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Front and back covers: The ornamental grass display at Longwood Gardens in Kennett Square, Pennsylvania, has been consistently popular with visitors. It features over seventy-five grasses that have been tried in the research nursery and found worthy of use in the mid-Atlantic region. Photograph by Rick Darke.


Inside back cover: Miscanthus sinensis catches the autumn light at the Case Estates of the Arnold Arboretum. Photograph by Rácz & Debreczy.
A Century of Grasses

Rick Darke

"Of late years public taste has been turned to the advantageous effect of grasses in landscape gardening. Ferns had the credit of first winning attention from colour to form, and grasses next stepped in to confirm the preference for grace and elegance over gaudy colouring. . . ." Margaret Plues, British Grasses (1867)

Though more than a century old, these lines capture much of the spirit behind the current fervor for ornamental grasses. Grasses are indeed enjoying a renaissance as gardeners learn to look beyond flower color to embrace the more subtle satisfactions of line, form, texture, and translucency. Lacking typical broad-petaled, brightly colored flowers, grasses derive much of their beauty from a unique set of attributes centered on line, light, and movement. Grasses provide a strong linear presence that results from the close parallel arrangement of so many narrow leaf blades. Their flowers are delicately translucent, particularly when dry, and they glow brilliantly when backlit or sidelit by the sun. Coaxed by the wind, the plumes move in and out of sun streams, creating magical flickering effects while the glossy foliage below alternates between translucency and shimmering reflection. Stirring gently in a summer breeze, dancing before an autumn storm, or flying in a spring gale, grasses mirror nature's moods and bring a special dynamism to the garden. Modern designs feature these luminous qualities and movement.

Also responsible for the renewed interest in grasses is a dramatic increase in the number of species and varieties available to today's gardener. In the Victorian heyday of ornamental grasses, a limited few such as Arundo, Cortaderia, Miscanthus, and Pennisetum were repeatedly employed, most often as specimen curiosities set into broad lawns. Plant exploration, introduction, breeding, and selection in recent decades have enriched the modern palette of ornamental grasses so that it now includes myriad variations in size, form, texture, and color to suit a multitude of purposes in the garden.

The innovative nurseryman Karl Foerster (1874–1970) was an early and constant promoter of ornamental grasses, and his influence has been wide ranging. Foerster assembled plants from around the world and grew them for evaluation in his nursery in Potsdam-Bornim, Germany. By the 1940s his catalog offered more than one hundred varieties of ornamental grasses. Foerster also developed a more naturalistic style of garden design based on his nursery trials and his observation of grasses growing in association with other plants in native habitats. His 1957 book Einzug der Gräser und Farne in die Gärten (Using Grasses and Ferns in the Garden) provided a record of his experiences and is still one of the most compelling works on the subject. Foerster's teachings have inspired two

Miscanthus 'Purpurascens' in the author's own garden. All photos by the author.
Ernst Pagels (seen here with horticulturist Anke Mattern), a student of Karl Foerster, has selected and introduced many spectacular early blooming cultivars of Miscanthus at his nursery in northwestern Germany.

generations of German horticulturists. A superb feather-reed grass, Calamagrostis x acutiflora 'Karl Foerster', is named for him and is now common in gardens around the world.

Richard Simon of Maryland brought some of Foerster's influence and plant palette to North America in the late 1950s, when availability of ornamental grasses was at a particularly low ebb in the United States. With the help and encouragement of landscape architect Wolfgang Oehme and nurseryman Kurt Bluemel, both German-born advocates of Karl Foerster's philosophies, Simon began offering ornamental grasses through his Bluemount Nursery catalog. Bluemel's own Maryland nursery, founded in 1964, has since become the premier commercial introducer of grasses to the United States. Bluemel has worked to propagate, promote, and develop the market for new grasses introduced by institutions such as the United States National Arboretum and Longwood Gardens. One such example is the feather-reed grass Calamagrostis brachytricha discovered by Richard Lighty while on a Longwood-sponsored plant collecting expedition to Korea in 1966. John Creech and Sylvester March of the National Arboretum introduced a number of ornamental grasses from Japan in the mid-1970s, including the variegated Miscanthus cultivars 'Cabaret', 'Cosmopolitan', and 'Morning Light', as well as the diminutive green-leaved Miscanthus 'Yaku Jima'. These mainstays of modern horticulture were first offered commercially by Kurt Bluemel, as was Miscanthus transmorrisonensis, introduced from Taiwan in 1979 by Paul Meyer of the University of Pennsylvania's Morris Arboretum. In the
1980s a number of stellar introductions such as Panicum virgatum 'Heavy Metal' and Miscanthus sinensis 'Sarabande' originated from Bluemel. In recent years he has been an important conduit for selections from England such as Phalaris arundinacea 'Feesey' and the spectacular early blooming Miscanthus cultivars developed by Ernst Pagels of Leer, Germany, including 'Graziella' and 'Malepartus'.

During the 1990s, many of the most important additions to the gardening world's palette of grasses have been native North American species and cultivars thereof. A fresh look at American grasslands by horticulturists from coast to coast is generating an abundance of widely adopted ornamentals. Native plant specialist Roger Raiche at the University of California’s Berkeley Botanic Garden has woven many beautiful, drought-tolerant western natives such as Festuca californica, Muhlenbergia rigens, Calamagrostis foliosa, and Carex spissa into the garden's displays and has worked with nurseries to make them available. At the University of California’s Santa Barbara Botanic Garden, Carol Bornstein’s initiative to explore native grasses has resulted in fine introductions such as Elymus condensatus ‘Canyon Prince’. Prairie Nursery in the Midwest has extolled the virtues of previously obscure but highly ornamental prairie species such as Sporobolus heterolepis. In the eastern states, Longwood Gardens' nursery trials of native American grasses have produced Sorghastrum nutans ‘Sioux Blue’; Kurt Bluemel has developed Panicum virgatum ‘Squaw’ and ‘Warrior’; and Bluemount Nursery has selected a giant, blue-leaved form of Panicum virgatum named 'Cloud Nine'.
Muhlenbergia rigens (deer grass), a stunning, little-known native of the western United States, is seen naturally sidelighted against boulders in Ojai, California.

The true grasses, which constitute the family Poaceae, are among the most highly evolved plants on the earth. It should be no wonder grasses are proving such a treasure trove of ornamentals: this truly cosmopolitan group of herbaceous annuals, perennials, and semiwoody plants includes over nine thousand species belonging to more than six hundred genera. Members of the grass family are found on all the continents in nearly all habitats. Grasses are part of almost all ecological formations and are the dominant vegetation in many, such as prairies, steppes, and savannas. Karl Foerster’s characterization of grasses as “Mother Earth’s hair” is not just fanciful: grasses are the principal component in more than one-fifth of the planet’s vegetation cover. Immensely important economically, grasses include all the cereal crops as well as sugar-cane, bamboos, canes, and reeds. Herbaceous perennial grasses are unquestionably the most varied, versatile group for purposes of landscape design.

Perennial grasses are among the easiest to grow of all garden plants. Properly utilized, they can contribute to richly rewarding landscapes that are truly low in required maintenance. Grasses are adaptable to a wide range of soil, temperature, and moisture conditions and are relatively free of pests and diseases. In native habitats the greatest number of grasses prefer sunny sites, and this is also true for the majority of ornamental species in the garden. Sun-loving species often need two-thirds to full-day sun for best performance. Shading these grasses usually results in lax, elongated
growth and diminished bloom. Light requirements may vary considerably even among related cultivars, however. Most Miscanthus varieties demand considerable sun, yet the cultivar 'Purpurascens' stands upright and flowers well in half shade. Some grasses need both full sun and long growing seasons. For example, many Miscanthus fail to develop flowers in the short seasons of the northeastern United States and northern Europe. Again, proper choice of cultivars can alleviate this problem. Ernst Pagels developed his recent Miscanthus introductions (including 'Graziella', 'Malepartus', 'Kleine Fontäne') with the goal of producing plants that would flower in the relatively cool, short season of northwestern Germany. These plants are extremely useful in much of England and in cooler parts of the United States. Grasses imported from warm southern climates, on the other hand, sometimes succumb during winters in northern countries. The cause may be not the low temperatures in the new environment, but instead a lack of hardiness resulting from a weak sun in the growing season. For example, Saccharum ravennae (better known under its synonym, Erianthus ravennae) flowers well and easily tolerates winter lows of zero degrees Fahrenheit in parts of the United States that enjoy hot summers. In England it often does not bloom and may fail in winter.

Although fewer than sun-loving species, there are a number of grasses native to moist, shady woodlands and woodland edges. Some of these, such as Calamagrostis brachytricha, Chasmanthium latifolium, and Spodiopogon sibiricus are highly ornamental choices for the shade garden. Other ornamental species such as Deschampsia flexuosa and Hystrix patula grow happily in very dry shade, which is always a difficult niche to fill in the garden.

Grasses are tolerant of many different soil types. An inquiry into the particulars of a grass's native habitat often provides insights useful for siting plants in the garden. For example, grasses such as Miscanthus or Spartina that naturally inhabit wet areas tolerate low soil aeration. These species often are ideal choices for poorly aerated garden soils such as heavy clays. Species found on infertile sands in the wild will obviously tolerate similar garden conditions; however, many also appreciate a rich garden loam. Some, such as the fescues, demand well-drained soils. These types will succumb to root rots in soils that stay moist, especially in winter. Although woodland natives respond particularly well to fertilization, it is generally unnecessary for most grasses except when they are planted in infertile sands. On rich loams and clays, fertilization can produce an overabundance of soft growth and may cause grasses to flop over.

The fibrous root systems of grasses are very efficient, making most grasses extremely drought tolerant. Once established, most ornamental grasses rarely need supplemental watering even in the driest summers. However, there is sometimes significant variation in the drought tolerance even among closely related cultivars. For example, the narrow-leaved Miscanthus 'Sarabande' will go through extended droughts with only minor tip burn. Broader-leaved Miscanthus 'Purpurascens' will scorch badly under the same conditions. Grasses roll the edges of their leaves inward in response to moisture stress, and this can be used as an indicator of the need for watering. Shade species such as Chasmanthium or Spodiopogon will perform well in full sun if given additional water in dry periods.

Grasses are generally free of pests and diseases. However, a mealybug, Pilococcus miscanthi, introduced to the United States in the late 1980s, now poses a serious threat to Miscanthus. Believed to be of Asian origin, the mealybug produces one generation per year, overwintering as adult females, with eggs hatching in spring. By fall the lower culms and insides of the leaf sheaths may be caked white with mealybugs. The mealybug attacks all parts of the plant including the roots, so aboveground mechanical or chemical methods are not sufficient for control. Drenching with systemics has proved effective; however, this is a management technique that needs to be used with the greatest caution. Preferably,
extreme care should be taken to obtain uninfected stock.

