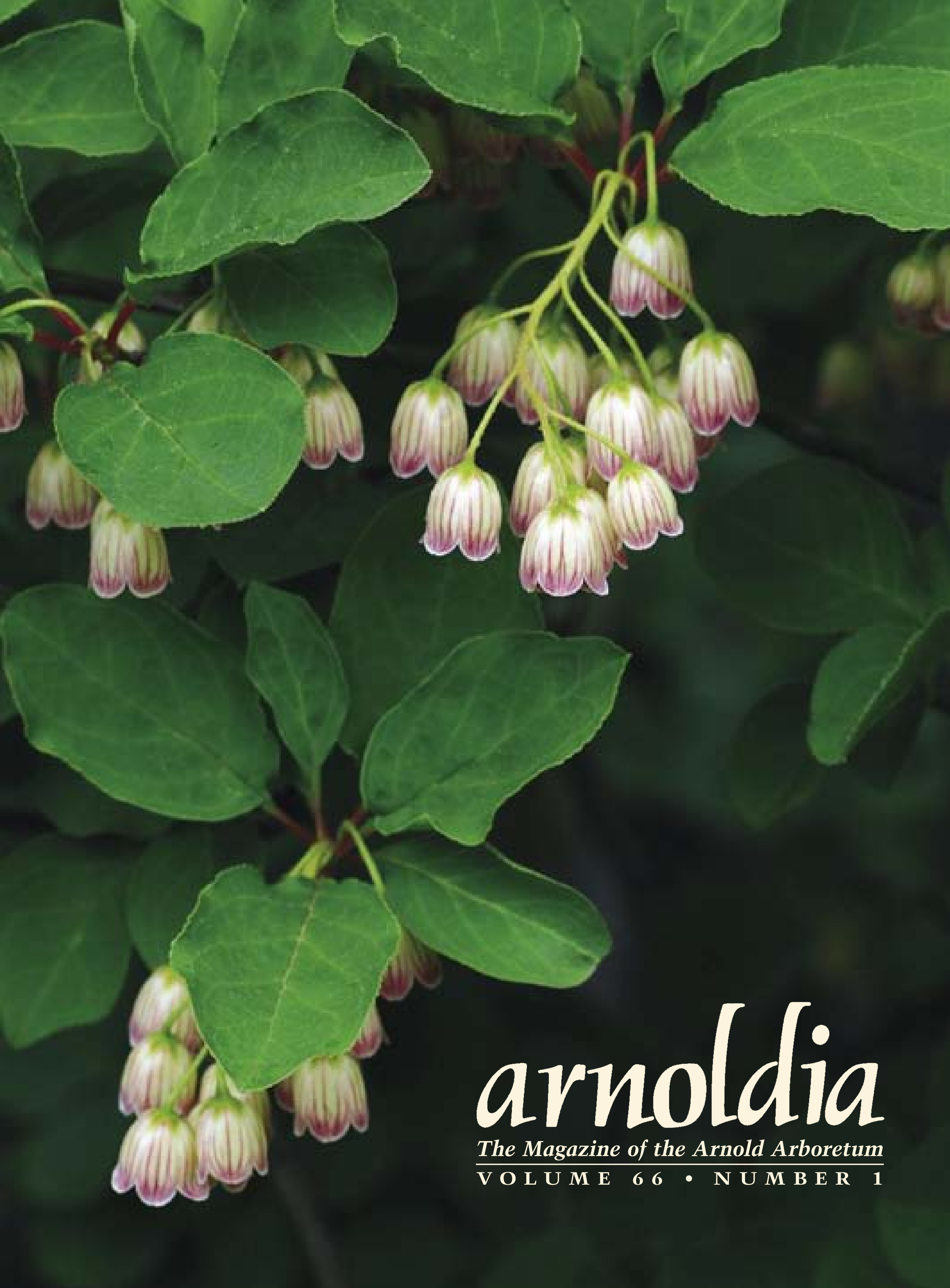

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The ARNOLD ARBORETUM of HARVARD UNIVERSITY

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Front cover: The delicate bell-shaped flowers of *Enkianthus campanulatus* 535-93, one of eight accessions of this species at the Arboretum. For in-depth information on how and why accessions are added to the Arboretum collections, read curator Michael Dosmann's article on the Living Collections Policy. Photo by Nancy Rose.

Inside front cover: Swamp azalea *(Rhododendron viscosum)* typically bears white or very pale pink flowers when it blooms in June, but this form (*R. viscosum* f. *rhodanthum*) is noted for its striking bubblegum-pink flowers. Accession 638-62-A, shown here, grows in the recently renovated Azalea Border along the Arboretum's Meadow Road. Photo by Michael Dosmann.

Inside back cover: The majestic silver maple (*Acer saccharinum,* accession 12560-C) near Meadow Road is featured in this issue's plant profile. The tree was around 100 feet tall when photographed in April 1988 by Istvan Rácz and Zsolt Debreczy.

Back cover: This hand-colored emulsion-on-glass lantern slide, made around 1920 by photographer John Horace McFarland, shows two women in fashionable cloche hats walking on a path through the ferns and towering eastern hemlocks of the Arboretum's Hemlock Hill. From the Archives of the Arnold Arboretum.

The Chinese *Parrotia:* A Sibling Species of the Persian *Parrotia*

Jianhua Li and Peter Del Tredici

The Persian ironwood *(Parrotia persica)* has a well-deserved reputation as a beautiful garden plant—mainly because of its exfoliating bark and gorgeous fall color—but also as a tough species that tolerates drought, heat, wind, and cold (Dirr 1998). Less well known is the fact that Persian ironwood has a sister species, the Chinese ironwood *(Parrotia subaequalis)* (Figure 1), growing about 5600 kilometers (3500 miles) away in eastern China. Remarkably, this species was correctly identified only sixteen years ago (Deng et al. 1992a).

The Persian and Chinese ironwoods are members of the witch hazel family (Hamamelidaceae), and in order to appreciate their uniqueness and evolutionary history we need to first examine one of their more familiar relatives, the witch hazels *(Hamamelis).* There are five species of witch hazel distributed throughout the temperate regions: *H. mollis* in eastern China, *H. japonica* in Japan, and *H. virginiana, H. vernalis, H. mexicana* in North America. The genus shows the intercontinental disjunct distribution between eastern Asia and North

