears would please the clematis tribe" and asked to be provided with a list of "tree-climbing creepers."

WILSON AND THE SHRUB GARDEN

When E. H. Wilson's book about the Arboretum, *America's Greatest Garden,* was published in 1925, most of the chapters had fanciful titles such as "Spring Pageantry," "Summer Luxuries," "Cherry Blossom Festival," "Crabapple Opulence," and "Azalea Carnival." By contrast, the chapter appearing second to last had the unadorned title "The Shrub Garden," followed only by "What the Arboretum Does." The chapter on the shrub collection opens with Wilson's declaration that "A garden where the convenience of the public has to be shown preference, labors under disadvantages unknown to private gardens where landscape effects alone have to be considered." Acknowledging that the shrub garden was established for the instruction of students, landscape gardeners, and plant lovers, and that its long, formal beds gave each plant ample room to develop, he described its arrangement as practical, convenient, and useful.

The design, he thought, did have some drawbacks: although every shrub was identified by name on two "boldly lettered" labels, one facing the grass paths on each side of the plant, some careless visitors made shortcuts across the beds and "many a small plant has carelessly been trodden to death as a consequence." As to its location, he could not say enough. It was the coldest spot in the Arboretum in the winter, and the hottest in the summer; and because it was low-lying, its air drainage was the poorest, so that it suffered the first frosts in fall and the last frosts of spring. If nothing else, it made an splendid testing ground for plant hardiness—in Wilson's estimation, if a plant could survive in the Arboretum's shrub collection it would "withstand the winter's cold and summer's heat of any part of New England." Regardless of its lack of "landscape beauty" and its less-than-ideal site, he thought there was probably "no more instructive a collection of shrubs in existence."

Between Sargent's death in 1927 and his own in 1930, Wilson, as "Keeper of the Arboretum," dutifully took up authorship of the *Bulletin.* Of the shrub collection he wrote that it "is a never failing source of interest to all visitors, filled as it is with a general miscellany of shrubs." He also liked to point out the attractiveness of various Asiatic representatives, many of which were his own introductions.

WYMAN AND THE SHRUB GARDEN

The collection's greatest champion since Sargent, Donald Wyman, was appointed horticulturist, a newly minted position, in 1936. In 1970, a year after his retirement, Wyman reflected on the state of horticulture at the Arboretum when he first arrived there, shortly after the deaths of both Sargent and Wilson, describing it as at an "all time low," with a pronounced "lack of staff interest in the living collection." In his opinion, "there was much work to be done."

Oakes Ames had replaced Sargent, though as supervisor rather than director. During his administration, from 1927 to 1935, specialists in plant pathology, wood anatomy, and genetics filled new staff positions. Elmer Drew Merrill, who succeeded Ames in 1935 and led the Arboretum until 1946, created the position of horticulturist and hired Wyman, who remained to serve under two more directors, Karl Sax (1946–1954) and Richard A. Howard (1954–1978).

Wyman valued shrubs, as well as groundcovers, hedges, vines, small trees, "choice evergreens that never grow tall," the best of flowering crabapples and lilacs, and all plants ornamental. As Sargent had championed trees, Wyman carried the banner for shrubs—his *Shrubs and Vines for American Gardens* came out two years before its much slimmer companion volume, *Trees for American Gardens.* A prolific author, his bibliography reflects his leanings: generally, the more ornamental a plant, the better, and even better yet if the plant was a shrub. He wrote articles about shrubs on the color, sequence of bloom, and seasonal interest of early, late, and summer blooming ones; he wrote about those not to be overlooked; those that were dwarf, fruited, and rare; and those that could be used for hedges or in the shade. He listed "Forty-five of the Best Shrubs for Massachusetts Gardens" in *Arnoldia* (1951, vol. 11, no. 1), suggesting that shrubs could "fill your garden with color," but cautioning, in an October 1950 issue of *Horticulture* magazine

(vol. 28), "Be Careful with These Colored Foliage Shrubs." His advice in a November issue (1947, vol. 25) was to "Look Around This Month for Fruited Shrubs to Plant."

He introduced the practice of displaying "the best, most ornamental" plants in the Arboretum. From a horticultural standpoint, the opportunity to compare plants growing side-by-side—especially the many that were by now mature specimens—was distinctly useful. So valuable did he find the shrub collection, now numbering over a thousand plants, that in "How to Spend an Hour in the Arboretum," published in 1945 in *Arnoldia* (the renamed *Bulletin of Popular Information*), he suggested that visitors with only a limited amount of time could best spend it "examining the long rows of shrubs many of which are commonly grown in nurseries and hence are available to every homeowner." He concluded the article with these remarks: "This shrub collection is one of the very few places in this country where so many different kinds of woody plants can be seen and closely examined in such a small area. An hour spent here is well worth while to both amateur gardeners and professional plantsmen."

An additional motivation for writing the article may have been that Wyman now knew each of the shrubs intimately, having just completed his own revamping of the collection. This rearrangement was driven more by the necessity to reduce the amount of hand labor needed to manage the collection than to increase its numbers or to enhance its display. The institution was on the cusp of recovering from war-related labor shortages that had exacerbated the effects of the hurricane of 1938 as well as ongoing seasonal damage due to "snow and ice . . . storm and fire." In Merrill's annual report for 1945–1946 he decries the condition of the grounds, admitting, "some of the plantings actually approached a deplorable condition" and hoped to "go far in repairing the ravages due to neglect." One laborsaving cost reduction Merrill could report on was that "through the rearrangement of the very large shrub collection, permitting the use of mechanical equipment, the actual maintenance cost has been reduced to one-fifth of what it was."

A NEW COLLABORATION: WYMAN AND FARRAND

To help restore the collection, Beatrix Farrand was "added to the staff, on a retainer basis, as a consulting landscape gardener." According to Donald Wyman, "Although many had tried to obtain permission to become consulting landscape architects," she was the first landscape architect since Olmsted to work at the Arboretum. Farrand's association with what she considered her *alma mater* had begun in the 1890s, when as a young student she had studied at the Arboretum under Sargent's guidance. While Farrand may have known the collections well, in Ida Hay's estimation her "grasp of the *raison d'etre* behind the Arboretum's original layout and subsequent development was somewhat sketchy."

The Arboretum's archives include much of Farrand's correspondence and other writings regarding her plans for rejuvenating the collections. The notes she made after a visit to the Arboretum in the spring of 1947 include her first mention of possible changes to the shrub collection. "The remodeling of the present shrub collection should be done as soon as financially possible. All the formal beds in straight rows should be removed and the space now occupied by their stiff lines made into a big meadow, where moisture loving trees might be planted . . ." She pointed out that there was sufficient space nearby "to exhibit a collection of the best shrubs, choosing the most attractive varieties and relegating the less good sorts to the 'study' nursery whether at Weston [the recently acquired Case Estates] or elsewhere." She also asked for a list of the shrubs (presumably from Dr. Wyman) "with comments on their attractiveness and their size and condition . . . some would be banished . . . and others, perhaps the newer sorts, would be added." Wyman, just having successfully laid the shrub collection "to rest," must have wondered just exactly where the role of the horticulturist intersected with that of the consulting landscape gardener. The Wyman-Farrand collaboration was to prove every bit as challenging as that of the earlier team of plantsman and landscape architect, Sargent and Olmsted.

In 1946, in an effort to eliminate hand labor and reduce costs, a "judicious arrangement" of the shrub collection's beds coupled with replacement of alternate grass walks with harrowed swaths and repositioned labels enabled the use of mechanized equipment and weed killers. A Ford-Ferguson tractor is seen here harrowing between the rows for weed control.