Herbaceous perennial grasses may be grouped loosely into two categories, warm season growers and cool season growers, based on the plants' physiologic cycles. Warm season grasses like it hot. They tend to sulk in cool spring weather, but once temperatures reach approximately 80 degrees Fahrenheit they begin a vigorous growth that continues unabated through summer. Most bloom toward summer's end and then die back to ground level with the onset of cold temperatures. In colder climates it is risky to divide or transplant warm season grasses in autumn; the plants' food reserves are lowest after flowering and seed set, the leaves are no longer photosynthesizing, and the roots are relatively inactive in winter. Therefore, warm season grasses are best divided or transplanted in spring after strong growth has resumed. Examples of warm season growers are Miscanthus, Cortaderia, Pennisetum, Panicum, and Andropogon.

Cool season grasses behave oppositely, growing best at temperatures below 80 degrees Fahrenheit. New foliage begins to grow in late winter or early spring, followed by spring or early summer flowers. Cool season growers sulk in summer: some simply interrupt growth, while others go into a full summer dormancy, dying to the ground. Growth resumes in autumn and often continues until winter temperatures drop below 40 degrees Fahrenheit. Cool season grasses may be divided or transplanted almost any time of year except during their hot summer lull. Examples are Arrhenatherum, most Festuca species, Koeleria, and Calamagrostis x acutiflora.

Although all grasses spread to some extent by rhizomes or stolons, for horticultural purposes they can be segregated into clumping and running types. Each type has its strengths for different design uses. The majority of perennial species—fescues, for example—produce only a modest annual increase in girth, effectively remaining in a clump or tuft. Since they stay in place, these types are relatively easy to control. On the other hand, they can result in high landscape maintenance if planted for groundcover since they will not fill in spaces where individual clumps have weakened or died.

The rhizomes of running types such as Spartina pectinata or Glyceria maxima are aggressively invasive and may travel nearly three feet in a single growing season. Restraints will be required if plants are commingled with less aggressive companions. However, these are ideal for groundcover use. Only a minority of perennial grasses have the potential to be seriously invasive. Nonetheless, this aspect should be given careful consideration in choosing plants, especially if the garden is located near a sensitive native plant community. The popular Miscanthus sinensis, for example, is rapidly naturalizing coastal areas and bottomlands in the mid-Atlantic and southeastern United States. The new early blooming cultivars, especially those from Pagels, will certainly accelerate the naturalization of this species. The potential for invasiveness of any particular grass varies from climate to climate. Cortaderia jubata is a serious problem in coastal California, but it poses no threat in the cold eastern states.
Grasses that self-sow prolifically can add substantially to maintenance chores in the garden. Fortunately they are few. Especially for mass plantings near vulnerable natural communities, grasses such as *Calamagrostis x acutiflora 'Karl Foerster*', which rarely if ever sets viable seed, are more responsible choices.

In 1909 the nursery catalog of Storrs & Harrison Company, Ohio, commented on the place of ornamental grasses in landscape design:

In the laying out of lawns and artistic gardens a few of the many beautiful hardy grasses should not be overlooked. Their stateliness, tropic luxuriance, and soft colors harmoniously punctuate the prevailing green, while their graceful, sinuous yielding to every wind gives animation to gardened landscapes too apt to look “fixed.”

These lines acknowledge the subtle beauty of grasses and celebrate the movement they bring to the garden. However, they also stereotype grasses as curious afterthoughts useful chiefly for providing contrast with the ubiquitous lawn. Other contemporary writings and many of surprisingly more recent vintage suggest that grasses are best grouped by themselves in the garden. It is unfortunate that these two approaches have been so widely adopted since they rarely realize the potential for grasses’ contribution to the landscape.

There is also a genuine concern that ornamental grasses will eventually suffer from overuse. In the American South, pampas grass has long since passed from favorite to cliché. More recently, *Miscanthus* and *Pennisetum* have become staples in the obligatory landscaping that tries to mitigate the monotony of commercial sites, but this trend may be forestalled as the wide diversity of grasses becomes better known.

The characteristic fine texture and linearity of grasses is most effective when visually balanced by other garden elements—annuals, biennials, perennials, shrubs, and trees—that contribute strong, solid forms to the composition. These might be companion plants with bold foliage such as *Silphium teretifolium*, *Rudbeckia maxima*, *Petasites*, or *Gunnera*. A number of coarse biennials such as *Verbascum bombyciferum*, *Angelica gigas*, and *Cynara cardunculus*, as well as annuals like *Ricinus* and *Helianthus* are also ideal. Large-flowered companions such as *Hemerocallis* and *Hibiscus* provide exciting contrast, as do the dark, massive trunks of trees.

An unusually versatile group, ornamental grasses can serve infinite capacities in the garden, limited only by the imagination of the designer. Native landscapes offer a rich source of inspiration. It takes little observation to know that grasses often occur naturally in huge sweeps and masses. In savannas and prairies, they are the form and foundation, the matrix of the landscape. Space permitting, many ornamental grasses are most effective when used in these ways in the garden. Meadow gardens, by their nature, should have a consistent framework of grasses through which flowering forbs make seasonal appearances. Prairie natives such as *Andropogon* and *Schizachyrium* are obvious choices for massed plantings, especially in naturalistic gardens. Coastal lowlands in Japan are a splendid sight when millions of native *Miscanthus* bloom shoulder to shoulder in autumn. A bit of this drama can be recreated in large gardens by planting *Miscanthus* in mass. In modest gardens, a sweep of refined grass such as *Calamagrostis x acutiflora 'Karl Foerster'* can create a mass effect without actually occupying so much area. This same grass and taller species such as *Miscanthus 'Giganteus'* or *Saccharum ravennae* can also be massed to enclose or form garden spaces. Most grasses need not be cut back until late winter. Screens and hedges will disappear temporarily after grasses are cut back, but most reappear quickly and are fully functional through summer, autumn, and most of winter.

In wild landscapes and in the garden, grasses are especially beautiful near water. Their fine foliage is stunning when mirrored in the broad surface of a dark pool or pond. Many grasses are native to wet habitats. Ornamental vari-
Hakonechloa macra ‘Aurcola’ in a bonsai park near Tokyo. The Japanese have long grown grasses in containers.

ants of these species, such as Glyceria maxima ‘Variegata’ or Spartina pectinata ‘Aureomarginata’, will thrive along pond edges and streambanks. Another winning combination borrowed from native landscapes is that of feathery grasses tumbling over massive boulders. Species such as Panicum virgatum and Deschampsia cespitosa literally produce clouds of the finest textured inflorescences. These grasses are dramatic when set among rocks or stones in the garden and can make a superb backdrop for garden sculpture. Garden pathways of stone offer similar contrast. They should be wide enough to allow grasses and other plants to spill over them. Grasses are also ideal for softening overly heavy architectural features in the garden.

Although they may pale in comparison with tropical flowers, grasses are hardly without color. Modern cultivars offer summer foliage in countless shades of green as well as white (Arrhenatherum ‘Variegatum’), yellow (Milium effusum ‘Aureum’), blue (Sorghastrum ‘Sioux Blue’), and red (Imperata ‘Red Baron’). These are followed by an autumn array of golds (Molinia ‘Skyracer’), burnt-ums (Sporobolus heterolepis), and burgundies (Panicum ‘Hänse Herms’). Indeed, grasses are unparalleled in their ability to enliven the autumn garden.

The rigors of winter fail to diminish the beauty of ornamental grasses. In the opinion of more than a few gardeners, this is their peak season. The splendid autumn tones of foliage and flowers weather gracefully to winter hues of chestnut, fawn, and russet. Frost often traces the graceful lines of grasses on winter mornings. Even in dormancy, many species
retain their shape and stature through sleet, snow, and freezing rain. Little bluestem, Schizachyrium scoparium, and broomsedge, Andropogon virginicus, paint broad golden-orange brushstrokes on winter’s white canvas. Encrusted in ice, the spikelets of Chasmanthium become jewel-like. And the plumes of Miscanthus that were downy in summer become stunning filigrees in winter. Thoughtful placing of grasses so that they may be viewed from inside the house can be quite rewarding. Through a window, the movement of the grasses may catch the eye, providing a subtle connection and beckoning the gardener into the garden even in winter.

Many grasses make reasonably good groundcovers. Even though they are clumping types, the sturdy Seslerias, including Sesleria caerulea, Sesleria autumnalis, and Sesleria nitida, are low growing, long lived, and evergreen in milder climates. Prairie dropseed, Sporobolus heterolepis, is another clump-former suited to groundcover massing. Deep-rooted and extraordinarily drought tolerant once established, Sporobolus remains attractive for decades without the need for division or resetting, a claim that can be made for few perennial flowers. Spreading or running species such as Elymus arenarius, Glyceria maxima 'Variegata', and Hakonechloa macra often make good groundcovers. Flowering bulbs such as narcissus and tulips are happy to coexist with groundcover grasses. The bulbs usually flower earlier than the grasses and afterward their foliage is effectively masked by that of the grasses.

Japan has a long tradition of growing grasses in containers. The red-leaved Imperata cylindrica and variegated forms of Hakonechloa macra are rarely planted in Japanese landscapes, but for more than a hundred years they have been grown in decorative containers as companions to specimen bonsai. These and a host of other grasses deserve more frequent experimentation as container subjects in Western gardens. Grasses with colored foliage such as Helictotrichon sempervirens provide steady, multiseason interest when planted in containers with annual flowers or foliage plants. Tender perennials such as Rhynchelytrum repens, Pennisetum villosum, or Pennisetum setaceum and its red-leaved forms may be enjoyed in containers outdoors during the warmer months. Also, many perennial grasses are sufficiently cold hardy to remain outdoors in unprotected containers through winter. Calamagrostis x acutiflora 'Karl Foerster', for example, has easily survived zero degrees Fahrenheit in a modest-sized concrete urn at Longwood Gardens.

Allowing for their seasonal ebb and flow, grasses can be stunning specimen focal points or accents. For example, the classic symmetry of a variegated giant reed, Arundo donax 'Variegata', might serve as a living sculpture. Many truly have multiple seasons of interest and can carry a design through much of the year. In these instances it is especially important to take advantage of natural backlighting or sidelighting to feature the grasses’ luminous qualities.

The net result of this century of design development is that ornamental grasses are no longer stereotyped as curiosities that punctuate the lawn, and the myth that they should be relegated to segregated “grass garden” groupings has been dispelled. Rather, they have become integral to the well designed year-round garden. It seems certain that the unprecedented diversity now existing in ornamental grasses will firmly and permanently establish their place in the garden palette.

This article is excerpted in part from the forthcoming Royal Horticultural Society Manual of Grasses. Rick Darke is also author of For Your Garden. Ornamental Grasses, published in 1994 by Little, Brown and Company. He is Curator of Plants at Longwood Gardens in Kennett Square, Pennsylvania, where he has been responsible for the development of the ornamental grass display.
George Barrell Emerson and the Establishment of the Arnold Arboretum

Ida Hay

“When shall we be able to point to a complete, or even a respectable, American collection of our indigenous trees and shrubs?” Perhaps more than any other individual, George Barrell Emerson was responsible for filling this need in nineteenth-century New England.