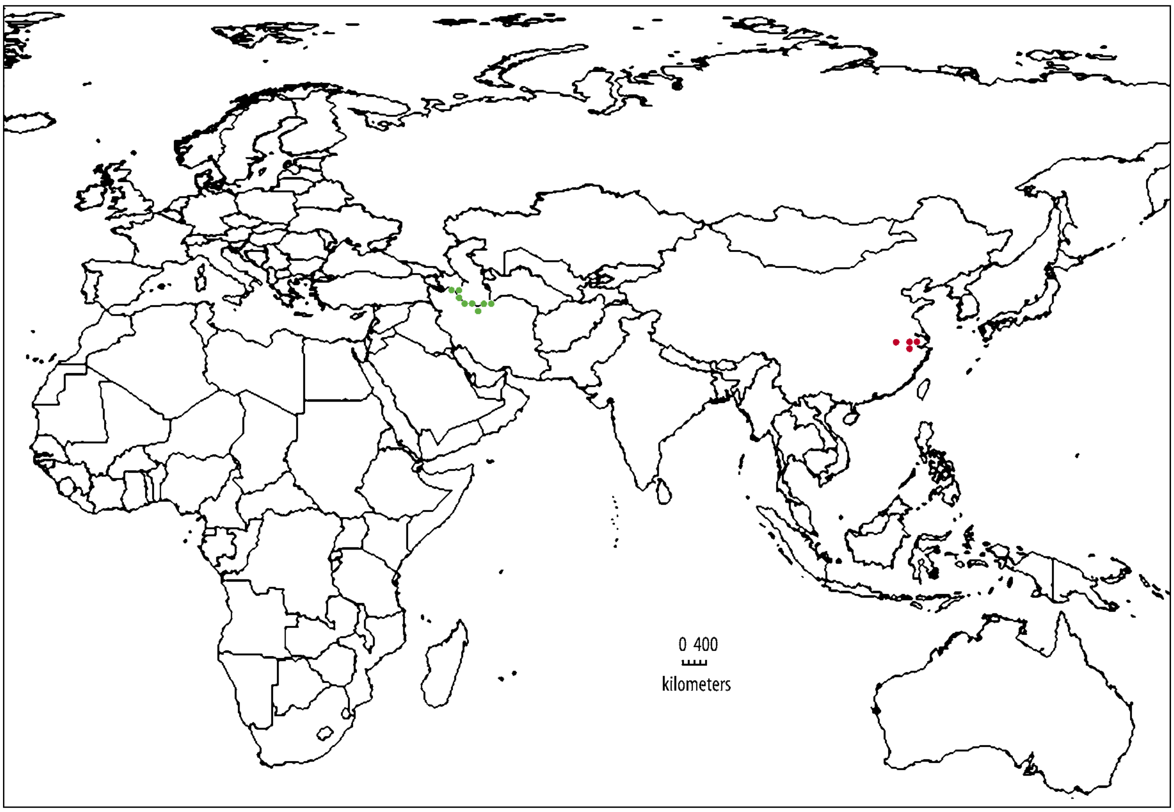

Figure 1. Geographic distribution of *Parrotia persica* (in green) and *P. subaequalis* (in red). Note that the scale bar is 400 kilometers.

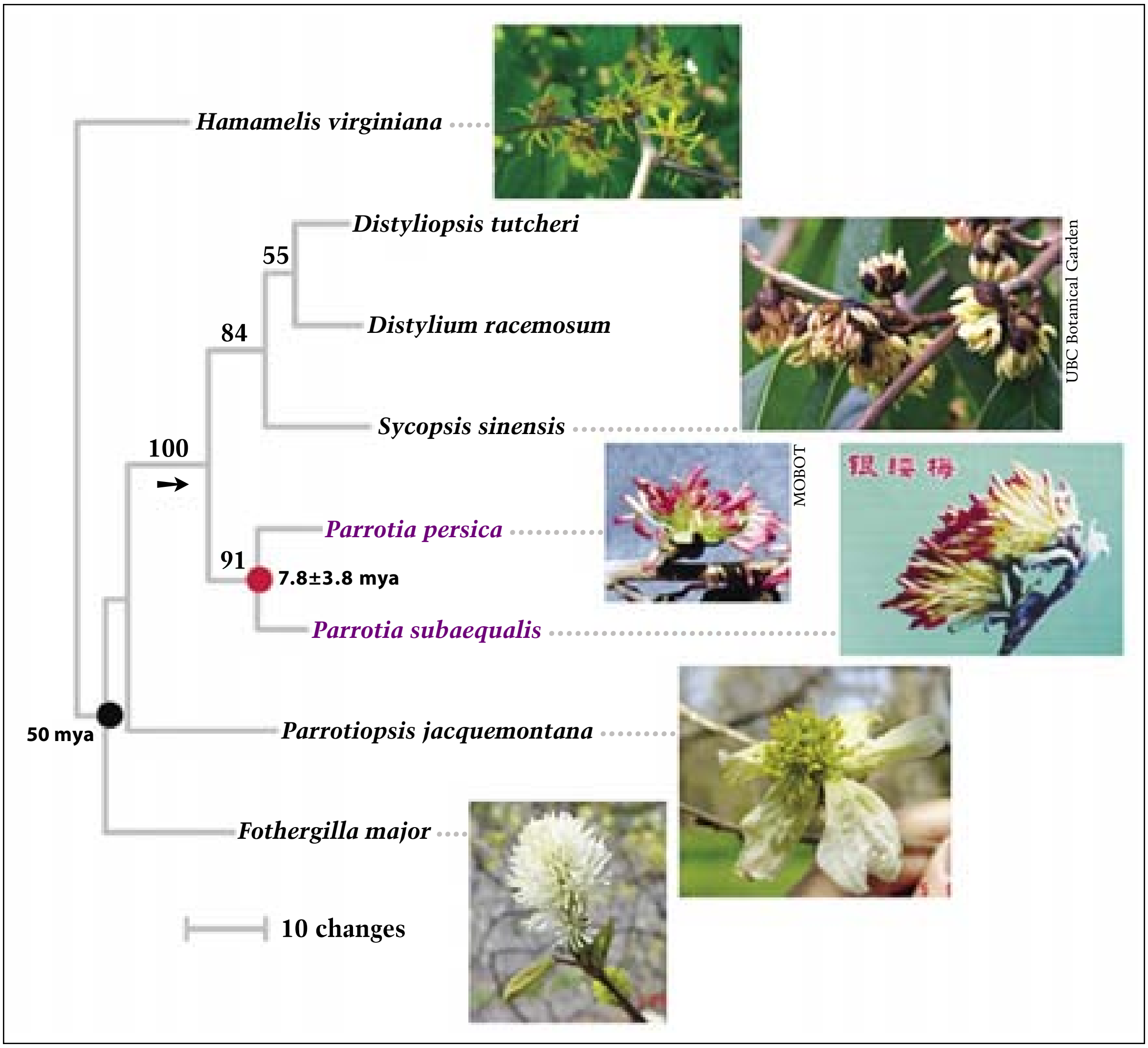

Figure 2. Evolutionary relationships of *Hamamelis* and petalless genera, showing shift (the arrow) from insect to wind pollination. Black dot indicates the fossil calibration point and the red dot shows the divergence time of the two *Parrotia* species.

The scale bar represents ten changes in nucleotide composition as measured along the horizontal branches of this phylogenetic tree. Changes in nucleotide composition indicate genetic evolution over time.

The numbers that appear over several of the branches indicate the percentages of statistical support for those groupings. Higher numbers indicate stronger evidence of support.

(mya=million years ago)

America that has fascinated many scientists since the time of Asa Gray (Gray 1846).

Witch hazels have four ribbonlike petals (Figure 2) that come in a variety of colors from yellow to reddish copper. Six other genera in the witch hazel family have similar ribbonlike petals and occur in Southeast Asia, Africa, Madagascar, and northeastern Australia. These genera have traditionally been considered closely related to one another and to *Hamamelis* because they have the same number of similarly shaped petals.