Donald Wyman experimented with a series of weed killers that ran the gamut from using flame throwers to "burn off" poison ivy to spraying sodium arsenate and sodium chlorate on annual weeds. He also introduced spent hops (probably acquired from local breweries in Jamaica Plain) as a weed-controlling mulch. In this photograph "Dowpon" (2,2-dichloropropionic acid) sprayed on the grass is used to edge the beds.

Donald Wyman and Beatrix Farrand did agree on the state of the grounds. Faced with an overcrowded and undermaintained landscape, they both saw a need for better management. While Wyman wanted to select the most ornamental material and weed out the rest. Farrand wanted to eliminate "duplicate and over-aged plants." But she too wished to "display to advantage the best and most ornamental of the plants now growing at the arboretum," according to her 1946 article "Contemplated Landscape Changes at the Arboretum."

Wyman did act on many of Farrand's suggestions. Although it bore no relationship at all to the Bentham and Hooker system, the azalea border along Meadow Road, arranged by color and designed by Farrand to present a sequence of bloom, was attractive and an instructional addition. The north slope of Peters Hill was rehabilitated, as was part of the top of Bussey Hill. The dogwoods were relocated, some along Bridal Path and others on Bussey Hill. The shrub collection itself, however, remained inviolate.

Between 1947 and 1952, while her other suggestions were being carried out, Farrand's proposed renovation of the collection was the subject of over fifteen letters between her and Karl Sax, the Arboretum's director. Sax thought at first that there "were some differences of opinion regarding this project. Wyman thinks that the present arrangement is much less

Beatrix Farrand envisioned a delicate rose arbor to replace the trellis, but the unanticipated relocation of the wisteria collection in 1951 required the construction of a very long, substantial edifice of cedar posts. Farrand, ever gracious, wrote to Sax inquiring about its design. "The news you have finished the arbor and planted the wisterias is thrilling. You are most secret as to what the arbor is made of, how large and long it is, so I am in a twitter to hear more about it." Sax's reply was less than enthusiastic "The new arbor in the shrub collection looks a bit raw at present, but it will mellow with time, I hope. As is the case in all our work we have to make some compromise between expense, botanic garden objectives and landscape design."

expensive to maintain," and though Sax is clear that he had "never liked the present arrangement . . . some of the other people seem to like to have the shrubs in an orderly catalogue collection as they are at present."

The next year, however, he wrote, "I can assure you that none of us like the rigid arrangement of the shrub collection, but if we are going to maintain the shrub collection on the Arboretum grounds there is not much alternative." She argued the need "to consider the eventual elimination of these rigid beds, situated where Professor Sargent felt they were not wisely placed from the point of view of design."

By 1950 Sax was asking if Farrand had "figured out how our 600–700 shrubs can be properly arranged in the available space?" She replied that "indeed I am struggling with the monumental problem of how to rearrange the 600–700 shrubs in a less grid-iron manner" and asked, "Do the beds really need to be 20' wide or could 10' beds and 8' walks be substituted?" She had calculated that she could fit in 665 shrubs, feeling that the number "can probably be squeezed up to the 700 by crowding some of the smaller species," and she sent him a quick drawing. Receiving no reply she wrote, "Was the plan so bad that it has caused you to faint and fall by the wayside, or have you any comment on which we can start our drawing?"

Actually faced with a plan, even though it was only a sketch, Sax changed the thrust of his argument, now emphasizing maintenance costs as the reason for squelching the project. "Certainly the revised plan of the shrub collection is a great improvement in design, but the initial cost would be high and the subsequent maintenance

would be increased at least three-fold." His next letter assured her that "we realize the need for re-vamping the shrub collection . . . but it looks as though we are due for a continued and perhaps severe inflation. We do not want to develop projects which would add materially to future maintenance costs until we can see some way of meeting these financial obligations." She replied, "Indeed your dilemma and problem are most sympathetically understood here by a very aged and devoted friend of the Arboretum," but "Perhaps—and this is but a suggestion—it might be worth thinking over doing over a small section at a time . . ."

Only one more mention of the shrub collection appears in their correspondence. Sax wrote, in 1951, that another problem had arisen that would further complicate her revision: the wisteria collection had to be moved from the grounds of the Bussey Institution, requiring that a new arbor be quickly constructed adjacent to the shrubs. As Farrand's plans had always included a design for the arbor—a very delicate design—the wisterias' needs finally brought an end to the project.

Wyman's recollections in "Horticulture at the Arnold Arboretum, 1936–1970" (*Arnoldia* vol. 30, no. 3) support the maintenance issues and raised additional objections that were perhaps not voiced in the 1950s. "When [Farrand] recommended that the shrub collection be removed and the shrubs planted in small groups in the same area, it became obvious to both Dr. Merrill and Dr. Karl Sax that some of her ideas, if carried out, would cost far too much in day-to-day maintenance. It has always been my strong conviction that landscape planning should be left to those on the staff who have had landscape training and who understand the diverse practical problems of maintaining the plantings."

Wyman used the shrub collection as a teaching tool and as an important resource in his famous series of Friday morning Arboretum "walks." But with his retirement in 1969 the collection lost its spokesman and defender, and the next decade saw a decline in the number of new plantings. The diversity of the collection—always noted for its encyclopedic content—began to diminish, with large gaps appearing when aging plants died and were not replaced. The sharply edged grass paths had long since disappeared. Mechanized cultivators (rather than more careful human hands) had been used since the mid 1940s to keep weeds between the rows to a minimum; nonetheless, woody weeds began to overtake some of the specimen plants and the entire collection took on a forlorn and unkempt appearance.

THE FINAL CHAPTER

Peter Ashton's arrival from Britain in 1979 to replace the retiring director, Richard Howard, coincided with a renewed interest in the design legacy of Frederick Law Olmsted. Assessing the grounds from this point of view, and with a knowledgeable and practiced eye for naturalistic landscapes, Ashton was astounded by the sight of the shrub collection. It had been so much a part of the Arboretum's landscape for so long that no one on the staff questioned its existence, location, or design, but Ashton felt strongly that it not only jarred with the Olmsted design it was, in fact, an eyesore.

Investigations at what was soon to become the Frederick Law Olmsted National Historic Site turned up a full set of plans for the Arboretum that showed Olmsted's original intentions for this part of the grounds. Ashton was excited by the opportunity to finally put the rose family in its rightful place, considering this a project that could initiate a restoration of the entire grounds to the Olmsted-Sargent plan. Through the generous bequest of Eleanor Cabot Bradley, a longstanding member of the Arboretum's visiting committee and an avid plantswoman in her own right, the garden of rosaceous plants took shape on the site of the shrub collection. It had taken over a hundred years to implement the last piece of Olmsted's plan; it would take two more decades, a new director, and another generous woman, Frances Leventritt, to find a new site and to perfect a design for the shrub and vine collection that realized Sargent's goal for "a collection for investigation, which need not necessarily be permanent, and which should be arranged in a manner to permit the admission of . . . new forms and the removal of others which have served their purpose."

Sheila Connor is horticultural research archivist at the Arnold Arboretum.