The Arnold Arboretum was officially established in March 1872, when an indenture was signed by which trustees of a bequest of James Arnold agreed to turn the fund over to Harvard College, provided the college would use it to develop an arboretum on land bequeathed earlier by Benjamin Bussey. Mastermind of this scheme was George Barrell Emerson (1797–1881), one of the trustees of the Arnold bequest. A schoolmaster and educational reformer, he widely promoted the study of natural history and pursued an interest in trees to the extent of publishing a scholarly work on them that remains valuable today.

Raised in Wells, Maine, when that state was still part of Massachusetts, Emerson spent much of his boyhood roaming the fields, woods, and seaside and working on the family’s farm. After a few years of preparation at Dummer Academy in Byfield, New Hampshire, the young Emerson entered Harvard College in 1813, concentrating in mathematics and Greek.

Apparently the first thing Emerson did after getting settled at college was to visit Harvard’s botanic garden, hoping to learn from Professor William Peck the names of some plants he had found in Wells that he could not identify. His father, a Harvard-educated physician, had taught him the Linnaean system of classification, and as a boy George had learned as many of the trees and plants around Wells as he could. He was pleased that Peck recognized them instantly from his descriptions.

It was an exciting time at Harvard, its Augustan age of literary achievement. Under the administration of John Thornton Kirkland, the college adopted progressive methods of education; students were being urged to think rather than recite facts by rote. Upon graduating, Emerson began a career in education himself. First as master of a private boys’ school recently established in Lancaster, Massachusetts, then as the first headmaster for Boston’s new English Classical School (later called English High School), he developed many of his own ideas on the best methods of education. In 1823 he opened an institution for young women in Boston.

Emerson lectured widely and published on such topics as the education of girls and women, moral education, health, home economics, and sanitation. When the Boston Society of Natural History was founded in 1830, Emerson helped to organize it. He was a very active member, holding several offices, curating one of the collections, and regularly attending meetings.

In 1832, at the beginning of Emerson’s second decade as master of his school, his wife
George Barrell Emerson (1797–1881), a leader of movements to improve natural-history education at all levels, influenced his brother-in-law James Arnold (1781–1868) to leave the bequest that was used to start the Arnold Arboretum (From, respectively, R. C. Waterston, Memoir of George Barrell Emerson, LL.D., 1884, and the Archives of the Arnold Arboretum).

and assistant in the school became ill and died. George was left with three children, aged seven, five, and three, whose healthy and proper upbringing was a source of concern to him. After two and a half years, in late November 1834, he remarried. Emerson’s second wife, Mary Rotch Fleming, was a widowed sister of Sarah Arnold, wife of James. With his second marriage, George commenced a close friendship with the Rotch family, including James and Sarah Rotch Arnold. During visits to New Bedford, George and Sarah found they shared an interest in shell collecting, and James led them to neighboring geological sites.

Report on Trees and Shrubs
By 1836 Emerson had been chosen president of the Boston Society of Natural History. The following year, inspired by a recent state-funded geological survey, BSNH members proposed to undertake botanical and zoological surveys for the Massachusetts legislature. Emerson not only acted as commissioner for the surveys but conducted the investigation of trees and shrubs himself. He worked on the project for nine summers, whenever school was not in session.

One of the goals of the surveys was to collect information on the economic importance of each subject. To find out more about how Massachusetts’ trees were used and how forests or woodlots were managed, Emerson sent a circular with twenty questions to some fifty landowners in the state, and their responses provided valuable information. On his own fact-finding excursions, Emerson visited shipyards in Boston, New Bedford, and other towns, as well as numerous sawmills, machine
George B. Emerson traveled throughout Massachusetts to observe its trees, and he noted particularly large individuals of each species. In Hingham, he admired this old American elm at Rocky Nook. Emerson reported its dimensions as thirteen feet in circumference and sixty or seventy feet in height, with a crown more than ninety feet in breadth (From L. N. Dane and H. Brooks, Typical Elms and Other Trees of Massachusetts, 1890).
shops, and workshops for making furniture, agricultural implements, and other articles using wood.

Issued in late 1846, Emerson's Report on the Trees and Shrubs Growing Naturally in the Forests of Massachusetts turned out to be the most popular of the volumes published in the survey. His ability to present accurate scientific information with lucidity and contagious enthusiasm was universally praised. "It is a work that every intelligent farmer, educated at a New England School, may read and understand fully—and which is at the same time as truly [not pedantically] learned, as if it had been prepared for the Academy of Sciences," reported Andrew Downing's Horticulturist [Anonymous, 1847, p. 566].

The main portion of the work consisted of descriptions that, drawn as they were from firsthand observation, had a freshness and vitality that took the reader out into the woods with the observant schoolmaster. The plants were arranged according to a natural system of classification based on Lindley's interpretation of the works of the Candolles. The discussions accompanying the treatment of each species incorporated such facts as the tree's usual habitat, the uses that might be made of its wood or bark, its qualities as fuel, the size it usually attained, and the locations of particularly large examples.

The introduction presented an instructive overview of Massachusetts forests. Emerson summarized the report's chief objective:

A few generations ago, an almost unbroken forest covered the continent. The smoke from the Indian's wigwam rose only at distant intervals; and to one looking from Wachusett or Mount Washington, the small patches laid open for the cultivation of maize interrupted not perceptibly the dark green of the woods. Now, those old woods are everywhere falling. The axe has made, and is making, wanton and terrible havoc. The cunning foresight of the Yankee seems to desert him when he takes the axe in hand. The new settler clears in a year more acres than he can cultivate in ten, and destroys at a single burning many a winter's fuel, which would better be kept in reserve for his grand-

What followed was an enumeration of the benefits forests provide for man: improving and holding soil, moderating the climate, providing material for fuel and uncountable necessary objects. Emerson also discussed the nonmaterial, the aesthetic and spiritual, merits of forests and trees.

Massachusetts trees, he argued, could be used not just to supply timber, but, thoughtfully planted, they could beautify many a human environment—dooryards, pastures, roadsides, estates, and public grounds.

In a section entitled "Continuation and Improvement of the Forests," Emerson argued for conservation, management, and restoration of forest resources. Such ideas were just beginning to be discussed in America. There were no governmental authorities to regulate forest use nor any forestry schools, and conservation organizations did not yet exist. Emerson summarized the experience of many landowners who answered his circular on such topics as how to plant timber trees, when to thin and prune them, how many years each species required to reach suitable size for harvest, and the methods and timing of felling. On these topics, Emerson realized that his report was merely a starting point. Much more scientific study was needed, as well as further development of the fine art of "the best disposition of trees in the landscape." Emerson was sure that Americans should start to conserve forests and plant trees. Educating them to appreciate trees
was a step in the right direction; founding an institution with this role would be another step that Emerson would take.

**Natural History and Landscape Gardening**

Emerson’s research into Massachusetts trees widened his contacts and fostered his reputation as a serious scholar. He was offered the Fisher Professorship in Natural History in 1838, but declined to take it. A few years later he supported the appointment of Asa Gray to the post. The two naturalists began a cordial relationship as soon as Gray was established at the botanic garden. Emerson sought the new professor’s counsel for his report and found Gray especially helpful when composing the key to identification included in the book. The two men together measured some of the state’s noteworthy trees.

When Asa Gray donated his herbarium to Harvard, Emerson was instrumental in raising the fund to endow it. After its transfer to the college, Emerson served on the visiting committee for the herbarium, and Gray turned to
him when funds were needed to advance its work. This behind-the-scenes activity is typical of Emerson's ever present support of botanical research and of his interest in education.

Emerson cherished his summers working in the countryside among the trees, and he was impressed by the estates he had seen in the course of his research. In 1847 he purchased thirty acres of land on the northeastern side of Chelsea harbor, on a promontory that stretched into Boston Bay. Although the barren site had poor, sandy soil, he was determined to clothe it with trees and anticipated his family's future pleasure in watching them grow.

Emerson was one of the first clients of the newly established landscape-gardening partnership of Robert Morris Copeland and Horace William Shaler Cleveland. Cleveland, Emerson's friend and former student, credited Trees and Shrubs of Massachusetts with influencing his own endeavors, and the two of them shared an experimental frame of mind with regard to tree planting. On Emerson's excessively poor and exposed land they set out many European varieties of oak, beech, birch, linden, maple, elm, ash, mountain ash, and pine to find out whether they were more hardy than the corresponding American trees. Twenty years later, in the second edition of his report, Emerson stated that the European species he planted had performed better than their native American counterparts at his seaside property.

George Emerson's relationship with Cleveland undoubtedly made the schoolmaster more aware of the goals of the emerging landscape profession. Certainly he kept abreast of activities such as the founding of Mount Auburn Cemetery and became a corresponding member of the Massachusetts Horticultural Society.

Arboretum Concept Refined

Emerson's conception of a public tree collection grew from many sources. As early as 1844, in an essay on the longevity of trees, Gray condemned the lack of a good living collection of trees and shrubs in America. After a discussion of the contribution of the French botanists André Michaux and his son, François André, he stated:

To these two persons, chiefly, are the French plantations indebted for their surpassingly rich collections of American trees and shrubs, which long since gave rise to the remark, as true at this day as it was twenty years ago, that an American must visit France to see the productions of his native forests. When shall it be said that this statement is no longer true? When shall we be able to point to a complete, or even a respectable, American collection of our indigenous trees and shrubs (Gray, in C. S. Sargent, 1889, vol. 2, p. 74)?

More than once Gray suggested to Harvard's administration that its botanic garden be supplemented by a collection of woody plants. From discussions in the horticultural literature and reports of recently established arboretas in England, as well as from unexecuted American proposals, the concept of an arboretum as combining a beautiful space with a scientific function was beginning to emerge. Just as the naturalistic style of landscape design was introduced from Britain, so too was the formula for an all-inclusive garden of hardy trees and shrubs after which the Arnold Arboretum would be patterned. Most active in this field was John Claudius Loudon, who may have been the first person to use the word arboretum in modern times. His dual facility with botany and horticulture allowed him to develop the notion that an arboretum could serve both educational and aesthetic purposes.

In the creation of an arboretum for Derby, England, and in all his publications mentioning the arboretum idea, Loudon continually emphasized five elements that define this type of garden: it is a tree and shrub collection; it includes only plants hardy in the outdoor climate where the garden is located; of these, it is to be all inclusive, with at least "one of every kind" being grown; the plants must be arranged in some rational order, preferably according to a natural system of classification;
and the plants must be labeled. He further stressed that the educational tree collection should be accommodated in a pleasing landscape, often suggesting that the best way to achieve this would be to arrange the collections along one main path that forms a circuit, so that arrangement could be viewed in order by the visitor.

**Unexecuted American Arboreta**

Americans were apprised of English arboretum activities through reports in the horticultural literature, and the ideas were given considerable discussion in American publications. Before the creation of the Arnold Arboretum there were a few proposals for such gardens in America—most notably, Andrew Jackson Downing's 1841 plan for the Boston Public Garden and Vaux and Olmsted's 1858 *Greensward* plan for Central Park—but they went unexecuted. Included in these plans were many of the suggestions put forth by Loudon.