But recent DNA analysis has determined that the genera with four ribbonlike petals do not form a closely related natural group because they are positioned on different branches in the

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Figure 3. The foliage of a specimen of *Parrotia subaequalis* growing at the Nanjing Botanical Garden.

witch hazel family tree. Interestingly, in each branch of this family tree the most advanced genera are those that have lost their petals, a trait that is generally believed to correlate with the transition from insect to wind pollination (Li et al. 1999). During this evolutionary transition period, a few genera in the *Hamamelis*—*Parrotia* lineage developed showy parts other than petals with which to attract insect pollinators. For example, *Parrotiopsis* of the western Himalayas possesses showy leaflike bracts beneath the inflorescences, while *Fothergilla* species in the eastern U.S. have conspicuous white stamen filaments (Figure 2). In contrast, *Parrotia* flowers lack not only petals but also showy bracts and stamen filaments. Instead, their anthers are elongated, a characteristic common to wind-pollinated species including the most advanced genera in Hamamelidaceae. Thus, the shift from insect to wind pollination is complete in the evolutionary branch leading to *Parrotia, Sycopsis, Distyliopsis,* and *Distylium* (Figure 2).

Taxonomic History of the Chinese *Parrotia*

The first recorded species of *Parrotia*—*P. persica*—was described by C. A. Meyer in 1831 and named in honor of F. W. Parrot, a German naturalist and traveler. For a long time it was the only known species in the genus. In 1960 Professor H. T. Chang of Sun Yat-sen University described a new species of *Hamamelis*—*H. subaequalis*—based on a fruiting specimen that had been collected twenty-five years earlier from Yixing county of Jiangsu province, China. Its main distinguishing feature was that it produced much smaller leaves than the Chinese witch hazel *(H. mollis)* (Figure 3) (Chang 1960). The fact that the plant described as *H. subaequalis* was not recollected until 1988—some 53 years after its initial collection—led to speculation that the plant had gone extinct in the intervening years.

In the fall of 1988, Miaobin Deng and colleagues at Jiangsu Institute of Botany discovered a natural fruiting population of *H. subaequalis* in the town of Yixing. After three years of continually monitoring the population, their patience was rewarded when the plants finally flowered again (Deng et al. 1992b). At that point it became clear that *H. subaequalis* lacked petals, making it dramatically different from *H. mollis* (Figure 4). They proposed a new genus—*Shaniodendron*—to accommodate the species which they named *S. subaequale* (Deng et al. 1992a). Dr. Riming Hao, who studied the floral morphology of *Shaniodendron,* pointed out that *Shaniodendron subaequale* was quite similar to *Parrotia persica,* but he did not place it within the genus *Parrotia* (Hao et al. 1996). In 1996, Dr. Yinlong Qiu sent some DNA of *Shaniodendron* to Jianhua Li, then a PhD candidate at the University of New Hampshire working on the systematics of the witch hazel family. He obtained nuclear DNA sequence data from the sample and, after comparing it with other genera of the family, determined that *Shaniodendron* was a sibling species to *Parrotia persica* (Li et al. 1997). After seeing the DNA results, Hao used this evidence to propose the merger of *Shaniodendron* with *Parrotia* (Hao and Wei 1998). Nevertheless, it seems that this

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Figure 4. The flowers of *Parrotia subaequalis* as shown on a sign posted at the Yixing Caves Scenic Area.

treatment may take some time for people to accept since recent studies continue to use the name *Shaniodendron subaequale* (Fang et al. 2004; Huang et al. 2005), despite the fact that the plant is listed as *Parrotia subaequalis* in the *Flora of China.*

Parrotia persica and *P. subaequalis* are very similar from growth habit to morphology. Both trees display exfoliating bark, have obovate leaves with bluntly toothed margins, and grow in moist habitats along streams. They bear four to seven flowers clustered in a head inflorescence subtended by broadly ovate, brownish bracts. Each flower has five sepals but no petals and four to fifteen stamens with long anthers (Figure 4). Their fruits are woody capsules consisting of two chambers, each with two brown seeds (Figure 5). *Parrotia subaequalis* can be easily distinguished from *P. persica* by its lanceolate stipules and sepals fused into a shallow saucer-shaped calyx (Hao et al. 1996).

When did *Parrotia persica* and *P. subaequalis* diverge?

Recent DNA work in Jianhua Li's laboratory has shown that witch hazels *(Hamamelis)* are more primitive than the petalless genera in Hamamelidaceae. The evolutionary sequence of the petalless genera appears in the order of *Fothergilla, Parrotiopsis, Parrotia, Sycopsis,* and *Distyliopsis* plus *Distylium,* and the two species of *Parrotia* are grouped together (Figure 2).

Fossils can provide evidence for the minimum age of the lineage to which they belong. Unfortunately, fossil information is often unavailable for a specific taxon. Nevertheless, if DNA molecules evolve at a constant rate, that is, a certain number of nucleotide changes per million years, we can use the total number of changes between the two species to estimate how long ago they diverged. Our statistical tests indicated that the evolution of the nuclear genes we have used to reconstruct the evolutionary history of these genera followed a clockwise manner. The next thing we needed was to calibrate the ticking rate of the molecular clock using one or more known fossil dates. Luckily, Radtke et al. (2005) found a fossil leaf that could be unequivocally assigned to *Fothergilla,* specifically *F. malloryi.* This fossil leaf is part of the Republic Flora of northeastern Washington State, dating to the late Eocene (about 50 million years ago), and thus provides a minimum separation age of *Fothergilla* from the branch leading to other genera (Figure 2). Based on the molecular clock calibrated using the fossil, our estimates suggest that the two species of *Parrotia* diverged around 7.5 million (plus or minus 3.8 million) years ago, during the Lower Miocene. This divergence time is consistent with the geological evidence

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Figure 5. Fruit and seed of *Parrotia subaequalis.*

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Figure 6. *Parrotia subaequalis* cultivated as penjing at the Nanjing Botanical Garden.

that the cooling temperature in the Lower Miocene plus the uplifting of the Himalayas and the mountains of western China from 55 million years ago to the Middle Miocene may have restricted biological exchanges between central Asia and eastern China (Yin and Harrison 2000; Sun and Wang 2005).

Forests in the Caspian region of central Asia and those in eastern Asia are both relicts of the widespread Tertiary vegetation (Wolfe 1975; Hosseini 2003; Sun and Wang 2005). Besides *Parrotia,* the two regions share many other woody plant genera including *Acer, Albizia, Buxus, Castanea, Carpinus, Diospyros, Fagus, Pterocarya, Quercus, Sorbus, Taxus,* and *Zelkova.* From an evolutionary and biogeographical standpoint it would be interesting to determine whether central Asian species within these genera are siblings of the eastern Asian species, and if so, whether their separation time agrees with that between the two *Parrotia* species.