Ordering and Terracing in the Leventritt Garden

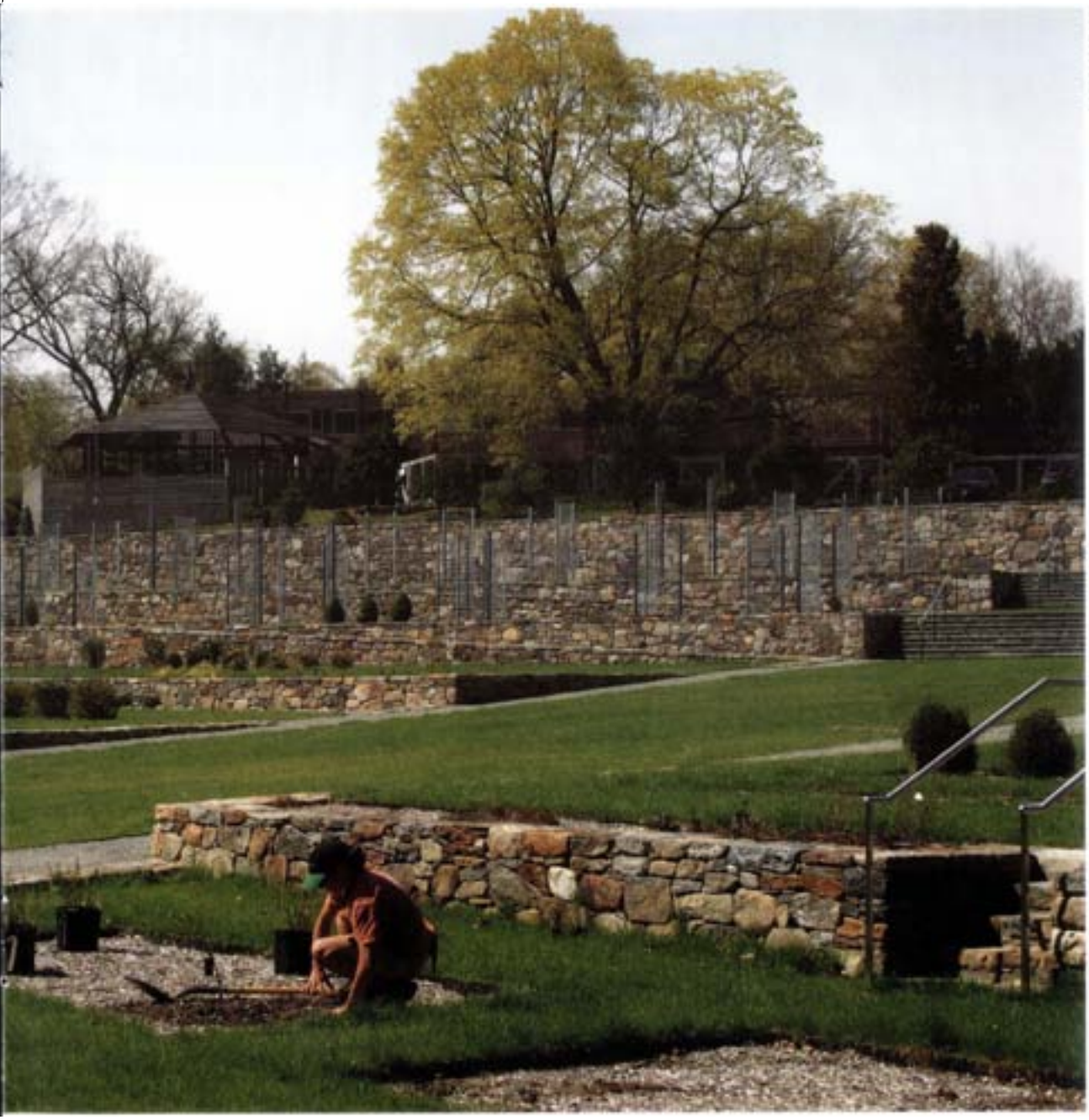
Douglas P. Reed and Gary Hilderbrand

We think of gardens as one of our fundamental means of cultural expression: they embody particular ideas of use, or cultivation, commemoration, or other aspects of human enterprise. The Arnold Arboretum's new M. Victor and Frances Leventritt Garden for sun-loving shrubs and vines, as an enclosed garden—a *hortus conclusis*—within the larger Arnold Arboretum landscape, gives expression to an essential question of botanical and horticultural purpose: How should plants be arranged for study and display?

The garden's layout pursues the question with directness in two ways. First, the land, a fan-shaped parcel that slopes more than thirty feet, has been reshaped into level terraces of varying width to fit the site's irregular outline. This reshaping is rooted in the ancient practice of leveling ground for cultivation where the land is not naturally flat. Second, plants are arranged in rows or within geometric groups, a familiar method stemming from the most basic of horticultural traditions. Geometry aids in our work with nature.

Anyone who has grown their own lettuce or apples or corn knows the importance of this practice: for planting, for harvesting, for pruning and irrigating, some system of order is required; planting in rows on level ground makes sense. During the sixteenth and seventeenth centuries, when emerging medical faculties in European universities began to build knowledge in plant culture and taxonomy, they organized "physic gardens"—at St. Galls, Oxford, Leiden, Padua—in rectilinear or curving rows, with an eye to the aggregate pattern as an artful exercise in order. The Italians, who possessed almost no flat land,

Bethany Grasso, shrub and vine gardener, planting the Leventritt Garden The lath house of the Larz Anderson Bonsai Collection is at center, to the left of an imposing sugar maple. Metal trellises, soon to be covered in vines, range along the top two walls



The vine supports in Claude Monet's garden at Giverny, France, is one of many precedents for simple, straightforward, metal trellises

At Monticello Thomas Jefferson designed a thousand-foot-long terrace for his vegetable garden, which was both practical—a source of food—and experimental.

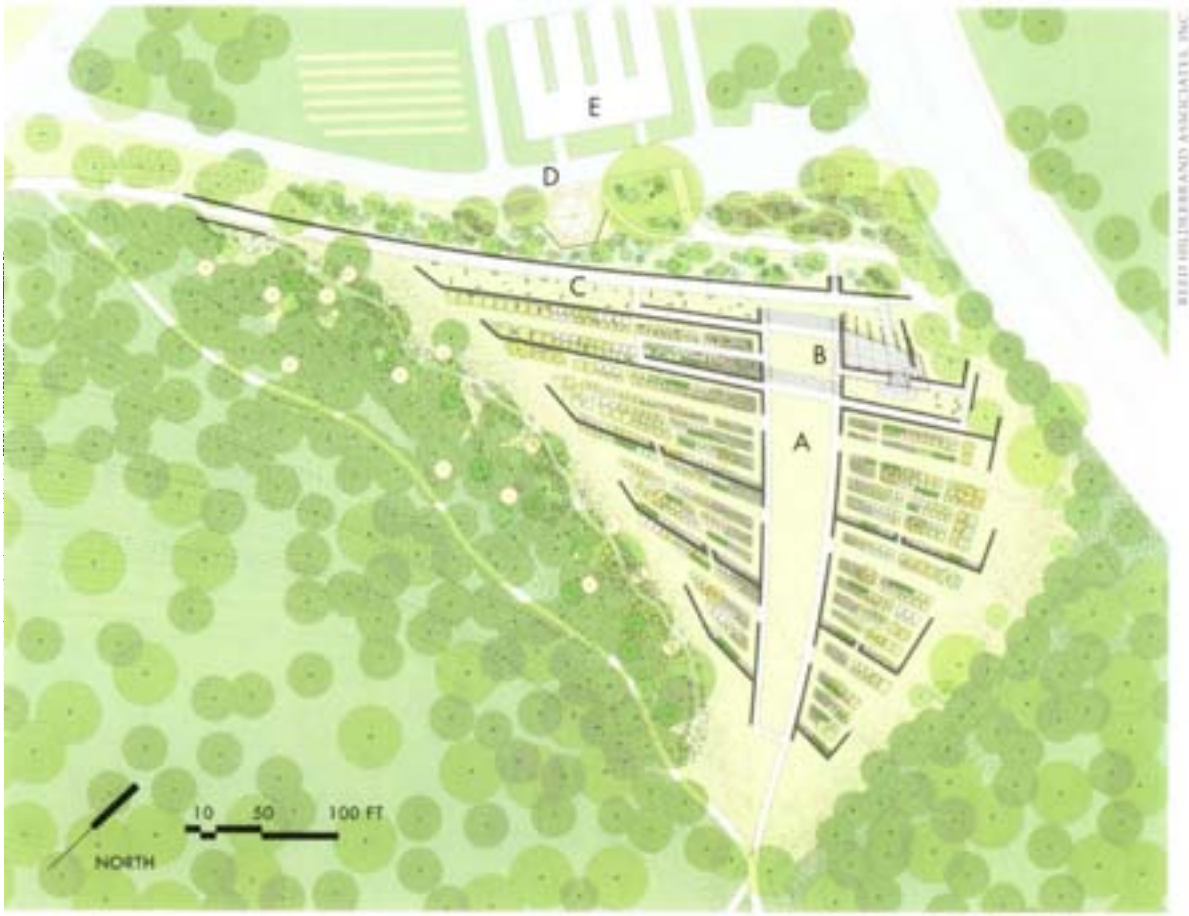
mastered the art of terracing as their primary spatial means in display gardens, meanwhile developing a tendency toward aggrandized processional space across and between terraces for spectacle and ceremony. French seventeenth-century garden designers elaborated these patterns to the point of extreme formalism, but always rooted their gardens in the measured logic of ordered planting.