For Central Park Vaux and Olmsted planned to include native American trees and shrubs in an arrangement that harked back to Loudon's many proposals:

The northeast section of the upper park is shown as an arboretum of American trees, so that everyone who wishes to do so may become acquainted with the trees and shrubs that will flourish in the open air in the northern and middle sections of our country... The principal walk is intended to be so laid out, that while the trees and shrubs bordering it succeed one another in the natural order of families, each will be brought, as far as possible, into a position corresponding to its natural habits, and in which its distinguishing characteristics will be favorably exhibited (Olmsted and Kimball, 1973, pp. 230, 335).

Right down to the order of tree families, the full description of the proposed arboretum is prophetic of the Arnold Arboretum, with which Olmsted would be involved nearly twenty-five years later.

In the interim, there was another arboretum proposed for an urban park system by Emerson's lifelong friend, Horace W. S. Cleveland. In 1869 Olmsted engaged him to do some work for Prospect Park in Brooklyn. The following year Cleveland moved to Chicago, where he was placed in charge of South Park and the approach boulevards under development by Olmsted and Vaux. There Cleveland proposed that a fourteen-mile-long parkway connecting the city's three parks be treated as an arboretum on a grand scale. He thought that the usual enhancement of natural topography with plantations would not work in Chicago because the land was so flat and featureless. Instead, he suggested,

Let the avenue form in its whole extent, an arboretum, comprising every variety of tree and shrub which will thrive in this climate, each family occupying a distinct section, of greater or lesser extent, according to its importance (Cleveland, 1869, p. 17).

He proposed using masses of each kind of tree in botanical sequence along the boulevard rather than individual specimens, stressing the artistic as well as the educational effect of such an arrangement. Unfortunately Chicago's political and economic situation, the latter exacerbated by the great fire of 1871, prevented Cleveland's vision from being realized.

**Emerson Masterminds the Indenture**

In 1855, George Barrell Emerson turned his school over to a nephew but continued to tutor and counsel former students and stayed active in educational affairs. He began to spend more time on philanthropic activity, serving, for example, on a commission responsible for recruiting teachers for schools for freedmen in the South during the Civil War. Many affairs—the need for better natural history education, concern over man's impact on native forests, the importance of trees and naturalistic landscaping in improving public grounds, and the proposals for arboreta—were on Emerson's mind during the 1860s.

At this time James Arnold, too, was thinking of philanthropy as he revised his will after the deaths of his wife and only child in 1860. In this matter, he turned to Francis E. Parker,
who was one of Boston's finest trust lawyers, skilled in helping others turn their good ideas into permanently funded institutions. It was through Parker's influence that, although Arnold was convinced that an arboretum was a much needed resource, he left his will sufficiently indefinite to allow his trustees flexibility to act. Arnold named another family friend, John James Dixwell, as the third trustee of what became the arboretum bequest. Dixwell was a prosperous merchant and president of the Massachusetts Bank. He and Emerson had long been united in their support of the Boston Society of Natural History. On his Jamaica Plain estate, on Moss Hill, Dixwell grew as many kinds of trees as he could obtain, and it was this fondness for trees that formed a bond between him and the Arnold family as well.

James Arnold died in 1868. More than three years passed from the time Arnold's will was approved by the court until the trustees, Emerson, Dixwell, and Parker, signed an in-
denture with Harvard establishing the Arnold Arboretum. With an arboretum in mind, the trustees had spent the time weighing how best to carry out their duty. To turn the Arnold fund over to Harvard College, the oldest and most prestigious center of learning in New England, would be a sure way to provide for the continuance of the trust. Both Emerson and Parker were graduates, and all three had close social and professional connections with the college.

Some time was spent considering the best place to locate the hoped-for arboretum. Since the trustees knew of Asa Gray's opinion that a tree collection was needed to complement the herbaceous plantings of the Harvard Botanic Garden, they pondered two sites suggested by the professor of botany. While one, the grounds around the astronomical observatory, had the advantage of proximity to the botanic garden, its size was limited. Gray also urged the use of "Brighton Meadows," a flat parcel along the Boston side of the Charles River that Henry W. Longfellow was planning to purchase and present to the college. George Emerson and the poet discussed this possibility, but another tract showed much greater promise than the Charles floodplain, the undulating, partially wooded land in what was then West Roxbury, bequeathed to Harvard by Benjamin Bussey.

Bussey had left his farm and funds to the college stipulating they be used to start an institution for the study of agriculture, horticulture, and related subjects. After his death in 1842 the property was subject to the life tenancies of Bussey's heirs. At the time Arnold trustees were contemplating the disposition of the fund left in their care, Harvard established the Bussey Institution, having gained the approval of Bussey's granddaughter to utilize seven acres of the West Roxbury estate. Harvard's new president, Charles Eliot, consulted with Emerson on the education programs for the agricultural center in 1869, and after completion of the building for instruction in 1871 the Bussey Institution officially opened to students. George B. Emerson wisely surmised that using land already in possession of the college would leave the entire Arnold fund available for development of the arboretum. Apparently, the parties involved agreed such use of the land would be compatible with Bussey's wishes, clearing the way for a final pact to establish the arboretum on part of the Bussey property in West Roxbury. In the inden- ture, signed 29 March 1872, Emerson, Dixwell, and Parker agreed to turn the Arnold fund over to the president and fellows of Harvard College, provided the college allow some 120 acres of its Bussey estate and the income of the fund to be used for:

the establishment and support of an Arboretum, to be called the Arnold Arboretum, which shall contain, as far as is practicable, all the trees, shrubs, and herbaceous plants, either indigenous or exotic, which can be raised in the open air at the said West Roxbury, all which shall be raised or collected as fast as is practicable, and each specimen thereof shall be distinctly labelled, and [for] the support of a professor, to be called the Arnold Professor, who shall have the care and management of the said Arboretum, subject to the same control by the said President and Fellows to which the professors in the Bussey Institution are now subject, and who shall teach the knowledge of trees in the University which is in the charge of the said President and Fellows, and shall give such other instruction therein as may be naturally, directly, and usefully connected therewith. And as the entire fund, increased by the accumulations above named, under the best management and with the greatest economy, is barely sufficient to accomplish the proposed object, it is expressly provided that it shall not be diminished by supplementing any other object, however meritorious or kindred in its nature.

With the site and an endowment secure, establishment of the Arnold Arboretum achieved many of Emerson's and his colleagues' objectives. Here would be a living collection to augment the "cabinet" of the Boston Society of Natural History. With one of every kind of tree and shrub, each labeled and
available for study, and arranged after Loudon's models, it would be Emerson's report come alive, a living inventory of the region's arboreal resources.

Emerson kept in touch with the Arboretum during the ensuing decade. He and director Charles Sargent shared an interest in the writings of Vermont conservationist George Perkins Marsh, and Emerson urged Sargent to educate the public on the potential effects of forest destruction. One of the first efforts in this direction was publication of A Few Suggestions on Tree Planting (1875) in which Sargent argued for planting trees and for halting the uncontrolled clearing of forests. George B. Emerson was so pleased with the pamphlet that he wrote Sargent, "If the Arboretum had never produced or would never produce anything else, I shall be richly paid for all I have done for it" (Arnold Arboretum Archives, G. B. Emerson correspondence, 9 March 1876). Emerson was also instrumental in Sargent's appointment as investigator on forest trees for the Department of the Interior's Tenth Census. In March 1881, when Sargent and Olmsted were at the height of their campaign to convince city officials to bring the Arboretum into the Boston park system, Emerson died at the Brookline home of his daughter, Lucy Lowell. In memorial tributes written upon his death, Emerson was remembered fondly for his inspirational leadership in the field of education and for his activities promoting the study of natural history, not the least of which was his influence on the founding of the Arnold Arboretum.

References


Now an Arnold Arboretum Associate living in Northampton, MA, Ida Hay was on the staff of the Arnold Arboretum for over twenty years. This article is excerpted from her book, Science in the Pleasure Ground, which will be published in December by Northeastern University Press.
Exploring the Complexities of Plant Hardiness

J. C. Raulston and Kim E. Tripp

We often use cold-hardiness ratings as the sole indicator of plant suitability for a given region. But in actuality, a much broader range of factors determines plant performance in the landscape.

In the United States plant hardiness has usually been interpreted as cold hardiness—the ability of a given plant to survive the winter of a given region. However, even in our most northerly regions, plant survival depends on a far broader set of environmental conditions than just those found in winter. In addition to extremes of cold temperature, survival is linked to the amount and seasonal timing of precipitation, the intensity of light, the annual cycle of daylength, the texture and fertility of soil, the consistency of temperatures, and the duration and degree of high temperatures. Cold, heat, sun, clouds, drought, flood, early frosts, late ice storms, compacted soils, chainsaw-bearing contractors—all can influence a plant's hardiness.

While in any region, a plant's viability depends on its fit with this entire range of local conditions, the relative importance of each environmental factor varies geographically. In the North, tolerance to cold usually assumes the greatest importance, whereas in the South, heat hardiness is more often the limiting factor, and in most of the West, drought tolerance is the predominant influence on survival. All the same, we most often focus on cold hardiness, even in Florida and California, perhaps because at least superficially, winter damage is dramatically visible and easily understood: a cold front comes through tonight and tomorrow the plants are brown. This may explain why cold hardiness has been the focus of much horticultural research and evaluation effort, with far less attention paid to the other factors. Nonetheless, no prediction of a plant's viability can be accurate without considering the diverse combination of landscape conditions.

Dealing With Frost: Tolerance vs Avoidance

Like all forms of life, plants consist largely of water, and when temperatures drop low enough, that internal water, like all water, can freeze. Perennial plants fall into two categories based on the way they deal with frost and freezing temperatures: they can either tolerate freezing by employing a variety of physiological mechanisms; or they can avoid freezing by shedding or insulating vulnerable plant parts. Most temperate perennial plants use a combination of tolerance and avoidance to survive winter's freezing temperatures, but rely primarily on the tolerance mechanisms (which are generally more effective for surviving long periods of freezing temperatures) to protect aboveground, persistent tissues. For example, evergreen woody plants tolerate freezing in both stems and leaves while deciduous trees avoid freezing in their leaves by dropping them and tolerate freezing only in their persistent branches and trunks.

The Importance of Acclimation

A frost-hardy plant's ability to get through the winter depends on the seasonal change in its metabolism to a quiescent or dormant state...
known as *acclimation*, which is influenced by a variety of environmental factors. Acclimation is the process whereby the plant “hardens off” for winter. In order for a normally cold-hardy plant to survive the most severely cold temperatures it is genetically capable of surviving, it must complete the acclimation process before experiencing severe cold; otherwise it will be damaged. Similarly in the spring, as temperatures warm and days lengthen, plants need to deacclimate in order to resume active growth.

There are four cases in which a plant can be damaged by freezing temperatures:

1. When temperatures fall below the plant’s maximum cold-hardiness limit, even after normal acclimation has occurred;

2. When premature freezing occurs before the plant has acclimated in the fall, even if the plant is potentially able to survive those temperatures in midwinter;

3. When unusually late freezes occur in the spring after the plant has deacclimated, even if it can survive those temperatures while it is hardened off in midwinter, and

4. When there are prolonged swings in temperature during the winter that cause the plant to deacclimate before the threat of severe freezing is over.