Parrotia subaequalis in China

According to Chengxin Fu, Riming Hao, and various accounts in the literature, there are five populations of *Parrotia subaequalis* in eastern China: two each in Jiangsu and Zhejiang provinces (Huang et al. 2005) and one in Anhui (Shao and Fang 2004). Professor Fu's team is currently conducting a survey to determine the levels and patterns of the genetic diversity in Chinese *Parrotia* populations. The results will provide a scientific foundation for designing conservation strategies. Regeneration of *Parrotia subaequalis* populations will be challenging because of the species' alternate-year fruit production, serious habitat competition from bamboos, and increasing human activities. It is essential to take immediate action and institute stricter measures to protect the species.

Peter Del Tredici first saw two plants of *Parrotia subaequalis* on October 8, 1994. They were being cultivated in containers as penjing (bonsai) in a lath-house at the Nanjing Botanical Garden. At that time, the foliage had turned a beautiful, rich, deep red (Figure 6). According to the Director of the Garden, Professor Shan-an He, the plants had been collected in Jiangsu province at the Yixing Caves Scenic Area, which is located about 120 kilometers (75

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Figure 7. Dr. Hao Riming of the Nanjing Botanical Garden with a plant of *Parrotia subaequalis* grown from a cutting.

miles) southwest of Nanjing on the east side of Tai Lake. Both specimens had massive trunks and the larger of the two was about 50 centimeters (20 inches) tall by 70 centimeters (28 inches) across. The form of their trunks, along with their extensive yet well-healed wounds, suggested that both plants were very old. When Peter returned to the Nanjing Botanical Garden in September of 1997, he didn't see the penjing specimens but saw one young plant—recently propagated from a cutting and about 2 meters (6.6 feet) tall—growing out on the grounds of the garden (Figure 7).

On September 1, 2004, we [Del Tredici and Li] had the good fortune to be able to visit the Yixing Caves Scenic Area (known as Shan Juan Park) with Professor Cheng-xin Fu and Ying-xiong Qiu of Zhejiang University. Upon entering the park, the group immediately encountered a large specimen of *Parrotia subaequalis* growing on a steep slope above a small pond at the mouth of the largest of the karst caves. The plant was hard to miss because it was identified with a large sign with a close-up color photograph of the plant in bloom (Figure 4). The tree, which was about 6 meters (20 feet) tall, had two main trunks, the largest of which was 24 centimeters (9.4 inches) in diameter (Figure 8). The bark appeared to be at the peak of its exfoliation, with patches of fresh greenish white bark showing where sections of the old bark had sloughed off. There were no fruits on the plant—the species typically flowers only every other year—but there were numerous seedlings growing beneath it.

A second large specimen was spotted about 30 meters (100 feet) away, on a slope in a mixed woodland with bamboo and other trees. We observed at least two cases where the exposed roots of this plant were producing vigorous young suckers, a phenomenon which had not been reported in the literature (Figure 9). Interestingly, sprouting from the base of the trunk was not observed on any of the trees.

Later that afternoon, the group drove to Longwang Shan in Anji Xian, in northern Zhejiang Province, about 90 kilometers (56 miles) south of the Yixing Caves. This relatively small mountain is considered part of the larger Tian Mu Shan range that forms the border with

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Figure 8. The trunk and foliage of a *Parrotia subaequalis* specimen growing at the Yixing Caves Scenic Area.

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Figure 9. Root suckers from a mature specimen of *Parrotia subaequalis* at the Yixing Caves Scenic Area.

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Figure 10. *Parrotia subaequalis* on Longwan Shan, 9.5 meters (31 feet) tall with a diameter at breast height of 38 centimeters (15 inches).

Anhui Province. After spending the night in comfortable accommodations at the research station, we hiked partway up the mountain to about 650 meters (2,130 feet) elevation and located two specimens of *Parrotia subaequalis* growing near the side of a stream, amidst a pile of boulders. The larger of the two trees was about 9.5 meters (31 feet) tall with a trunk diameter at breast height of 38 centimeters (15 inches) (Figure 10). Its bark was exfoliating in a dramatic way—shedding jigsaw-puzzle-shaped plates of old, blackish brown bark to expose conspicuous patches of greenish white bark below (Figure 11). The second specimen had a double trunk, was about 8 meters (26 feet) tall, and its bark was not exfoliating as dramatically as the larger plant. Neither was producing any sprouts from the base of its trunk or any root suckers. Unfortunately there were no fruits on either plant, although there were curious hard, round, gall-like structures about a centimeter or so in diameter on many of the leaves of the smaller, double-trunked plant. Some of the notable associates growing with *Parrotia subaequalis* on Longwang Shan were *Fortunearia fortunei, Styrax confusus, Pterostyrax corymbosum, Cornus controversa, Stewartia rostrata,* and *Stewartia sinensis.* We were told that the *Parrotia subaequalis* population at Longwang Shan consisted of about twenty individuals at that time.

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Figure 11. This specimen of *Parrotia subaequalis* (same plant seen in Figure 10) shows a very knobby trunk, indicating that it has lost many lower branches over time.

Parrotia subaequalis at the Arnold Arboretum

The Arnold Arboretum has two established plants of *Parrotia subequalis.* So far, both of them have survived two winters outdoors and they are now about 1.5 meters (5 feet) tall. On June 23, 2005, during their first growing season at the Arboretum, seven cuttings between 5 and 10 centimeters (2 to 4 inches) long were taken from the two plants. A month later, on July 25, another nine cuttings were taken from the plants. All sixteen cuttings were treated with a five-second dip in an aqueous solution of 5,000 parts per million KIBA, stuck in flats filled with a mix consisting of half sand and half perlite, and placed in the high-humidity greenhouse under intermittent mist and fog. Remarkably, all sixteen of the cuttings rooted and three of them are planted in the nursery.

With five plants now growing outdoors, the Arboretum is in a position to begin evaluating the horticultural potential of *Parrotia subequalis.* Successful establishment at the Arboretum also facilitates continued research on the genetics, physiology, reproductive biology, and conservation of this rare and evolutionarily important species.

Acknowledgments

We thank Cheng-xin Fu and Ying-xiong Qiu of Zhejiang University for their field assistance.

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Curatorial Notes: An Updated Living Collections Policy at the Arnold Arboretum

Michael S. Dosmann

Museums, by definition, collect things, and in the case of botanical gardens and arboreta, those things are plants. In this quest to collect, curators must exercise discipline and prudence in determining what new things to acquire as well as which ones to remove. Garden collections can be notably challenging to curate because of the overwhelming breadth of possible biodiversity to accumulate. Thus, it is essential for curators to make use of a collections policy—a tool which defines the scope of the collection. The collections policy is mission-driven; it defines short- and long-term goals and establishes the direction of collection building. While the specifics of what items to collect may occasionally be included in the collections policy, they are typically outlined separately in a detailed collections development plan. Likewise, the tactics of curation, such as the means of acquisition, intricacies of database management, standardization of nomenclature, or tasks related to plant maintenance, are best housed within a separate procedural manual.

Collections policy history at the Arboretum

Since its inception, the Arboretum has built its living collection of plants with the aid of a collections policy, although the policy's content and application have varied considerably over the years. The indenture signed by the President and Fellows of Harvard College and the Trustees of Mr. James Arnold on the 29th of March, 1872, included the original collections policy:

> "The Arnold Arboretum... 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..."