Garden traditions were carried to the New World by collectors and farmers alike. Planters such as Thomas Jefferson and George Washington pursued an American model of husbandry on large landholdings, carving magnificent estates out of old growth forest and patchwork farms. They organized portions of their land to capture views and exploit scenic possibilities, and with the luxury of vast holdings, they anticipated a more romanticized view of the landscape for Americans. Yet when it came to planting for production or display, both relied on practical linear arrangements and simple terracing. The rational beauty of these devices can be seen today in the restored gardens of Monticello and Mount Vernon.

For us, the task of designing a new shrub and vine garden at the beginning of the twenty-first century presented a clear challenge: to provide an arrangement that would satisfy the curatorial needs of the Arboretum staff and to develop a memorable spatial experience of the site. Here we found a convergence of horticultural science and landscape design that evolved into a unique expression of program and site.

The advantages of terracing the site were obvious. Level terraces accommodate the planting beds; slopes, ramps, and stairs provide accessible routes throughout. A main terrace, separated from the adjacent drives and greenhouse area by a stone wall nearly 500 feet in length, provides a setting for the garden's outdoor pavilion and principal space for public events. This terrace also organizes the majority of trellises for vine display. From here, successively wider terraces descend toward the lower portion of the site. The outlines of these terraces reflect the topographic form of the site, and the shrub beds also conform in shape and proportion. A gently sloping arc of lawn, also envisioned as a gathering space, cuts across each terrace and provides a visual center to the garden.

With the shape and orientation of display terraces established, the collections were organized according to horticultural criteria—soil



The Leventritt Garden in plan A is the central lawn; B is left of the pavilion; C marks the vine structures; D the Larz Anderson Bonsai House; E the Dana Greenhouse complex

and moisture requirements, exposure and shade tolerance, size and growth habit—to reinforce the spatial form of the site. A distribution of small deciduous trees and groups of broadleaf evergreens are distributed across the scheme to amplify the garden's structure and add winter interest. The garden's edges are used to fulfill certain curatorial objectives, including the display of plants from the woodland edge community, and also accommodate relocated plants from the dwarf conifer collection that inhabited the site prior to construction.

Seen from the vantage point above the garden's main terrace, the scheme is expansive and directional, with the site's roughly triangular shape emphasizing an arcing lawn and path that gesture back toward the Arboretum's open lawns and pervasive canopy trees. Yet when viewed from below, as the true breadth of terraces and masonry walls becomes more apparent, the scheme's dual nature is realized: it is both a traditional terraced display and an active, modern sculptural form whose essential expression is derived from the site's specific conditions.

These design intentions bring coherence to the garden and establish an identifiable spatial image for the site. The earthwork and masonry efforts required to achieve this were monumental, but they were well within the enduring traditions of garden making. Planting the collections and bringing them to maturity will take time, but the order and structure are visible at the outset and the real work of the garden—research and display, cultivating and maintaining—is well under way.

Douglas Reed and Gary Hilderbrand are principals of Reed Hilderbrand, the Leventritt Garden's landscape architects They collaborated with Maryann Thompson, Architect.







Sun-Loving Shrubs and Vines for the Leventritt Garden

Peter Del Tredici, Michael Dosmann, Tom Ward, and Julie Coop

The position of the shrub is distinctly secondary, and the burden of the inferior race is upon it. A tree may be valued for what it is, but a shrub is rated for just what it can do. It must render a service to compensate for its cultivation. This service may be one of beauty, through its flowers; or of use, by its fruit; or its foliage or habit of growth may be especially attractive, or of such a nature as will give it value as a shield or a cover for waste and barren places.

—Harriet Keeler, *Our Native Trees and How to Identify Them*, 1900

The Leventritt Garden adds a new component to the Arboretum's collections—a display of sun-loving shrubs and vines suitable for southern New England. Unlike the main Arboretum collections, which are principally intended for scientific research, the new garden has been designed to demonstrate the horticultural qualities of both species and cultivars. Nonetheless, it will contribute to the Arboretum's scientific mission by adding genera—particularly vines and herbaceous perennials—in botanical families that are important to our research.

Selecting the Plants

Working from fall 2000 through spring 2001, our plant selection committee—the authors, landscape projects manager Laura Tenny Brogna, former assistant education director Ellen Bennett, gardener Bethany Grasso, and intern Stacey Berghammer—generated the list of plants to be included, first establishing our criteria. We agreed to give preference to plants that meet at least two and preferably three of the criteria in any of the three categories, horticultural, botanical, and educational. Many of our selections already exist in the Arboretum's collections, and many more will be acquired from other botanical collections and commercial sources.

Criteria for Horticultural Display

MULTISEASONALITY. In most instances, plants of single-season interest will not be included. To ensure interest year-round, preference will be given to plants with a minimum of two, if not three, seasons of ornamental interest, whether bloom, fruit display, autumn leaf color, or texture.

PROVEN PERFORMANCE. Most shrubs will be selected for outstanding horticultural merit, that is, nursery selections that are superior in size, color, or persistence of bloom; in texture, form, or color of foliage; or form and stature of habit. Choices will be determined by performance in the Arboretum as well as in other botanical gardens and landscapes. These will include the best of the dwarf conifers previously located on this site. Some of the vines will also be chosen for horticultural merit; the genus *Clematis* will be well represented, as will *Lonicera* and *Wisteria*.

Botanical Criteria

GENERA AND SPECIES THAT ARE PART OF IMPORTANT BOTANICAL FAMILIES BUT ARE NOT WELL REPRESENTED IN THE MAIN COLLECTIONS. These include shrubs that do not prosper in the main collections because they lack sun or because small stature or slow growth rate exposes them to damage by dogs, humans, and mowers.