Only the first case relates to the traditional definition of cold hardiness—the definition expressed in hardiness zone maps. In the other three cases, freezing damage occurs not be-
cause the plant is located where temperatures fall below its potential maximum cold tolerance, but because its stage of acclimation is out of step with the weather. If a woody plant that is normally winter hardy to -20 degrees Fahrenheit experienced such temperatures in July, it would suffer severe damage and is likely to die. However, this same plant could experience decades with those minimum winter temperatures and thrive.

Mapping Cold Hardiness

Hardiness zone maps generally identify areas with similar average minimum temperature ranges in which, theoretically, the same groups of plants should be viable. But these systems have a serious limitation. They do not take into account all of the different environmental conditions that vary from region to region, from soils to rainfall patterns, and this limitation causes problems. Consider just one example, zone 8, which encompasses Raleigh, North Carolina; Dallas, Texas; Phoenix, Arizona; and Seattle, Washington. Then compare the plants that are grown in those areas. At least twenty-five species of palm grow in Phoenix that won’t grow in Raleigh. The extremes of temperature are very different even though the averages lump Raleigh and Phoenix into the same zone.

The same problem turns up in the hardiness zone maps for Europe and China that were published in Germany in the 1970s. There we find Raleigh in the same zone as London. However, Raleigh has more extreme temperatures (especially during the summer), more variable precipitation, more frequent ice storms, less cloud cover and fog, and much higher light intensity year-round. These differences influence cold hardiness, and a given plant grown in England may be less cold hardy there than the same plant grown in Raleigh. Over an entire year, variables like availability of photosynthetic for growth, accumulation of storage carbohydrates, timing of flowering and fruiting, and amount of root development as influenced by moisture availability, can influence a plant’s ability to survive the winter. Clearly hardiness zones based on temperature alone cannot predict a plant’s ability to survive.

A better system for mapping plant adaptability is the one developed by Sunset Books, called the “Sunset Zones.” This system, which includes Colorado and points west, presents twenty-four zones that are defined by many variables, including high and low temperatures, dry desert winds, rainfall, and other moisture (for instance, fog cover). This system is widely used in the West and has proven very helpful there. It’s especially effective at pinpointing microclimates, a critical tool on the West Coast, where great differences occur over short distances. Los Angeles alone has nine different zones.

Another excellent system is the Walter System, developed in Germany. It is based on a graphic presentation of average monthly temperatures combined with average monthly amounts and kinds of precipitation over a full year, using data collected from Walter Stations in cities all over the world. By looking, for example, at the graph for Seattle we can see not only the amount of rainfall but also the temperatures during the months of high and low rainfall. Each station graph also shows the extremes of temperature recorded for the station and altitude of the station. In just one visual image the Walter System gives a much more complete picture of what the growing conditions are for that area than the temperature-based USDA zone map can give.

**Why Plants Die of Cold**

To understand the importance of acclimation, we need to look at the process whereby plants die from the cold. There are several kinds of cold injury, but a primary cause of frost- or freeze-related death in woody plants is water freezing within the plant's cells. When water crystallizes and freezes within a cell, it ruptures and kills the cell. If enough cells are killed, the plant will suffer significant stress and the entire organism may die. On the other hand, if freezing is restricted to water in the intercellular spaces of the plant's tissue—that is, in the spaces between the cells, outside the boundary membranes of the cells themselves—then usually the cells are not damaged and the plant does not suffer.

The cells' contents change during acclimation such that the concentration of solutes increases. We know that adding certain solutes to water can retard its freezing, and that the higher the concentration of these solutes, the lower the temperature required to freeze the solution—this is how antifreeze works in a car radiator. In general, the intercellular solution in a woody plant—the liquid between the cells—has a lower concentration of solutes than the solution inside the cells. This difference is accentuated after acclimation, leading to more solutes in the cells. Therefore, the solution outside the cell walls freezes at a higher temperature—and earlier—than the solution inside the cell walls.

Because of this differential solute concentration, ice formation is restricted to the intercellular spaces during normal winters. If the temperature goes significantly below the plant's tolerance, however, the osmotically driven maintenance of the concentration differential between the inter- and intracellular solutions cannot be maintained; in that case, ice finally forms inside the cells, causing them to rupture and die.

The lesson here is that for plants to acclimate themselves to winter, temperatures must drop during the appropriate season and at the appropriate rate. A plant of ivy (*Hedera helix*) that has had a chance to acclimate can survive -30 degrees Fahrenheit, but it will freeze at 25 degrees Fahrenheit if that temperature occurs in the summer during active growth.

In any discussion of hardiness, it is important to remember that plants are made up of many different organs. The specific mechanisms of acclimation that result in freezing tolerance or avoidance vary among organs, and therefore hardiness does as well, which makes sense considering the different environments in which various plant organs occur. Roots, for example, are much less hardy than the shoots of woody temperate plants. Because of the insulating properties of soil, roots experience much less variation in temperature throughout the year than occurs in the air above it. This becomes an especially important consideration when dealing with container plants. The temperatures that containerized plant roots are exposed to are potentially much more extreme than those experienced by roots insulated in the soil—lower in winter and higher in summer.

There can also be significant differences in hardiness even among the aboveground parts of the plant. For example, flower buds are usually much less cold hardy than vegetative buds. Here in Massachusetts you are likely to see effects of the snowline in the spring where parts of the plant below the snowline have survived, be they floral or vegetative. But above the snowline, the flower buds may be killed while the vegetative buds will break and develop healthy foliage in the spring.

**Environmental Cues for Seasonal Acclimation**

The mechanisms described above—collectively referred to as acclimation—are triggered within the plant by environmental cues, of which the most important are seasonal changes in daylength and temperature. Differences among plant species range from the purely photoperiodic in which temperature plays almost no role to those that are purely temperature-controlled with no response to photoperiod (*i.e.*, daylength). Most plants fall somewhere between these two extremes. In
spring, once daylength extends beyond a certain point—known as critical daylength—deacclimation is initiated in photoperiodically sensitive species, active growth is triggered, and the plant will not become quiescent again until the shortened daylengths again trigger acclimation the following fall. Because the daylengths differ throughout the year at different distances from the equator, the cues that trigger spring growth (and winter acclimation as well) in a plant of Floridian provenance will be slightly different than those for a plant of Canadian provenance. In Canada, critical daylength will be much longer than in Florida. Not only is winter longer in Canada, but also the days become much longer earlier in the spring the farther north you go. So if you moved a Florida red maple north to Canada, it might begin active growth too early in the spring and thus be subject to freezing damage.

On the other hand, if you moved a Canadian red maple south to Florida, the days may never get long enough to trigger active growth in the northern plant, and the plant would never break dormancy and grow.

Photoperiod responses can be influenced by artificial lights as well as by the sun. There are documented instances of delayed leaf fall in autumn on trees adjacent to streetlights, as well as premature initiation of growth on conifers decorated with large, nonflashing Christmas lights in midwinter. This is usually not a significant problem because cold temperatures generally override the influence of artificial lights.

In nonphotoperiodically triggered species, temperature is the most important cue for winter acclimation. Not only absolute tem-
Rhododendrons on Boston’s Copley Plaza show dessication caused by sun and wind on parts of the plant not protected by snow (J. C. Raulston).

Temperatures, but also cumulative temperatures throughout the growing season play an important role, especially when we start moving plants around the globe. Many woody plants that are native to climates with long, hot summers can withstand very cold winter temperatures when grown in similar climates, yet if grown in climates with cooler summers and mild winters they are less cold hardy. In other words, the conditions for the previous season’s growth can effect a plant’s ability to withstand cold. This makes sense when we consider that growing conditions can affect processes like photosynthesis and carbohydrate metabolism. If a plant grows in a high light environment—for example, in the American Southwest—it may be able to store much greater quantities of carbohydrate, which may improve its ability to acclimate to severe cold. If you take the same plant, however, and grow it in a lower light climate, even one with a milder winter—Britain, for example—this same plant may not be able to survive that milder winter because the conditions of the previous growing season have prevented the plant from satisfying its physiological requirements for optimal winter acclimation.

As a specific example, crape myrtles (Lagerstroemia indica) are perfectly winter hardy in North Carolina where sunlight is intense, the summers are long and hot, night temperatures are high, and winter temperatures routinely drop to zero degrees Fahrenheit. But try to grow crape myrtles in England, where light is low and summers are cooler, and the plants will not survive winter, even though the temperature rarely falls below 10 degrees Fahrenheit. This is an example of the cumula-
The Significance of Provenance

We tend to characterize an entire species as being of a certain degree of hardiness. Even within a species, however, individual plants adapt to the cues that are present in their specific region at the critical transitional times of the year—for example, daylength, light intensity, cumulative temperature, or moisture conditions. When we move a plant to another region, we may interfere with those cues and prevent the plant from exhibiting its “normal” hardiness.

Reproduction from seed is a sexual process that results in genetically variable offspring. Any population of seedlings will demonstrate an amazing array of variability. For example, a row of seedling “blue” spruces will include green, blue, and gray Picea pungens. Part of what genetic variation is about is survival. The populations of a species now found in a given region are therefore those that adapted over many thousands of years to the specific climate of that region. If over a few hundred years the weather gets colder in part of a species’ territory, seedlings that are more cold hardy will survive and those that aren’t will be frozen out. The result, then, is a population that varies widely in cold hardness from one end of its range to the other. Red maples (Acer rubrum), for example, occur in wild populations from Florida through Canada, but red maples of Floridian provenance are likely to be far less cold hardy than red maples of Canadian provenance. (It is important to note that the hardness of a given seedling depends not on the location of the nursery where it was grown, but rather on the ancestral location of the parent trees from which the seed was collected.)

But the combination of evolutionary genetics and long-term climate changes can play tricks on us. For example, there are several species of plants now found growing only in Florida that are completely cold hardy at far more northerly latitudes. During the most recent glacial era, these plants germinated successfully south of the glacial front but did not survive in glaciated areas. As a result, these species retreated southward in front of the slowly advancing glaciers. This long-term process did not cause a loss of cold hardness in the plant’s genome, which had evolved preglacially in much colder environments than those in which the surviving plants were later found. As a result, one can grow Magnolia ashei, which is now native only to the panhandle of Florida, as far north as Chicago and Toronto. Red maples in Florida, however, are the product of continuous evolution in that region, rather than of migration from the north ahead of the glacier. Unlike M. ashei, therefore, a Floridian red maple seedling is not likely to perform well in Chicago or Toronto. Nonetheless, conventional thinking holds that Acer rubrum is significantly more cold hardy than M. ashei.

The Effects of Human Intervention on Cold Hardiness

Whether a plant can thrive in a specific environment depends on the interaction of the plant with its environment. In other words, we must consider not only what the environment is doing, but also what the plant is doing. Humans often influence both elements and thereby significantly affect the cold hardness of a given plant.