It was simple, direct—and too broad for Charles S. Sargent, the Arboretum's first curator and director. While he followed the spirit of the indenture's charge with aplomb, acquiring as many taxa as possible, the focus quickly shifted almost solely to woody plants, leaving most herbaceous plants out of the permanent collections. His keen interest in the floras of North America and eastern Asia, no doubt influenced by his mentor Asa Gray, led to substantive biogeographic collections from these locales. And Sargent's fascination with ornamentals resulted in the acquisition of many horticultural plants, including great numbers of botanical formae and varieties that are now considered cultivars.

Sargent (1922) estimated that during the Arboretum's first half-century some 6,000 taxa grew in the collections. But space became limited in the 265-acre landscape, and the collections became crowded. The problem became acute in the years following Sargent's death in 1927; in the absence of his careful direction the collections multiplied unchecked. To respond to this dilemma, landscape architect Beatrix Farrand was hired in 1946 by Karl Sax, Arboretum director at the time, to create a restorative plan. In her assessment (Farrand 1946), she questioned whether "the comparatively small acreage of the Arboretum can wisely accommodate all the species and varieties of woody plants of the temperate regions." The recommendation that she and the Administration came up with was that the collections grown in Jamaica Plain would be "the best and most ornamental"; research plants that lacked the desired showiness, yet had scientific merit, would be transferred to the Case Estates in Weston, where they could be lined-out in experimental nurseries. This strategy's execution was left to Donald Wyman, the Arboretum's horticulturist. Wyman undoubtedly sighed in relief with this decision. He acknowledged (Wyman 1947) the difficulty of maintaining an expanding number of plants solely at Jamaica Plain given the institutional reticence to modify any collections following Sargent's death (particularly those that Sargent had a hand in building). In theory, this split-site solution allowed the living collections to

HERBERT W. GLEASON, ARCHIVES OF THE ARNOLD ARBORETUM

Arboretum planting space was already filling up when this photograph was made in May of 1930, a few years after Sargent's death. The photo shows Korean azalea (*Rhododendron yedoense* var. *poukhanense*) and other plants on Bussey Hill.

PHOTOS BY MICHAEL S. DOSMANN

Starting in the late 1970s, the Arboretum shifted its priority to collecting plant material of documented wild origin. Representative plants collected on expeditions made during this period include (clockwise from upper left): *Weigela subsessilis* collected in the Republic of Korea in 1977, *Sorbus yuana* collected in the People's Republic of China during the Sino-American Botanical Expedition in 1980, and *Cotinus coggygria* from the 1980 expedition to the Russian Federation (then the U.S.S.R.).

remain comprehensive—as per the original collections policy of 1872—while providing focus to the two sites: research collections in Weston and ornamental collections in Jamaica Plain.

For the next 30 years, this practice continued and the Arboretum landscape in Jamaica Plain accrued great numbers of ornamental taxa, particularly cultivars under evaluation. This swing was reinforced by the post-war proliferation of cultivars introduced by the nursery industry, the institutional goal of becoming a showcase of horticultural material, and practically complete cessation of plant exploration efforts. It is important to note that while the collections policy did not shift, per se, its method of realization did.

In the late 1970s, a shift again took place—this time with an eye towards documentation, the prime metric used to assess a collection's value. While material of cultivated origin may carry with it notable documentation, its value is generally eclipsed by material of wild origin, particularly once it has been verified to identity. Thus, in a new living collections policy, priority shifted away from ornamental and toward botanical taxa (Spongberg 1979). While the emphasis was placed upon botanical taxa of wild origin, provisions were in place to accession or maintain garden-origin plants (as temporary placeholders), as well as cultivars—provided they were of historic significance (i.e., those with Latinized epithets proposed prior to 1953). This policy change coincided with the reinstated tradition of field collection of germplasm, both domestically and abroad. As a result, many new acquisitions of documented wild origin again crossed the Arboretum's threshold, particularly in Jamaica Plain. With respect to the practice of growing material in both Jamaica Plain and Weston, Peter Ashton (1979) reflected that the two-site strategy had come at a cost: the loss of valuable germplasm which did not survive the transfer from Jamaica Plain to Weston, including original introductions of species by E. H. Wilson and other explorers. The ambitious goal of acquiring everything—maintained in two separate sites—was too lofty, particularly with the resources available, and Jamaica Plain was deemed the primary repository.

This formal policy direction was sustained for the next decade, and then reaffirmed in 1991 (Living Collections Long-Range Planning Committee 1991). As in the 1979 version, the goal stated that "the living collections of the Arnold Arboretum were to consist of a scientific collection of entities tied to botanical, not horticultural nomenclature." Because the emphasis was placed on names and not necessarily taxonomy, a great deal of space in the new policy was dedicated to the "problem of cultivars and their relationship to taxa of infraspecific botanical rank."

The need for a collections policy update

Shortly after joining the staff as Curator of Living Collections in January of 2007, I convened the Living Collections Committee to review the Arboretum's existing living collections policy and place it in context with current, as well as future, institutional needs. After thorough discussion and assessment, we restructured the policy with several broad goals in mind:

- The policy needs to describe the entire scope of our living collection, including collections that previously had not been highlighted such as the Larz Anderson Bonsai Collection and plants in our natural areas. It should also articulate levels of commitment, or priority (i.e., high to low), depending upon the type of collection. This would allow us greater flexibility as well as focus in collections development.
- The policy should not perpetuate the hierarchy between wild-origin and cultivated material. Instead, the emphasis should be placed on the level of documentation associated with individual accessions, as well as their programmatic use(s) in furthering the mission of the institution. This is particularly important when we consider the immense research potential of the collections (Dosmann 2007).
- The policy must be clear and usable, yet not burdened by too many details; the policy was not intended to be a procedural manual. Instead, we appended it with a list of operational definitions to aid in interpretation.

Here is the result: the current living collections policy for the Arnold Arboretum. Notice that in spirit, it has remained true to the original plan of 1872; additional details have been added for clarity and for establishing organization and a sense of priority. Interspersed within the official policy below are text boxes and figures that provide illustrative examples and additional information.

Living Collections Policy

Policy reviewed and approved on 10 September, 2007

MISSION STATEMENT

The Arnold Arboretum of Harvard University discovers and disseminates knowledge of the plant kingdom to foster greater understanding, appreciation, and stewardship of the Earth's botanical diversity and its essential value to humankind.

I. INTRODUCTION

A. PURPOSE OF THE LIVING COLLECTIONS POLICY

The Living Collections Policy of the Arnold Arboretum guides the development, management, and enhancement of the institution's Living Collections, and applies to all plants outlined below under Scope of the Living Collections. The Living Collections Policy is written and administered by the Living Collections Committee, which comprises the Curator of Living Collections (Chair of the Committee), Deputy Director, Manager of Horticulture, Manager of Plant Records, Manager of the Dana Greenhouses and Nursery, and Senior Research Scientist; it is further reviewed and approved by the Director. The Living Collections Policy is reviewed every five years and revised as needed. Operational procedures related to implementation of this and related policies are detailed in the Arboretum's *General Procedures for Managing the Flow of Plants through the Department of Horticulture* (January 2007).