Left to right, top row: Enkianthus perulatus *form and flower; middle row,* Aconitum sinomontanum *(Chinese monkshood),* Elliottia racemosa *(Georgia plume),* Hamamelis x intermedia *'Diane' (hybrid witch hazel); bottom row,* Caragana arborescens *'Nana' (low-growing pea tree) form and flower. Photographs by Peter Del Tredici, Gary Koller, John Alexander III, Robert G Mayer.*

From left to right, Viburnum opulus *(European cranberry bush),* V. hupehense *(Hubei viburnum),* V. phleobotrichum, V. dilatatum *(linden viburnum).*

Examples of those that will find a home in the raised beds of the Leventritt Garden are *Buxus* and shrubby members of Fabaceae such as the brooms, *Cytisus* and *Genista.*

Many of the vines will be selected for their botanical value rather than ornamental interest. Structures for growing vines in the Arboretum's main grounds were heretofore limited to the few remaining perimeter fences. The Leventritt Garden will accommodate many vines new to the Arboretum.

Several important botanical families in North Temperate floras are represented primarily by herbaceous plants, including some that were cultivated at the Arboretum in earlier years. The garden provides the opportunity to augment the botanical collections of these families and genera.

Educational Opportunities

These selections will determine the opportunities for learning that the garden will offer. The range of subjects will expand over time; below are some of the areas of interest that our plant selections will support. Orientation and storytelling signs, informational pamphlets, identification labels, and docent tours will be used as interpretive aids.

COMPARISONS OF WILD TAXA WITH THEIR CULTIVATED TAXA. For instance, the flowering of redbuds, *Cercis canadensis* and its cultivars 'Kovey' and 'Alba', can be contrasted in spring. In summer, the differences between species hydrangeas, clethras, and stewartias and their respective cultivars can be studied.

PLANT SOLUTIONS FOR LANDSCAPE PROBLEMS. *Ilex glabra* and *Rhus aromatica* can stop bank erosion. Ericaceous plants grow well in acid soils. *Comptonia peregrina* tolerates poor soils. Vines can create wonderful vertical screens, and for horizontal screens, shrubby hedges are superb.

SPECIAL ORNAMENTAL QUALITIES. For ornamental winter interest, witch hazels lead the list. Buddleias are just one example of a widely adaptable plant that sustains flowering over much of the summer. For fragrance, the daphnes, jasmines, and honeysuckles are prime performers. Plants with colored foliage and bold textures will also be highlighted.

BIODIVERSITY AND BIOGEOGRAPHY. Biogeography—specifically the study of disjunct populations in Asia and North America—has been central to the Arboretum's research for more than a century. It will be demonstrated on the ground in the Leventritt Garden, where the native *Chionanthus virginicus* will be compared to its Asian counterpart, *C. retusus,* as will *Asarum canadensis* with *A. splendens* and *Pachysandra procumbens* with *P. terminalis.*

PLANT CONSERVATION. Another area of long-term interest has been the conservation of endangered plants by growing them *ex situ,*

namely, here at the Arboretum. *Elliottia racemosa, Prunus depressa,* and *Andromeda glaucophylla* head a long list of species in this category; among others to be included are *Amelanchier nantucketensis, Ilex collina,* and *Abeliophylum distichum.* At the other end of the spectrum, plants that thrive too well—often on what were the sites of presently endangered species—will also be available for study, kudzu and greenbriar among them.

Placing the Plants

In autumn 2001, Reed Hilderbrand Landscape Architects submitted a set of concepts for the planting plan that included locations and distributions of small evergreen shrubs as well as small- to medium-sized trees (arrayed for visual effects in spatial and rhythmic patterns) and drawings of microclimate variations, optimum shrub sizes (varying by bed and terrace position), and traffic flow.

The planting design committee—the authors along with Laura Tenny Brogna and Bethany Grasso—began its task by considering the distribution and size constraints of evergreens and small trees. We placed larger plants at the sides and toward the middle of each terrace, and slotted a high proportion of low-growing plants in the lower terraces.

Microclimate variations (sun/shade, dry/mesic soils) in the garden are minor and we assigned them a low priority with a single exception. We designated the lower, northernmost end as a frost pocket. Tender material, if included at all in this garden, will be placed in the uppermost terrace and above the great wall.

With these considerations in mind, the committee began to partition the entire plant list into manageable groups and to locate individual taxa and groups in plan.

Vines were sited in the upper terraces according to their growing requirements and their collections and ornamental value. Because wisterias require a high degree of structural support, they are primarily clustered on and around the pavilion; the remaining plants climb on trellises, columns, and/or wall bases.

Small- to medium-sized trees were included on our list specifically for design effect. We followed the landscape architects' proposals in locating most of them within the terraces or at the garden edges with individuals extending from the ravine area across the terraces. Eastern redbud *(Cercis canadensis)* and a few of its variants were selected as the primary tree candidates. We sited deciduous and evergreen shade trees along Centre Street to serve as sound and visual barriers.

Clockwise from top, Chionanthus virginicus *(white fringetree) flowers,* C. retusus *(Chinese fringetree) flowers and fruit*

Growth Patterns of Vines for the Leventritt Garden

The plants that we call vines have in common a climbing habit, but how they climb varies widely. The major mechanisms will be represented in the Leventritt Garden.

Adventitious Root Climbers

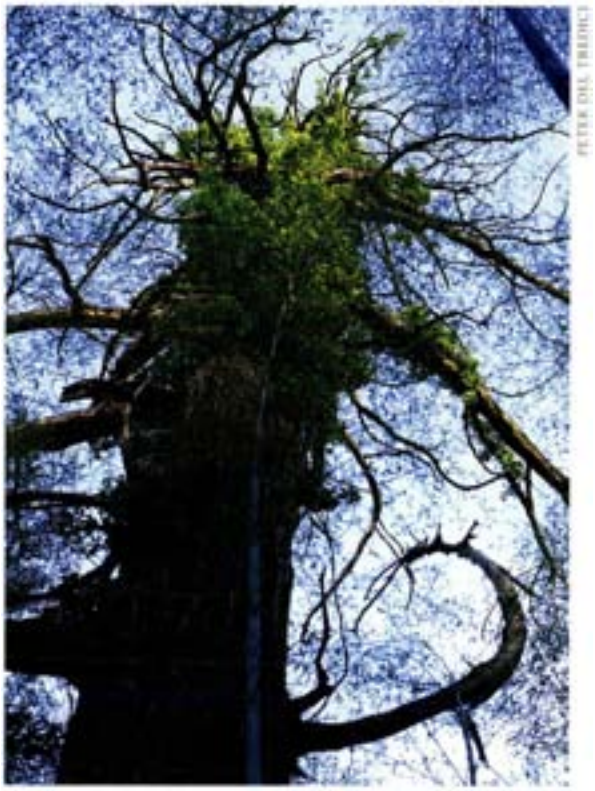
These plants climb masonry walls or the trunks of trees; they can also grow as groundcovers.

Campsis radicans (trumpet creeper)
Euonymus fortunei (winter creeper)—many cultivars
Hedera (ivy)—two species and many cultivars
Hydrangea anomala subsp. *petiolaris* (climbing hydrangea)
Schizophragma hydrangeoides

Twining Woody Vines

Some of these vines, including *Celastrus*, *Pueraria*, *Wisteria*, require heavy posts or trellises to climb on; others do better on a mesh support such as chainlink.