It’s easy to imagine how we can change the environment to influence a plant’s cold hardness—an extreme example would be to put it in a greenhouse—but it’s harder to imagine how we can influence the plant itself to affect its hardness. However, horticulturists can influence a plant’s hardness both intentionally and unintentionally. For example, watering and fertilizing late in the season, to keep plants looking attractive or to push a second flush of growth, can lead to disaster. Comparison at North Carolina State University of azaleas fertilized throughout the growing season with plants fertilized only in spring demonstrated that the heavily fertilized plants looked
more attractive in the fall but suffered much greater winter damage and were less attractive the following spring. In another experiment, we promoted and distributed plants of a Japanese species of crape myrtle, *Lagerstroemia fauriei*, after finding it hardy to -10 degrees Fahrenheit. However, growers complained that their plants died after experiencing minimum winter temperatures of +10 Fahrenheit.

The growers had prevented the plants from hardening off for winter by prolonging irrigation and fertilization into late fall in order to increase annual growth and, thereby, profitability. The result was that the plants went into winter with soft, nonacclimated growth that was very vulnerable to freezing damage. In effect, the plant's metabolism was affected by growing practices that created an artificial

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**Hardiness Evaluation for the Southeastern United States**

Gardeners in the Northeast enjoy the benefits of a long tradition of plant importation and hardiness evaluation, but in the Southeast there has been very little institutional evaluation of plant adaptability and performance—until recently, that is. Just seventeen years ago, the North Carolina State University Arboretum was founded with a dual mission: determining the adaptability of new and uncommon landscape plants for use in the southeastern United States, and promoting the production and utilization of superior, adapted plants. Since 1977, the Arboretum has collected and evaluated over 9,000 plants from forty-five countries—this on only eight hard-working acres. Those eight acres currently contain over 5,000 different species and cultivars in over 450 genera.

Experience has led us to believe that the only way to test a plant's adaptability is to try growing it. This method results in large numbers of killed plants, but it has also uncovered exceptional plants that perform beautifully despite very different provenances. We've learned as much from the deaths as from the successes. It's by studying what happened that we find indications of how the plant or the environment can be modified for future success. We retain for selection and promotion those plants of significant ornamental value that have survived the various environmental stresses—and they have been many. In the years since the Arboretum was established we have experienced almost every extreme of weather including the coldest temperature ever recorded, the hottest summer, both the wettest and the driest years, and the earliest and latest frosts.

We've found wonderful surprises among both exotics and North American natives. Certainly natives have been underused and deserve greater attention and selection, but the key to the suitability of a plant lies in its adaptability, not its nativity. Many natives of the southeastern United States evolved in very specialized environments. Those from the cool, moist southern mountains often don't survive in the hot, wet summer of the Piedmont while exotics from analogous climates—for instance, humid areas of Japan and Korea—have proved very useful.

Since the Arboretum's mission is to encourage the production and use of the widest possible array of plants, our distribution and advocacy program is just as important as our evaluations. We make material available to the public, to other botanical gardens, and to the nursery trade—so far over 60,000 plants of 1,000 taxa have been distributed to nurseries and other growers around the world, and in order to move these plants to the public quickly, growers themselves have collected over 2,000,000 cuttings from the plantings.
microclimate to which the plant was not adapted.

It is especially easy to create microclimate effects in order to influence plant/environment interactions in an urban environment. The magnolias on east-west streets in Boston’s Back Bay are a case in point. Magnolias on the south-facing side of the streets reach full bloom when those on the shady north-facing side are just budding up. A late freeze would kill the blooms on the south-facing side, while the blooms on the north-facing side may be only minimally damaged. By planting early blooming plants in northern exposures or under higher canopies, we can minimize this kind of damage. Likewise, since a body of water can moderate local climate considerably, planting near small water features can extend your season, just as planting near south-facing brick or stone walls can, and it shares the same potential problem—spring growth may be induced so early that the microclimate is unable to protect the new growth from severe late freezes.

Just as north-facing or south-facing orientation can have a major impact on plant performance, whether a plant is primarily in sun or shade can make a dramatic difference in winter survival and performance. This can be a particularly important consideration in preventing winter damage on broad-leaved evergreens, especially the damage we call winter scorch. Plants lose water through their leaves constantly in the process of transpiration. Deciduous plants drop their leaves in the winter, avoiding this problem, but evergreens must contend with it year-round. Transpiration is increased by sunlight and wind. One of the ways this happens is that sunlight on the leaf increases the difference in temperature between the leaf surface and the air, thereby increasing water loss from the leaf. In winter, when water in the soil is frozen, it is impossible for the plant to replace the water that is lost from the leaves, and the leaf desiccates and may die. But if it is sited in shade the plant will be more protected from the possibility of winter scorch.

Sun scorch in winter can also occur on the south-facing side of trunks of trees. This is caused by the rapid expansion and contraction of the trunk in response to rapidly changing temperatures. Wrapping the trunk so that it is effectively shaded all winter (being sure to remove the wrap during the growing season) can help to ameliorate this problem. (Make sure to wrap from the bottom up if using a wrap of narrow width so it doesn’t collect water that freezes and thaws against the trunk, damaging bark and promoting disease.)

In the final analysis, the complexities of plant hardiness lie in the maze of environmental conditions that both plant and gardener
must negotiate each year. Because these conditions vary so greatly, even from one neighboring landscape to the next, and because humans can drastically alter the immediate growing environment of a plant, there is only one sure way to determine if an individual plant will thrive for you: you must try it in your own garden. To paraphrase the great English plantsman Sir Peter Smithers, I consider every plant hardy until I have killed it myself.

References


J. C. Raulston is director of the North Carolina State University Arboretum and professor of horticultural science Kim Tripp is a Putnam Fellow at the Arnold Arboretum. Previously she was curator of conifers and a postdoctoral associate at the North Carolina State University Arboretum. This article grew out of a lecture given by Dr Raulston at the Arnold Arboretum
A Late Summer Ornamental: *Poliothyrsis sinensis*

Stephen A. Spongberg

A handsome shrub with many desirable traits seeks a common name.

Relatively few shrubs or small trees are notable for their characteristic of flowering late in the summer season and into the fall, when the ornamental attributes of most woody plants consist of their fruits and fall foliage color. Within the past fifteen years, however, the Arnold Arboretum has received two shrubs as new introductions from China, both previously lost to cultivation, that have proved to be noteworthy, late summer-flowering ornaments. The so-called seven-son flower (*Heptacodium miconioides*) has received some attention in the horticultural press (Koller, 1986). Introduced by the 1980 Sino-American Botanical Expedition, *Heptacodium* has become established in the nursery trade and is now available both locally in New England from Haskell’s nursery in New Bedford, Massachusetts, as well as by mail order from Wayside Gardens, Hodges, South Carolina. The second plant, *Poliothyrsis sinensis*, however, has not to my knowledge been heralded in the American horticultural press although English botanists and plantsmen have chronicled its history in cultivation in the British Isles. It is so little known, moreover, that no common name has been coined for this interesting plant.

This species, the sole member of the genus *Poliothyrsis*, belongs to the otherwise largely tropical plant family Flacourtiaceae, and the only other genus in the family grown in the Arnold Arboretum is *Idesia*, also represented by a solitary species, *I. polycarpa*. First discovered by Augustine Henry at the end of the last century in central China, *P. sinensis* was not introduced into western gardens until the legendary plant collector E. H. Wilson supplied the Arnold Arboretum with seeds in 1908. Interestingly enough, these seeds were shared with botanical and horticultural institutions in Europe, where the plant has survived in cultivation to this day. At the Arnold Arboretum, however, established plants grown from Wilson’s seed introduction were inexplicably removed from the collections in 1933. The reintroduction of the species to our collections in 1981, when seeds were received from the Shanghai Botanical Garden, has provided us with another opportunity to evaluate this plant under Massachusetts growing conditions.

Two plants resulting from the seedlot from Shanghai were planted in a sunny location near the site of the old Bussey mansion. They are now multiple-stemmed shrubs approaching twelve feet in height, although in nature the plants apparently develop into moderate-sized trees to fifty feet in height. In habit our shrubs are rather upright, although their ultimate shape and height, as well as the bark of the stems, will undoubtedly change should the plants persist in our collections. Both, however, have been flowering annually—commencing in 1990—during late August and September. Numerous small, yellowish-white flowers are produced in moderately large inflorescences on the current year’s growth and contrast nicely with the dark, emerald-green leaves, which are borne on reddish stalks. Indeed, it was the attractive, lustrous green
leaves that first drew my attention to these shrubs. And while the reddish or almost magenta-colored petiole suggested that the fall color of the leaf blades might be of a similar hue, those of our plants assume a warm yellow in late October and November.

The flowers are either staminate or carpellate (the plants are monoeious) and include four to six sepals, the whorl of petals being absent. The carpellate ones develop into interesting capsules reminiscent in size and shape of those of the lilac. These ripen to a greenish-gray color, when the outer covering falls away to reveal the tan inner walls of the capsules. Once the outer walls have been sloughed off, the inner walls dehisce by three valves from the apex, and likewise, by three from the base. While the capsules are dissimilar in shape and substance from those of Franklinia alatamaha, the dehiscence pattern—from both the apex and base of the capsule—is shared by these otherwise unrelated genera.

The inflorescences of Poliothyrsis sinensis are produced on the current year’s growth in terminal corymbose racemes and contrast with the dark green leaves (Rász & Debreczy).
and is unknown in other woody genera cultivated in the Arnold Arboretum. These opened capsules, moreover, persist on the shrubs into the winter months, adding to the landscape interest of the plants during that time of year.

To date, our plants from Shanghai have suffered no winter damage, and the fact that the original plants introduced by Wilson persisted in the Arboretum’s collections for twenty-five years suggests that *Poliothyrsis* is perfectly hardy in the Boston Basin. Its limits of hardiness and its potential as a landscape plant, however, have yet to be determined.

*Poliothyrsis sinensis* is currently available in the North American nursery trade from Woodlanders, Inc., 1128 Collecton Avenue, Aiken, South Carolina 29801; Glasshouseworks Greenhouses, P.O. Box 97, Stewart, Ohio 45778; and Heronswood Nursery, 7530 288th Street NE, Kingston, Washington 98346. And plans have been made to propagate the plants at the Arnold Arboretum and to make them available at a future Arboretum Plant Sale. As a consequence, this interesting Chinese species, easily propagated by seed and softwood cuttings, will undoubtedly find its way into the gardens of those who enjoy growing the curious and little known—in this instance a shrub that flowers and provides landscape interest at an unlikely time of year.

Initially lime green in color, the fruits mature to a light tan color before dehiscing to disclose the numerous, small, winged seeds produced within (Rácz & Debreczy).

**References**


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Spongberg, S. A. Taxonomic Notes from the Arnold Arboretum. *Arnoldia* [1990] 50[3]: 29–32. This article reports the change in name from *Heptacodium yasminoides* to *H. miconoides*.

Stephen A. Spongberg, Horticultural Taxonomist at the Arnold Arboretum, was a member of the 1980 and 1986 Sino-American Botanical Expeditions to China. At the Arboretum he is responsible for the curation of the living collections.
BOOK NOTES


Garden history is a young field, and like all adolescents it is struggling to free itself from familial ties, in this case the disciplines of art history and literary theory. Chambers, a professor of English at the University of Toronto, moves the field of garden history beyond the social history of patrons and the documentation of careers of designers to an approach in which plants and planters—gardener, nurseryman, and amateur botanist-owner alike—take center stage. He focuses on the period from the middle of the seventeenth century to the middle of the eighteenth, when Stowe, Stourhead, Chiswick, and Rousham, the great icons of the English landscape garden, were being developed. Chambers' descriptions of the processes and materials of gardening are greatly enhanced by his familiarity with the botanical and horticultural history of the period. This was an era of extensive plant exploration and importation combined with the profound scientific contribution of Linnaeus' elaboration of the principles of taxonomy.