B. PURPOSE OF THE LIVING COLLECTIONS

The Living Collections of the Arnold Arboretum are essential to achieving its mission as a research institution dedicated to improving the understanding, appreciation, and preservation of woody plants. As a national and international resource for research in the various fields of plant biology and beyond, the Arboretum's Living Collections are actively developed and managed to support scientific investigation and study, as well as key educational and amenity roles.

C. LEGAL AND ETHICAL CONSIDERATIONS

Activities related to the development, management, and use of the Arnold Arboretum's living collection comply with all relevant local, state, federal and international laws. This includes compliance with all necessary documentation and phytosanitary require-

NANCY ROSE

Phellodendron amurense **(Amur corktree; fruit shown at left) is currently monitored for its invasive potential in the Arboretum. Spontaneous trees have been removed, and female trees lacking sufficient documentation have been deaccessioned as a means of limiting seed production. However, other individuals of documented origin—some representing unique provenances—remain in the collection because of their high scientific value.**

NANCY ROSE

RUPERT TAYLOR

Nearly 500 plant genera are common to both North America and eastern Asia. Many representatives of this disjunct group are included in the Arboretum's collection, including two strikingly similar *Cornus* species, *Cornus alternifolia* from North America (left) and *Cornus controversa* from eastern Asia (right).

ments during acquisition and distribution activities. All taxa are evaluated for their potential invasiveness, and should invasive or potentially invasive plants be retained for their scientific value, additional management procedures are put into place for containment purposes; they are not distributed for horticultural use.

II. SCOPE OF THE LIVING COLLECTIONS

The Living Collections are divided into three primary collection categories: Core, Historic, and Miscellaneous Collections; within each are secondary collections. This organization allows priority to be assigned to all extant, as well as potential, accessions within each category, thus guiding collections development, management, and enhancement. It should be noted that none of the primary, or secondary, collections are mutually exclusive and that many accessions fall into multiple categories.

A. CORE COLLECTIONS

The Core Collections are of highest priority and receive the greatest focus with respect to development, management and enhancement. In general, these collections are intrinsic to the mission of the institution through their research use, and preference is placed on material of documented wild origin. Exceptions to provenance requirements are made only in specific cases when the value is significant enough to warrant accessioning. By and large, these collections are regarded as obligatory.

1. **Biogeographic Collections**
   Collections representing the floras of eastern North America and eastern Asia have been an important traditional focus, strongly supporting research related to the floristic relationships between these two regions. In particular, eastern North American-Asian disjunct taxa receive high priority with respect to collections development.

2. **NAPCC Collections**
   As part of its commitment to the North American Plant Collections Consortium (NAPCC), the Arboretum maintains and develops collections of botanical taxa

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Interspecific diversity is attained by growing as many species as possible within each of these high-priority genera. To increase intraspecific diversity, we strive to acquire germplasm from multiple provenances of each species so that we may illustrate genetic variation as a function of geographic source.

Japanese beech *(Fagus crenata)* is just one of the species of beech grown as part of the NAPCC collection.

within the following genera: *Acer, Carya, Fagus, Stewartia, Syringa* and *Tsuga.* Because they serve as national germplasm repositories, development and maintenance maximizes both inter- and intraspecific diversity.

3. **Conservation Collections**
   As part of its commitment to the Center for Plant Conservation (CPC), the Arboretum maintains and develops collections of the following species: *Amelanchier nantucketensis, Diervilla rivularis, Diervilla sessilifolia, Fothergilla major, Ilex collina, Rhododendron prunifolium, Rhododendron vaseyi, Spiraea virginiana,* and *Viburnum bracteatum.* These species, as well as other taxa of conservation value outside the scope of CPC, are developed and maintained with the goals of preserving as high a level of intraspecific diversity as is practicable.
4. **Synoptic Collections**
   Collections of documented wild-origin species that together provide a synoptic representation of the woody flora of the North Temperate Zone are maintained and developed. Emphasis is first placed on generic diversity, and then inter- and intraspecific diversity as is practicable.

The goal of a synoptic, or comprehensive, collection is to include the broadest possible representation of the item or group being collected. At the Arboretum this means seeking the greatest breadth across all families that contain woody plants. The Arboretum's synoptic collections cannot contain every woody species, let alone every botanical variety or subspecies, so representative genera and species are selected based on institutional priorities and available space.

B. HISTORIC COLLECTIONS

The Arboretum's early contributions to plant exploration and horticultural improvement are manifested in a number of Historic Collections. In general, these collections are obligatory and maintained, but not actively developed except in cases where authentic material of Arboretum origin can be repatriated or the material is sufficiently unique to warrant accessioning.

1. **Arnold Arboretum Accessions**
   Plants collected by early Arboretum staff (e.g., C.S. Sargent, E. H. Wilson, J.G. Jack, J. Rock) may lack sufficient documentation, or be of garden origin. However, because they represent important historical chapters in the development of the institution, they are maintained in the Living Collections. In some cases, these accessions may represent genotypes no longer extant in the wild because of local extinction and thus have high conservation value.
2. **Nurseries and Horticulturists**
   Accessions derived from historically significant nurseries, botanical institutions and horticulturists (e.g., H. J. Veitch, T. Meehan, M. Vilmorin) may lack full documentation, but are maintained in the Living Collections. These often represent the initial introductions of species into cultivation and are, in all probability, wild-collected. In some cases, these accessions may represent genotypes no longer extant in the wild because of local extinction and thus have high conservation value.
3. **Distinctive Cultivar Collections**
   Early in its development, the Arboretum established diverse collections of garden selections now regarded as cultivars within various plant groups (e.g., dwarf conifers, *Malus, Rhododendron, Syringa*). Because of their period and oftentimes comprehensive nature, these collections are maintained but not developed.

NANCY ROSE

In 1885, C. S. Sargent described the goals of the Peters Hill landscape as housing "a collection for investigation which need not necessarily be permanent." Otherwise known as discretionary collections, these have often reflected the research interests of staff scientists. Prior to the substantial *Malus* collection (shown above), which grew through the work of director Karl Sax and horticulturist Donald Wyman, Peters Hill was home to extensive *Crataegus* collections—a long-term research project of Sargent.

ARCHIVES OF THE ARNOLD ARBORETUM

***Hydrangea paniculata* 'Praecox' is an old cultivar with a Latinized epithet. Originally collected in Japan by C.S. Sargent in 1892, this Arnold Arboretum introduction is noted for its precocious floral displays, blooming at least a month before typical plants of the species.**

4. **Cultivars with names proposed prior to 1953**
   The Living Collections contain a number of historic cultivars with Latinized names that were proposed in a botanical context prior to 1953. While not developed, these are maintained, particularly when they represent material unique in cultivation.
5. **Arnold Arboretum Cultivar Introductions**
   Throughout its history, the Arboretum has selected and introduced a number of clones for ornamental use, many of which were initially regarded as botanical formae but are now recognized as cultivars. Because they arose at the Arboretum, they are maintained and development occurs only to repatriate genotypes lost by the Arboretum.
6. **Larz Anderson Bonsai Collection**
   The Larz Anderson Bonsai Collection, while not actively developed, is of high priority within the Arboretum's Living Collection because of its historic and aesthetic value.