Campsis radicans *(trumpet creeper) at the Biltmore Estate, North Carolina*



Akebia quinata *on* Cryptomeria fortunei *(Japanese cypress) in China.*

Actinidia (kiwi vine)—four species and several cultivars
Akebia—three species
Aristolochia (dutchman's pipe)—two species
Berchemia scandens (supplejack)
Celastrus (bittersweet vine)—three species
Lonicera (honeysuckle)—five to ten species and cultivars
Pueraria lobata (kudzu)
Schisandra—two or three species
Trachlospermum asiaticum (star jasmine)
Wisteria—four species and many cultivars

Twining Herbaceous Vines

These vines need nylon mesh to climb.

Cocculus carolinus (Carolina moonseed)
Humulus japonicus (Japanese hops)

Menispermum canadense and *dauricum* (moonseeds)
Polygonium aubertii (silver fleece vine)

Vines with Coiling Leaf Petioles

A wall or other flat surface covered with nylon mesh suits these vines.

Clematis—fifteen to twenty species and cultivars

Vines with Coiling Tendrils

Most of these do well on trellises.

Ampelopsis (porcelain vine)—four species
Smilax (greenbriar)—species will be grown as examples
Vitis (grape)—many species and cultivars

Vines with Adhesive Tendrils

These should be grown on stone or masonry.

Bignonia caprioleta (cross vine)
Parthenocissus (Virginia creeper and Boston ivy)

Berchmia scandens *(supplejack)*

Wisteria *intertwined with* Parthenocissus *at Rockefeller University, New York City.*

Scandant Shrubs (also known as Weavers)

The growth habit is sprawling but with support these can "climb" to some extent.

Clematis—nonclimbing, "shrubby" species
Rosa—many species and cultivars
Tripterygium regelii

Many of these vines can cover large areas and several are very vigorous, even rampant; others—kudzu, *Schisandra*, *Trachlospermum asiaticum*, Carolina moonseed, silver fleece vine—lack vigor or die back in Boston.

This classification system is taken from "Physiological ecology of mesic, temperate woody vines" by A. H. Teramura, W. G. Gold, and I N. Forseth, in *The Biology of Vines*, ed. F. E. Putz and H. A. Moody (1991).

Clockwise from upper left, Daphne x burkwoodii *'Carol Mackii',* D. cneorum *'Eximia' (garland flower variety),* D. genkwa, D. altaica.

We selected several broadleaf evergreen shrubs (e.g., *Buxus* spp., *Ilex crenata, Ilex glabra*) to act as green foundations year-round throughout the garden, communicating much the same way as the stone walls do. The chosen plants share many features and characteristics (fine texture, ease of manipulation, similar form and habit). These evergreens were sited linearly in plan.

Next, the remaining shrubs, both deciduous and evergreen, were added to the plan. Because their eventual sizes at maturity limit their placement, we gave the largest shrubs first priority. Some genera on the plant list are heavily represented and prominently featured (for example, *Daphne, Viburnum,* and *Hydrangea*). Members of these genera will form patterns that diffuse across and down the terraces, interspersed with other shrubs. For example, *Viburnum* primarily extends down the ravine and across the eastern terraces, while *Hydrangea* has been massed at the northernmost edge of the garden and then across the western terraces. Species and genera with fewer representatives are integrated according to their growing requirements and aesthetic compatibility with surrounding plants and features. Plants that grow best and look best when sited as individuals (such as Japanese maple) are so treated, and those best used in masses (for example, brooms) are massed.

A few areas have been reserved for specialized plantings. Most of the sixty dwarf conifers have been sited above the garden, adjacent to the bonsai house and the large sugar maple. As a group, these plants tend not to integrate well with plants of different habits and architectural forms, and therefore new plantings of dwarf conifers will also be sited there. In the lower garden terraces, several beds have been prepared with acidic soils for ericaceous plants.

The last group—low shrubs, groundcovers, and herbaceous perennials—will be placed at the time of planting. Large and prominent plants have been sited for specific reasons, but flexibility is valuable when placing smaller plants around these anchors.

Peter Del Tredici is director of living collections; Michael Dosmann is a former Putnam Fellow, Tom Ward is greenhouse manager and propagator; Julie Coop is superintendent of grounds.

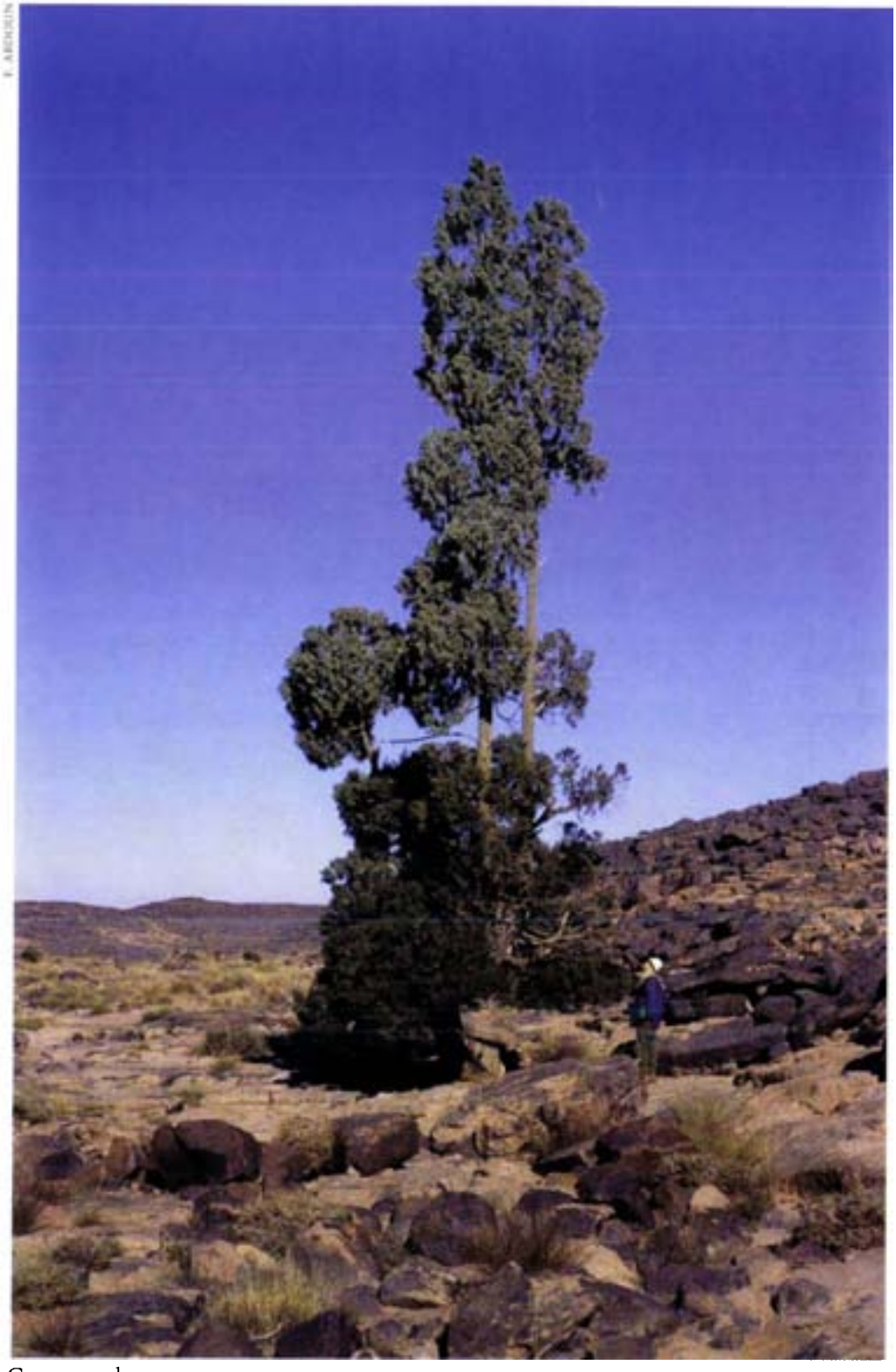
Genetic Piracy: A Newly Discovered Marvel of the Plant World