The opening essay, "The Patriots of Horticulture," is an excellent stand-alone commentary on English garden theory and its relationship to classical ideas of husbandry. Chambers identifies Virgil's Georgics as the aesthetic model for this new landscape. From this text he extracts classical concepts of arcadia, including the idea of rural withdrawal, the integration of farming and gardening ("the unity of beauty with profit and use with pleasure"), and the alliance of science and imagination in our understanding of nature.

Chambers also cites the influence of John Evelyn's Silva (1664) and Dendrologia (1706) on a new generation of estate builders. Evelyn's writings encouraged a massive replanting of English woodlands devastated by war. His motivation has been described as economic or technical, but the Silva had the unexpected effect of promoting the great wealth of trees available to the British gardener, not least the newly imported and highly valued North American species. His book inspired the planting of thousands of acres of both native and imported species, an effect that in turn required the development of new methods of transportation, planting, nursery management, and propagation.

Chambers examines the writings of Stephen Switzer, Lord Shaftesbury, and others for their ideas about appropriateness in plantings in a world of expanding options. Chambers also focuses in detail on the work of Lord Petre at Thorndon Hall, his estate in Essex. Petre's plans included massive tree-planting schemes that are described as combining beauty with botany: "The landscape and the greenhouse are one continuum."

Chambers' book is not unique in its focus on plants and planting techniques. Claudia Lazzaro, in her recent book, The Italian Renaissance Garden: From the Convention of Planting, Design and Ornament to the Grand Gardens of Sixteenth Century Italy (Yale University Press, 1990), places great emphasis on the contribution of plants to the architectural character of the Italian garden. She describes specific plants and their treatment as features in a larger composition. In her epilogue, she reflects on the transformation of these gardens over the years due to the maturation of plants and the changes in maintenance that have been dictated by changing tastes. This is an area all too often neglected by historians and one that needs far more work to support responsible efforts in present-day garden restoration projects.

Landscape historians John Dixon Hunt and
Joachim Wolschke-Bulmahn have recommended that garden history reach out beyond "high culture" to "lost habits of mind" to illuminate subjects that have been relegated to the margins. Both Chambers and Lazzaro are to be commended for bypassing a traditional academic approach and revealing the rich history of the planting process, a blend of craft, science, and technology.

Phyllis Andersen


For those interested in historic landscapes The Greek Plant World is a must. The author has painstakingly collected all references to plants in the writings of ancient Greeks—as well as references in works about the ancient Greeks—and assembled them in highly coherent and readable fashion. An excellent index makes it easy to track down what Homer, Herodotus, Plato, or Dioscorides had to say about a particular plant.

It would be a great book to read before visiting Greece, given that most of the plants covered are illustrated in sharp color photographs and are still growing there today. The armchair traveler, too, will find interest in its portraits of daily life in ancient Greece.

In a related vein, it is worth noting the recent publication of the final two volumes of Theophrastus' great work, the two-thousand-year-old De Causis Plantarum. Remarkably, this is the first publication of Books III through VI in English. [Volume I, encompassing Books I and II, was published in 1976 as Loeb Library no. 471.]

Theophrastus, born around 370 BC, is the author of the most important botanical works that have survived from classical antiquity. He was in turn a student, collaborator, and successor of Aristotle at the Lyceum. Like his predecessor, he was interested in all aspects of human knowledge and experience, especially natural science. His writings on plants form a counterpoint to Aristotle's zoological works. Books II and IV of De Causis Plantarum covers techniques of cultivation and agricultural methods in ancient Greece, while Books V and VI take up plant breeding, diseases and other causes of death, and distinctive flavors and odors.

For those interested in Theophrastus, the publication of these long-awaited books is cause for celebration. After two thousand years, it might even be called the publishing event of a lifetime.

Peter Del Tredici
Arboretum/National Park Service Partnership Receives Two Major Grants

Phyllis Andersen, Landscape Historian

The Arboretum’s partnership with the regional office of the National Park Service, known as the Olmsted Center for Landscape Preservation, is strengthened this year by the receipt of two grants for historic landscape preservation of national importance. We have just received a grant of $40,000 from the National Center for Preservation Technology and Training to produce a technical publication on the preservation of woody plants in historic landscapes. The publication will evolve out of a series of working group sessions involving professionals actively engaged in the landscape management of historic sites. It will address historic tree maintenance, the management of features such as woodlands, hedges, and vistas, the inventory and documentation of woody plants and the use of computer technology for both mapping and inventory control. We are particularly proud that this grant, one of only two awarded to landscape projects, is among the first group given by the newly created National Center for Preservation Technology and Training to produce a technical publication on the preservation of woody plants in historic landscapes.

The Olmsted Center has also received a grant of $12,500 from the Preservation Assistance Division of the National Park Service to hold a Forum on Historic Vegetation Management at the Arnold Arboretum in the spring of 1995. This one-day event will bring together speakers from all over the country to participate in panel discussions on a variety of topics including arboricultural practices at historic sites, the management of plant succession, and the identification, condition assessment, and replacement strategies for woody plants of historic importance. The Forum will be geared to individuals responsible for the ongoing management of historic sites with some space available for the general public.

Our partnership with the Olmsted Center continues to place us in the forefront of landscape preservation work. We are unique as an arboretum in our commitment. By bringing our traditional strengths in plant identification, propagation, and woody plant management to bear on the newly emerging methods of landscape preservation we are adding solid botanical and horticultural skills.
to those of landscape architects, preservation professionals, and general maintenance specialists. Our projects are diverse. Peter Del Tredici has identified plants lost to Fairsted, the home and office of Frederick Law Olmsted, from historic photographs of that site. Peter's work has contributed a new layer of authenticity to the treatment plan currently being implemented at Fairsted. Jack Alexander has grafted old apple varieties from Weir Farm, the home of American impressionist painter Alden Weir, now a property of the National Park Service, and from the Franklin Delano Roosevelt site in Hyde Park, New York, to provide replacement plants for historic orchards. The Olmsted Center, now located at the Frederick Law Olmsted National Historic Site in Brookline, has been nationally recognized as the only facility within the National Park Service devoted exclusively to historic landscape preservation, training, and technology development. The future of our partnership looks promising, and we are currently engaged in strategic planning to enable it to continue to play a leadership role in cultural and natural landscape preservation.

National Preservation Conference Honors Arboretum Staff

Bob Cook, director of the Arnold Arboretum, was given a Heritage Hero award by Roger Kennedy, director of the National Park Service, on the occasion of the 48th National Preservation Conference sponsored by the National Trust for Historic Preservation held in Boston, October 26–30, 1994. Heritage Hero awards are given to individuals who have made major contributions to the preservation mission of the National Park Service. Boston Mayor Thomas Menino was also honored with this award at a ceremony at the Park Plaza Hotel on October 27.

The renovation of Harvard Yard, including the Yard landscape, buildings, and encircling fence received the National Preservation Honor Award from the National Trust for Historic Preservation. Peter Del Tredici, assistant director for living collections, was a member of the committee that prepared the replanting plan, which will add over 250 trees to the Yard over the next 7 to 10 years. The replanting plan is a unique contribution to the field of landscape preservation in its detailed and sensitive approach to dealing with the loss of the key landscape element, the American elm.

The Arnold Arboretum interns of 1994 are, from left to right in the front row, Kirsten Thornton, Todd Forrest, Amy Spencer, Debra Castellano, Kirsten Ganshaw, and in the back row, Vincent DiFusco, Andy Bell, Amy Capron, Scott Wunderle, Lisa Farino, Chris Fannin, Merrill Whittington, Kyle Orr, and Pam Snow. Irina Kadis is missing from the photo. Their training included hands-on experience in grounds maintenance—including an extra dose of hard work on Peters Hill and Bussey Hill—labeling and mapping of trees and shrubs, plant propagation, and library curation. They also participated in plant identification and landscape maintenance classes and joined Arboretum staff members for tours and talks.
The Rain Forest Connection

Robert E. Cook, Director

Last month the Arboretum entered into an unusual collaboration with a company called Tom Snyder Productions. Supported by a $90,000 grant from the National Science Foundation, we will be working with them to develop The Rain Forest Connection, an interactive CD-ROM-based curriculum package for middle-grade students. CD-ROM is a technology that places vast volumes of information on a compact disc that can be rapidly accessed at any point. Tom Snyder Productions has extensive experience in creating award-winning educational materials that effectively integrate science content with cooperative learning, decision-making, and technology.

Based on our ongoing search for plants containing anti-cancer and anti-AIDS compounds in Indonesian tropical forests, The Rain Forest Connection will combine real-life narratives with collaborative problem-solving based on actual scientific research on the discovery and management of biological resources. The CD-ROM will include video, animation, still images, data sets, maps, remote sensing images, sound and music to provide story, information, background, incentives, and feedback. Classroom students will work in small cooperative teams made up of different scientific "experts." Each team will collect, organize, and analyze data from the CD-ROM, print booklets, and related hands-on activities.

Because each student "expert" has unique information, the team can succeed only by sharing their knowledge and ideas. As the teams make decisions, the direction of the narrative changes, reflecting the consequences of their choices and presenting new opportunities for problem-solving and decision-making.

John Burley, director of our programs in Indonesia, and Andrew MacDonald, our research associate who has just returned from six months in the forests of Borneo, will be working with me and a production team at Tom Snyder to develop the narrative and ensure scientific accuracy. It promises to be a very creative collaboration and will bring the work of the Arboretum to thousands of schoolchildren across the country.


Peter Del Tredici, Assistant Director for Living Collections

Hubei Province figures prominently in the history of the Arnold Arboretum. It has been the source of many of our most prized introductions. E. H. Wilson collected many plants in the vicinity of Yichang (on the Yangtze River) in the late 1800s and early 1900s, and in 1980 Chennongjia Mountain in the western part of the province was the principal site of the Sino-American Botanical Expedition, the first major plant-collecting expedition to China since 1949.

This fall, representatives from four of the institutions in the North American-China Plant Exploration Consortium (NACPEC), working in cooperation with the Nanjing Botanical Garden, joined in a collecting expedition to Wu Dang Mountain in northern Hubei Province. I was accompanied on the trip by Paul Meyer of the Morris Arboretum, Philadelphia, Kevin Conrad from the U.S. National Arboretum, Washington, D.C., and Mr. Zen of the Science and Technology Committee, Dang Jiang Kou City in Hubei Province, holds a fruiting specimen of Emmenopterys henryi collected on the 1994 NACPEC Expedition.
R. William Thomas from Longwood Gardens, Kennett Square, Pennsylvania, and two botanists from the Jiangsu Institute of Botany, Mao Caliang and Hao Riming. As well as being botanically interesting, Wu Dang Shan is famous throughout China as one of the principal centers of Daoism during the Ming Dynasty. Over 500 years ago, some 300,000 workers were employed in the building of some 46 temples and halls, 72 shrines, 39 bridges, and 12 pavilions on the mountain, many of which are still standing.