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In addition to housing permanent collections that require high maintenance, The Leventritt Shrub and Vine Garden also displays outstanding ornamentals with exemplary traits. Shown here is accession 178-93-A, *Forsythia* 'Courdijau'.

C. MISCELLANEOUS COLLECTIONS

In addition to those within the above collection categories, The Living Collections comprise a number of plants grown to achieve display effects, for interpretation, for evaluation, or that may fall outside of traditional scope and not even be accessioned. However, because they play important roles in the Arboretum's research, horticultural and educational work, they are included within the Living Collections. These may be obligatory or discretionary, and development and maintenance decisions are made on a case-by-case basis by the Living Collections Committee.

While they may not contain formally accessioned plants, several natural areas in the Arboretum (including the North Woods, above) are managed as part of the living collections because of their research potential as well as intrinsic beauty.

1. **Display Collections**
   Plants of cultivated origin, particularly cultivars selected for unique traits, serve important research and education roles; however their primary value is for display. Examples include ornamentals with exceptional ornamental qualities, landscape plants well suited to the New England climate (including those with stress-, insect-, and disease-resistance), as well as those under evaluation. These collections are regarded as discretionary and are developed and maintained as needed, with the acknowledgement that accessions may be deaccessioned when their value no longer meets the appropriate standard.
2. **Natural Areas**
   The Arboretum landscape contains several natural areas representative of the New England Flora. Generally, these are maintained through natural regeneration of the present vegetation; however development may occur under certain circumstances (e.g., restoration following major disturbance).
3. **Spontaneous Flora**
   Spontaneous generation of native, as well as exotic, plants occurs throughout the Arboretum's cultivated landscape. As a matter of course, some of these plants are removed because of their noxious characteristics, some are left in place, while others are accessioned (in particular spontaneous interspecific hybrids or landscape specimens). The forthcoming *Policy on the Spontaneous Flora* addresses this category more thoroughly.
4. **Dana Greenhouse and Nursery Collections**
   A number of plants are cultivated at the Dana Greenhouse and Nursery for experimental, observational, and other programmatic functions outside the scope of production for the accessioned Living Collections. Development and maintenance lies with the primary investigator or other assigned staff member, with the understanding that these may be formally accessioned at a later time.

APPENDIX: DEFINITION OF TERMS USED IN THE LIVING COLLECTIONS POLICY

An **accession** is the basic unit of a collection and identified by a unique accession number. By definition it represents a single taxon, from a single source, acquired at one time, and through one means of propagation. An accession may comprise a single plant, or multiple plants, each identified by a letter qualifier following the accession number, or in the case of mass plantings, MASS.

Accessioning is the process of adding specimens to the Arboretum's Living Collection and occurs at the time of entry regardless of its stage (e.g., plant, cutting, scion, seed). All accession records are permanent and are not expunged should deaccessioning occur.

Acquisition of new accessions may be through field collection, exchange, gift or purchase. All acquisitions must meet specific collections development goals in accordance with the Scope of the Living Collections detailed in this Living Collections Policy.

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The label for accession 638-88-C, *Fraxinus tomentosa.*

A **collection** is operationally defined as a group of accessions organized by a particular category for curatorial, educational, research, display or other use. A collection need not be physically grouped together, and a single accession may be part of multiple collections. From the perspective of commitment, collections may be discretionary or obligatory.

Curation is the process of managing the Living Collections to guarantee its conservation, guide its development, ensure its documentation, and facilitate its enhancement.

Deaccessioning is the process of removing a living specimen from the collection, but does not include the removal of any records related to that accession. Deaccessioning decisions are made by the Curator of Living Collections, in consultation with the Living Collections Committee.

Development is the process by which the Living Collections undergo change through the acquisition of new accessions and the deaccessioning of accessions no longer needed in accordance with the Scope of the Living Collections detailed in this Living Collections Policy.

Discretionary collections can be regarded as temporary or permanent. They meet specific research, display, education or other programmatic needs, but do not necessarily represent collections central to the mission and purpose of the Arboretum.

Enhancement is the process of adding value to the Living Collections through documentation, research, and other means.

The **Living Collections** comprise all plants formally accessioned, and in a broad sense also contain unaccessioned plants in natural areas, spontaneous flora, and research material.

Maintenance, from the standpoint of curating the Living Collections, is the practice of vegetatively repropagating an obligatory accession in order to preserve and perpetuate its genetic lineage. Multiple accessions of the same lineage are genetically identical.

Obligatory collections are considered permanent and represent collections central to the mission and purpose of the Arboretum.

A **taxon** (plural, taxa) is a unit of any rank within the taxonomic hierarchy (e.g., family, genus, species, variety, cultivar).

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SYLVIA WINTER

MICHAEL DOSMANN

Last year a decision was made to deaccession a prominent winterberry holly, *Ilex verticillata* 22879-F, from its location along Meadow Road across from the Visitor Center. Although it was a noteworthy specimen that consistently produced copious fruits, its large size (nearly 25 feet in diameter) prevented access to one of the original *Metasequoia glyptostroboides* (524-48-AA). An examination of the records showed that the holly was of unknown origin—not even a nursery source—and that seven other vigorous plants of the accession remained in the collection.

Ecosystems in Flux: The Lessons of Hemlock Hill

Richard Schulhof

Ten years after the first detection of hemlock woolly adelgid *(Adelges tsugae)* at the Arnold Arboretum, the hard lessons of biological invasion are written across the face of Hemlock Hill. Large gaps mark the loss of hemlocks, while many survivors, diminished by infestation, stand as relics in growing swaths of successional vegetation.

Introduced invasive organisms pose an increasing threat to native biodiversity. As is conspicuously evident on Hemlock Hill, newly arrived pests and pathogens can quickly decimate susceptible native species, creating issues that range from concerns for public access and safety to the long-term management of ecological disturbance. Invasive plant species often follow in the wake of such outbreaks, further disrupting native ecosystems.

Responding to invasive species in ways that safeguard people, plants, and the larger environment demands that we more wisely manage the uncertainties of a rapidly changing world. The story of hemlock woolly adelgid (HWA) at the Arnold Arboretum recounts the lessons learned in addressing the rarely predictable, often irreversible consequences of biological invasion.

New Invasives: A Steady Parade

The scope of the problem is substantial. A 2002 National Academy of Sciences study determined that the USDA inspects roughly 2% of cargo shipments yet intercepts over 53,000 arthropods, pathogens, and plants annually. Although few introduced organisms successfully establish, it is conservatively predicted that 115 non-native insect species and 5 plant pathogens will become naturalized in the United States between 2000 and 2020. Continuing loss of native biodiversity is recognized as perhaps the greatest long-term consequence of invasive species, which are second only to habitat loss as a primary cause of native species decline in the U.S. Of species on the threatened or endangered list, roughly 50% are at increased risk due to competition or predation from non-native organisms. Some unlisted species, such as the eastern hemlock *(Tsuga canadensis)*, face extirpation or severe reduction over large parts of their range. Each region of the country has its own list of problematic introduced insects and pathogens, with growing public awareness that emerald ash borer *(Agrilus planipennis)* and Asian longhorned beetle *(Anoplophora glabripennis)*, among others, are dire threats to both cultivated landscapes and native ecosystems.