Richard B. Primack

Plants have evolved a variety of reproductive systems. The trees of some species, such as ash and ginkgo, are differentiated by gender, with both a female and a male individual required for seed production. Other species, such as cherries and almonds, ensure cross-pollination without separating individuals by gender: each plant is self-incompatible, so that stigmas cannot be fertilized by pollen produced on the same plant. And then there are species that don't require cross-pollination, including the many weedy species and annuals that can produce seeds even when stigmas and pollen are from the same plant.

Yet another reproduction system, called apomixis, involves seed production with no fertilization at all. Apomixis occurs inside the ovary of the flower when a cell divides to become an embryonic seed. The resulting seed looks quite normal but is in fact a clone that is genetically identical to the parent plant, with slight differences arising from the peculiarities of cell division. Apomixis occurs in many plant families and is especially common in the raspberries of the genus *Rubus*. It is thought to confer certain advantages: no other plant is required for fertilization, and the seeds produced belong to a genotype of proven success.

The cypress Cupressus dupreziana *is found only in the desert of Algeria. Just 231 individuals of this endangered species remain alive in the world.*

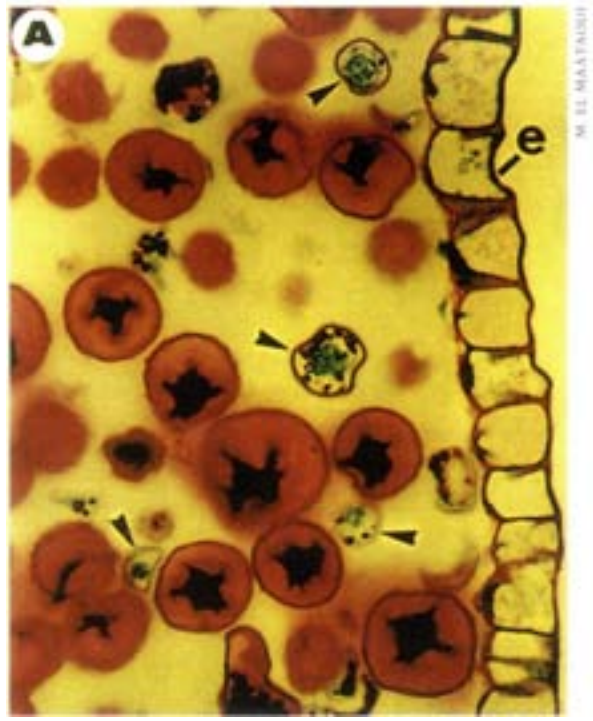


Cupressus dupreziana.

Until recently, all known examples of apomixis involved the production of seeds from cells of the female plant, that is, the plant that actually makes the seeds, although male (pollen-producing) plants existed, they made no genetic contribution to the embryo. Now, however, a group of French scientists headed by C. Pichot and M. El Maâtaoui have found an example of apomixis in which the seeds are identical to the pollen-producing plant, rather than the female plant. The species involved is a rare cypress, *Cupressus dupreziana*, that occurs only in the Tassili N'Ajjer desert of Algeria, in extremely hot, arid conditions. Because of its small population size and poor regeneration rate, it has been classified as endangered and studied intensively. Field research has shown that only around ten percent of wild seeds have a viable embryo; and since the same low rate has been observed in trees being cultivated in France, the problem was assumed to result from the intrinsic nature of the species, rather than simply from inadequate pollination.

But further study showed that the low rate of seed viability was related to *Cupressus dupreziana's* atypical meiosis process. In most diploid plant species (those with two sets of chromosomes), meiosis of the male reproductive cell results in the cell splitting to form haploid pollen grains—that is, grains with only one set of chromosomes, half the number of the parent plant. Seeds result from the merger of the haploid pollen grains with haploid egg cells produced in the ovule. In *C. dupreziana*, however, chromosome behavior and cell division are erratic: sometimes a nucleus divides, but the two resulting nuclei fuse together again; and instead of producing a uniform mass of haploid pollen, the male cones produce pollen of widely varying sizes, many with no chromosomes at all and some with one, two, or four sets of chromosomes. Laboratory studies have shown that only the diploid pollen is capable of germinating. This pollen is almost identical genetically to that of the pollen-producing tree itself, with slight variations arising during meiosis. And it plays a role in seed formation that is unique among known plants—male apomixis.

Analysis of seeds from a plantation of *Cupressus dupreziana* trees showed that the identifying DNA markers of the seeds did not match those of the mother tree—that is, the female tree on which the embryonic seeds developed. In typical diploid species, each seed contains half of the identifying DNA markers of the mother and half of those of the pollen-producing parent. The fact that the DNA markers of *C. dupreziana's* seeds match those of only one parent—the father tree—shows clearly that this species uses apomixis to produce seeds. Presumably, a diploid nucleus in the pollen tube enters the ovule within the young cypress cone and, instead of combining with a female nucleus, begins to divide on its own, taking on the appearance of an embryo. If there is a female nucleus present, it simply deteriorates.

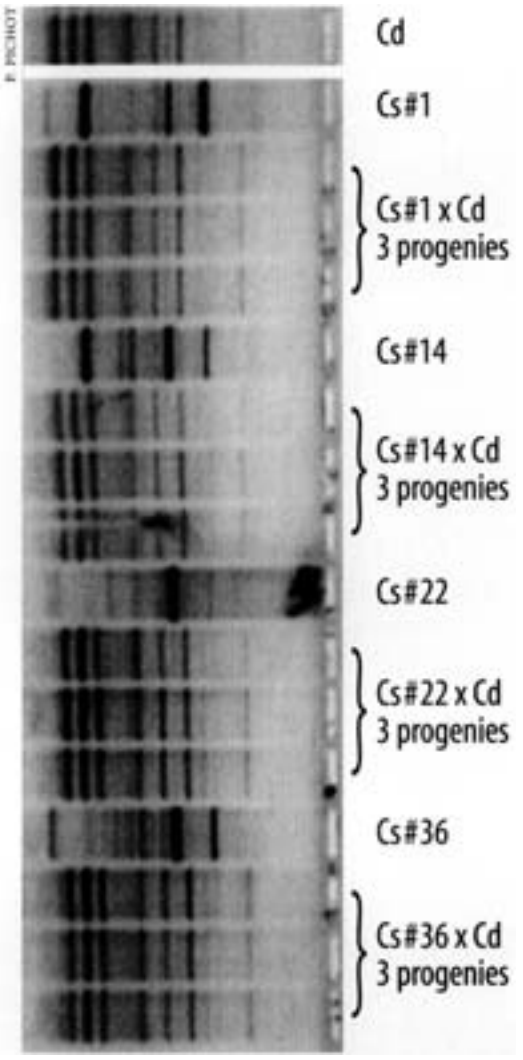


The pollen of Cupressus dupreziana *is variable in size and shape, as shown in this section taken through a microsporangium before the pollen is shed. Only the larger, round pollen would be viable, the other pollen grains will not germinate. The epidermal wall of the pollen sac is shown on the right side.*

The ability of the pollen of *Cupressus dupreziana* to produce new offspring via apomixis was further examined in a special plantation of hybrid trees that had been created by dusting pollen of *C. dupreziana* onto the receptive female cones of *C. sempervirens*, the com-

mon, or Mediterranean, cypress. The seeds produced by these crosses were germinated and then grown for fifteen years. The resulting "hybrids" were identical to *C. dupreziana* in twig orientation, female cone size, and pollen diameter; they bore no visible resemblance to *C. sempervirens*, suggesting that no genetic material had come from *C. sempervirens*. And in fact, the DNA markers of the hybrids were identical to those of *C. dupreziana*, but completely unlike *C. sempervirens*. These surprising results demonstrated conclusively that *C. dupreziana* pollen is able to produce seeds with no genetic contribution from the female plant, not only within its own species but also when "crossed" with other species.