The mountain itself is 5,285 feet in elevation. A good paved road takes visitors up to about 3,000 feet, where a handful of hotels are located. Beyond this point a steep stone path leads to the summit, which is crowned with the spectacular Golden Temple. Chinese tourists and pilgrims visit the mountain at all times of year, but their impact is generally confined to the immediate vicinity of the stone path. While the vegetation adjacent to the path shows signs of wear and tear, one can find well-preserved forest just a short distance from it. Indeed, it was very exciting to see many “old friends” from the Arboretum growing in their native habitat. Among the most interesting plants whose seeds we collected were Acer griseum, Castanea henryi, Emmenopterys henryi, Hamamelis mollis, and Sinowilsionta henryi.

In all, we made 127 collections of seed that are now being processed for germination at the Dana Greenhouses. With luck, this new generation of Chinese plants will flourish at the Arboretum well into the next century. In addition, many of them will be distributed to other botanical gardens and nurseries in order to diversify the germplasm currently available in this country. Readers of Arnoldia can expect a more detailed report on the trip in the near future.

Support for Field Studies

Arnold Arboretum Committee president Jim Gorman recently presented a check to Diane Syverson, manager of school programs, and friends from the Joseph Lee School in Dorchester. The recent donation caps a total of $26,000 contributed by the Committee to support the participation of Boston Public School students in the Arboretum’s Field Study Experiences Program.

Open House

On Sunday, October 16, Arboretum members and friends from the surrounding community joined director Bob Cook and staff for a special open house. In addition to tours of the landscape, greenhouses, and Hunnewell Building, participants enjoyed a demonstration of the Arboretum’s High Ranger truck (above) with arborist John Olmsted and grounds superintendent Patrick Willoughby.
Growing Classroom Gardens

As every good gardener knows, the experience of cultivating plants engages our best observational skills and provides a fascinating close-up window on the natural world. Through a recent grant from Northeastern University’s CESAME (Center for the Enhancement of Science and Mathematics Education), the Arboretum will make this experience part of the science programs at elementary schools in Dorchester, Hyde Park, and Mattapan. Coordinated by Arboretum school program manager Diane Syverson, the project will enable teachers from the Arboretum’s LEAP (LEarning About Plants) program to lead children in gardening science investigations developed by the Arboretum and the National Gardening Association. Known as The Growth Connection, the program is part of the Arboretum’s ongoing efforts to tap the potential of the world of plants and horticulture for hands-on science learning.

Arboretum Renovation Receives Preservation Award

Each year the Boston Preservation Alliance recognizes exemplary contributions to the preservation of the City’s rich architectural and landscape heritage. This October the Arnold Arboretum received a 1994 Preservation Award for “its outstanding restoration and the creation of handicapped access in the historical Hunnewell Building, circa 1892.” Preserving the historic character of both the Hunnewell Building and the surrounding landscape was a primary goal of the recent renovation, and we wish to extend recognition for the project’s success to Arboretum renovation manager Sheila Connor (and horticultural research archivist), landscape architect Carol Johnson, and architectural consultants The Primary Group.

New Staff at the Arboretum

Todd Forrest, our new curatorial assistant in the Mapping and Labelling department, came to the Arboretum from Portland, Oregon, as a grounds-crew intern in April of this year. His primary responsibility will be updating the Arboretum’s plant records using accessioning and planting lists and nursery inventory. In Oregon, Todd worked for a retail nursery as a landscape design consultant and spent his free time studying the ecology of the Douglas fir forests of the Western Cascades. He is a 1991 graduate of Wesleyan University and an inveterate plantsperson.

Ann-Marie Luciano is a recent addition to the Arnold Arboretum staff at the Harvard University Herbaria. She will be assisting John Burley with day-to-day tasks on the Biodiversity Collections Project with the government of Indonesia. Ann-Marie comes to us from the Department of Organismic and Evolutionary Biology.

Loretta Wilson and Flora Bussewitz were among the many honored at the recent luncheon held in recognition of Arboretum volunteers. Al Bussewitz’s illustrated lecture on Henry David Thoreau was the highlight of the event.

Volunteer Recognition

She was awarded a B.S. in journalism and public relations from Northeastern University in 1993.
The calm before the storm: volunteers prepare to register bidders before the 12th Annual Rare Plant Auction.

A splendid selection of unusual and choice plants from the Arboretum and other botanical collections, nurseries, and private collectors ensured a highly successful 12th Annual Arnold Arboretum Plant Sale and Auction. The Arboretum expresses its many thanks to the 55 volunteers who contributed over 780 hours of excellent effort to the event.

New England plant societies and horticultural organizations gathered on Society Row.

Members choose their bonuses outside the Case Estates barn.

A magnolia and other plants head for new grounds.
The Arnold Arboretum’s Education Department offers many short courses, lectures, and programs during the winter months. These cold months give gardeners the time to plan their gardening activities for the coming season, and to learn about new plant materials and horticultural techniques.

For a complete catalogue of programs and events at the Arboretum, call (617) 524–1718, ext. 162. Please note that course catalogue and event dates are for Arboretum members.

JANUARY

HOR 377 Woody Plant Groupings: Designing With Trees and Shrubs
Laura Eiserer, Landscape Designer
This class will examine the ways in which woody plants can be combined to shape space in boundary plantings. The instructor will also discuss canopy layers, understory levels, groves, allees, and orchards. The last session will emphasize ornamental pruning as a way of enhancing the effect of the tree and shrub groupings. Slides and plan drawings will be used to illustrate striking uses of woody plants.
Fee: $64, $77
4 Thursdays, January 5, 12, 19, 26/ 6:30–8:30 pm
(Dana Greenhouse)

FEBRUARY

HOR 406 Building the Design: How to Solve Problems in Landscape Construction
Bob Hanss, Landscape Architect and Design/Build Professional
This course is designed for the needs of landscape professionals, but homeowners or gardeners interested in doing their own subcontracting are also welcome. The class will see slides of current or recently completed projects that illustrate how to deal with the many problems and issues of turning a plan into reality. Topics to be covered include cost analysis and materials selection.
Fee: $54, $65
3 Wednesdays, February 1, 8, 15/ 6:30–8:30 pm
(Dana Greenhouse)

HOR 210 Fundamentals of Garden Design
Douglas Reed, Landscape Architect
Gardening begins with a plan, whether you are renovating an existing garden or starting from scratch. This course will help participants to visualize good garden design, get a plan down on paper, and choose plants consistent with the design.

The instructor will use lectures and slides to convey the steps in developing a plan, using before-and-after slides of garden sites and the sketches that led to the final plan drawings. Students will participate in weekly critiques of their plans in progress. Please note that all class members create a plan for the garden visited during the first class.
Prerequisite: Some knowledge of the basics of plan drawing is needed in this course.
Fee: $95, $110
1 Sunday, February 5/ 1:00–3:00 pm
(Hunnewell Building and required site visit)
and 5 Tuesdays, February 7, 14, 21, 28, March 7/ 6:30–8:30

HOR 277 The Business of Design
Carol Julien, Garden Designer
Every landscape practitioner, whether landscape architect, designer, installer, or maintenance specialist, has business issues that need to be successfully resolved. Experienced garden designer Carol Julien will introduce and discuss many of these business-related questions.
Fee: $40, $46
3 Mondays, February 6, 13, 27/ 6:30–8:30 pm
(Dana Greenhouse)

WAL 311 Classic and Choice Garden Roses
Stephen Scanniello, Rosarian, Brooklyn Botanic Garden
As Chairman of the Heritage Rose Foundation and a judge at the International Rose Competition held each year in Paris, Stephen Scanniello sees and evaluates the best rose introductions. This beautifully illustrated slide lecture will give rose admirers a chance to shake the winter doldrums and plan spring purchases.
Fee: $15, $18
Thursday, February 16/ 7:30–9:00 pm
(Hunnewell Building)

BOT 100 Introduction to Botany
James Martin, Arborist and Horticultural Instructor
An introduction to botany for students new to the discipline and a refresher for those who feel the need to brush up on old skills. Among the topics to be explored are plant cells and tissues, cell division, plant anatomy and morphology, plant diversity,
evolution, and ecology.
Fee: $98, $112
6 Tuesdays, February 21, 28, March 7, 14, 21, 28/ 6:30–8:30 pm (Dana Greenhouse)

HOR 458 Comparing the Viburnums in Form, Fruit, and Flower
Tom Ward, Manager, Dana Greenhouses, Arnold Arboretum
The viburnums offer a wide diversity of flower form, fruting characteristics, and landscape potential. Tom Ward’s talk will compare the viburnum species and cultivars in all seasons of the year and evaluate their pest and disease resistance, growth habit, and ease of cultivation.
Fee: $15, $18
Thursday, February 23/ 6:30–8:30 pm (Dana Greenhouse)

M A R C H

HOR 174 Witch Hazels: Winter Fragrance and Flowers
Chris Strand, Outreach Horticulturist, Arnold Arboretum
Hamamelis, better known as witch hazel, has the wonderful ability to flower in the depths of our New England winters. Different species will be in flower from the beginning of January through the end of March. Weather permitting, this course concludes with a walk through the Arboretum’s excellent witch hazel collection.
Fee: $10, $12
Thursday, March 9/ 10:00 am–noon (Dana Greenhouse)

WAL 330 China: Cradle of Species Diversity?
David Boufford, Assistant Director for Collections, Harvard University Herbaria
In this slide-illustrated course, Dr. Boufford will discuss his work with plant species native to China and Bhutan, presenting his views on current theories of species origination in eastern Asia.
Fee: $24, $28
2 Thursdays, March 23, 30/ 7:00–8:30 pm (Harvard University Herbaria)

BOT 118 Dwarf Conifers
Richard Stomberg, Manager, Harvard University Herbaria Glasshouses
Many of our common conifers have dwarf and other unusual forms. Whether they are 6-inch buns or 12-foot mops, they all add tremendous interest to our landscapes. We will also—rain or shine—walk through the Arboretum’s excellent collection of dwarf conifers.
Fee: $24, $29
Saturday, March 25/ 9:30 am–12:30 pm (Dana Greenhouse and Arnold Arboretum grounds)

The Italian Garden Photographs of Charles A. Platt
The Arnold Arboretum is pleased to announce an exhibit of the photographs of landscape designer Charles A. Platt (1861–1933). Platt’s 1894 publication, Italian Gardens, was the first illustrated volume in English to explore Italy’s rich garden heritage, and thus influenced a generation of garden designers and landscape architects. The exhibit presents many of the evocative images from this landmark book and will be on view in the Hunnewell Building from December 1 through February 15. The Arnold Arboretum extends its many thanks to the Bank of Boston for its generous loan of this exhibit. For more information, please call 524–1718.

Stone pines (Pinus pinea) and Italian cypress (Cupressus sempervirens), Villa Borghese, Rome