This is the only known example of apomixis involving the pollen parent. In human terms, this is equivalent to a human mother giving birth to a baby that is genetically unrelated to herself, but genetically identical to the father. The evolutionary advantages of this method of reproduction are not evident. One possibility is that isolated trees of this rare species can use the female cones of other cypress species growing in the vicinity as vessels for producing copies of its own genotype. This "genetic piracy" might allow the species to survive at low densities; however, at present no other cypress species grows nearby in *C. dupreziana's* wild habitat. But even if genetic piracy were feasible, this unusual reproductive system has its shortcomings: it cannot generate the genetic variations that allow sexually reproducing organisms to adapt as environmental conditions change.



This is a gel showing DNA markers of tissue taken from trees of Cupressus dupreziana (Cd) *and* C. sempervirens (Cs), *as well as from trees produced by cross-pollinating them. Pollen from one tree of* C. dupreziana *was used to fertilize four trees of* C. sempervirens. *Seeds from each of these hybridizations were used to grow three progeny trees from each mother tree. For each of the four crosses, tissue taken from the offspring is genetically identical to* C. dupreziana, *as shown by their DNA bands being exactly like* C. dupreziana *but unlike the DNA bands of* C. sempervirens. *These results clearly demonstrate that the inheritance of genetic material is strictly from the pollen-producing parent.*

References

El Maâtaoui, M., and C. Pichot. 2001. Microsporogenesis in the endangered species *Cupressus dupreziana* A. Camus: evidence for meiotic defects yielding unreduced and abortive pollen. *Planta* 213. 543–549.

Pichot, C., M. El Maâtaoui, S Raddi, and P Raddi. 2001. Surrogate mother for endangered *Cupressus*. *Nature* 412: 39.

———, B. Fady, and I. Hochu. 2000. Lack of mother tree alleles in zymograms of *Cupressus dupreziana* A. Camus embryos. *Annals of Forestry Science* 57: 17–22.

Acknowledgments

Helpful comments on the manuscript were provided by Elizabeth Platt, Spencer Barrett, and Christian Pichot.

Richard Primack is professor of biology at Boston University. He is currently conducting research at the Arnold Arboretum and in Concord, Massachusetts, on how climate change affects the flowering time of plants.

Book Note

Karen Madsen

Wild Flowers of Yunnan and Central China by Beryl M. Walden and Shui-ying Hu. Hong Kong: B. M. Walden, 2000.

The authors of this attractive volume tell us that of the 30,000 recognized plant species in China, 16,000 occur in Yunnan, a province that comprises only four percent of the country's land area. In an effort to promote conservation by increasing public awareness, the authors have given us watercolor images and botanical descriptions of 516 of these plants, most of them from cold-temperate areas and nearly all from Yunnan Province. (The "Central China" of the title refers to Jiangxi Province, where a small number of the book's plants originate.)

Both images and descriptions testify to the lavish diversity of the region. Included are seven each of asters, camellias, irises, and thalictrums; eight viburnums; ten pedicularises; thirteen each of gentians and roses; fourteen orchids; seventeen primulas; and an astonishing twenty-seven species of rhododendron. Many of the 516 taxa—150 of them—are endemic to Yunnan, some occurring only in one portion of a mountain range.

Yunnan's botanic diversity mirrors its spectacular range of climates and topography, which includes "lateral and vertical zones and mini-zones." The authors quote the English plant explorer Frank Kingdon Ward as he described northwestern Yunnan a century ago: "You will see flowers growing in reckless profusion . . . For days on end you may tramp over carpets of flowers. Rhododendron in incredible variety, yet no taller than heather in Scotland, though of every conceivable colour." Already at that time 5,000 plants had been introduced in the West from Yunnan.

Shiu-ying Hu, author of the botanical descriptions, has had a long and distinguished career and is well known at the Arnold Arboretum. An accomplished botanist and fieldworker when she arrived in the U.S. from China in 1946, she carried out her doctoral dissertation on the Chinese hollies under the direction of E. D. Merrill, director of the Arboretum, 1935–1946. Her many publications on the flora of China, especially of Hong Kong, include works on Malvaceae, Compositae, Orchidaceae, the Chinese material medica, and food plants. Beryl M. Walden provided the watercolors of the plants in *Wild Flowers of Yunnan and Central China*, as she did for earlier collaborations with Hu, *Wild Flowers of Hong Kong* (1977) and a two-volume *Wild Flowers of South China and Hong Kong* (1983, 1987).

Beryl Walden's watercolor of Lilium bakerianum delavayi, *endemic to Yunnan.*

Arnold Arboretum Weather Station Data — 2002

	Avg. Max. Temp. (°F)	Avg. Min. Temp. (°F)	Avg. Temp. (°F)	Max. Temp. (°F)	Min. Temp. (°F)	Precipitation (in.)	Snowfall (in.)
JAN	43	27	35	**68**	**10**	2.86	9
FEB	46	24	35	**65**	**9**	2.62	1
MAR	50	29	40	**71**	**16**	4.05	4
APRIL	64	41	**53**	**97**	**26**	3.74	0
MAY	70	47	59	**89**	**37**	**5.69**	0
JUNE	80	57	69	99	**42**	4.68	0
JULY	80	64	72	105	**50**	2.45	0
AUG	90	65	78	104	**53**	1.75	0
SEPT	81	57	69	99	**46**	4.17	0
OCT	64	40	52	**88**	**27**	4.26	0
NOV	50	32	41	**73**	**14**	6.22	3.5
DEC	40	21	**31**	**61**	**9**	6.59	14.1

Average Maximum Temperature	63°
Average Minimum Temperature	42°
Average Temperature	53°
Total Precipitation	49.08 inches
Total Snowfall	31.6 inches
Warmest Temperature	105° on July 4
Coldest Temperature	9° on February 12 and December 10
Date of Last Spring Frost	30° on April 27
Date of First Fall Frost	32° on October 18
Growing Season	173 days

Note: According to state climatologist R. Lautzenheiser, 2002 was warm and sunny with above-normal levels of precipitation; growing days numbered 173 compared to 132 in 2001. It was the warmest year since 1998 and ranks tenth in 132 years of weather records. With a total precipitation of 49.08 inches we were 5.5 inches above normal and well over the total of 45 inches in 2001. May and June were cool and moist, followed by record-breaking temperatures in July, August, and September. Year's end—October, November and December—was very cold; the first ten days of December averaged 10 degrees below normal.