The Home Front

It is with some irony that I survey the introduced invasive organisms that today inhabit the Arnold Arboretum. A leader in scientific collecting and importation of plants from east

RICHARD SCHULHOF

Egg masses in dense, cottony clusters provide a highly visible indication of the progress and intensity of hemlock woolly adelgid infestation.

Sweet birch *(Betula lenta),* shown here in golden fall color, is now growing across large areas of Hemlock Hill. As is typical across southern New England, this birch species is a dominant colonizer of the post-hemlock landscape.

Asia in the decades before and after 1900, the Arboretum is one of a great many agents that unwittingly introduced species to the North American landscape that later naturalized and wrought destructive impacts. Regardless of our respective "rap sheets", the Arboretum and other public gardens now work diligently toward devising management strategies to deal with problematic introduced species.

At the Arboretum, developing appropriate responses to invasive species is an ongoing responsibility shared by horticulturists, managers, and administrators. Aggressive incursions of winter moth *(Operophtera brumata),* garlic mustard *(Alliaria petiolata),* Japanese knotweed *(Polygonum cuspidatum),* and other invasives require that we stay abreast of new methods and information, not only to improve the efficacy of our management measures but to do so with ever diminishing environmental impacts. This past fall, the position of Manager of Plant Health was created to coordinate integrated pest management and associated environmental monitoring.

Cautionary Tales

As we have learned over the years, "best" practices are moving targets that shift with increasing knowledge and a changing environment. This can be particularly true in managing recently introduced insects and pathogens whose life cycles, host impacts, modes of spread, and other critical traits may still be relatively unknown. The long-term consequences of various management options are often equally unknown. How we make decisions in the face of uncertainty is of great importance. Confronted with approaching waves of introduced species, what can we learn from previous efforts to manage new invaders?

RICHARD SCHULHOF

Infested trees on Hemlock Hill in 2003 showing the defoliation and reduction of new growth typical of hemlock woolly adelgid infestation.

Most recently, the potentially harmful effects of biocontrols—non-indigenous species released to control invasive pests—have received considerable attention. The multicolored Asian lady beetle *(Harmonia axyridis),* intended to control a range of insect pests, now appears to outcompete and replace some native lady beetle species, while becoming a nuisance in its winter aggregations in homes and buildings. In southern Florida, native *Opuntia* species are threatened by a South American moth *(Cactoblastis cactorum)* that had been introduced to control *Opuntia* naturalizing in the Caribbean. Cases of unforeseen consequence, the non-target effects of some biocontrols may be remembered as cures worse than the disease.

From an earlier period, management response to Dutch elm disease *(Ophiostoma ulmi),* a public and politically charged effort, targeted its primary vector, the elm bark beetle *(Scolytus multistriatus).* The American elm's *(Ulmus americana)* importance as an icon in the cultural landscapes of the Northeast made saving the species a priority for state and municipal agencies, and the resulting massive applications of toxic pesticides contributed to an environmental disaster all too well known today. Past actors on a period stage, decision-makers were undoubtedly influenced by historical biases and limited by critical gaps in knowledge, yet their legacies suggest that response to uncertainty—particularly the consequences of our own actions—merits particular focus today.

Managing Hemlock Woolly Adelgid

Our ten years of managing hemlock woolly adelgid is a story of decision-making in a rapidly changing informational environment. We began with many uncertainties and traveled a path of pivots and about-faces led by growing knowledge of our own site, analysis of outcomes elsewhere, and key findings from the research community.

In 1997 HWA was first detected on the Arboretum's Hemlock Hill, a 22-acre historic natural site whose early public use included frequent visits in the 1840s from Margaret Fuller and other members of the Transcendentalist circle. Prior to infestation, Hemlock Hill was home to over 1,900 eastern hemlocks, some dating to the early 1800s. With its several stands of fully mature hemlock-dominated forest, the Hill had long been appreciated as a place of seemingly wild nature in the midst of the city.

The Arboretum was hardly among the first sites to deal with HWA. First detected in Richmond, Virginia in the early 1950s, HWA spread rapidly, decimating hemlock populations in the Mid-Atlantic and coastal Connecticut before reaching Boston. Across much of the range of infestation, the ultimate consequence of HWA was near to complete hemlock mortality within four to twelve years. There were few exceptions. With the prospect of losing one of Boston's most significant natural sites and an integral part of our own history, Arboretum managers addressed challenges of a scope not seen since the 1938 hurricane.

The process began with questions. What would be the rate of decline for our hemlocks? How many trees could we protect and at what costs to the larger ecosystem? Could a biocontrol under development save our trees? Although these and other questions would remain unanswered for years, management goals drawn from our organizational mission provided a strong compass for initial decision-making. Protecting visitor and staff safety, protecting the larger environment, and preserving a still undetermined number of hemlocks were our key priorities. But where to start?

Through the Learning Curve

We determined that obtaining reliable, site-specific information about the spread of the infestation and rates of hemlock decline would be essential to planning an effective management response. Monitoring the health of our hemlocks required mapping the locations and assigning an accession number for each tree. This significant investment was abundantly repaid in data that detailed the progression and severity of the infestation as well as the efficacy of our control efforts; information that continues to inform our decisions. Using assessments of crown health, we evaluated all hemlocks, finding that from 1998 to 2002, the number of trees in poor health increased from 30% to 70%. By 2003, Hemlock Hill was a sickly gray-green color. Data from other sites indicated that we could expect large numbers of hazardous and dead trees within two to three years.

That winter we visited forests in Connecticut that had been closed to the public because of the danger presented by hundreds of disintegrating dead hemlocks. Further, we learned that the highly hazardous brittle snags had precluded both salvage operations and efforts to contain rapidly growing populations of invasive plants. Foreseeing similarly grim prospects for Hemlock Hill, we anticipated removing over 1,000 rapidly declining trees within the next two years.

Fortunately, that large-scale removal never occurred. The winter of 2004, the coldest in many years, brought several nights with temperatures of -5°F or colder, delivering an unexpected reprieve. Although not well documented at the time, HWA is highly vulnerable to extreme cold. Based on surveys at other sites, we estimate that well over 90% of the existing HWA population perished that winter. The following summer, which also brought much needed rain, saw a revitalization of our hemlocks that was a wonder to behold. For once, extreme cold had been a gift, resetting the clock of infestation and allowing more time to find new strategies.

Additional changes in approach came with new information from the research community. Publications that elucidated site factors affecting rates of hemlock decline, the relative efficacy of different HWA control methods, and the field performance of highly anticipated biocontrols were part of a burgeoning informational environment that enabled knowledge-based decisions. The Arnold Arboretum was fortunate in that HWA arrived in our vicinity just as many research efforts came to fruition, providing us with essential information that was unavailable to managers of previous infestations.

Perhaps our hardest decision thus far concerns the number of hemlocks we attempt to save. The absence of host resistance and limited cultural controls leave us with few management options. Clearly any chemical treatment, even relatively benign horticultural oil, brings concern for the larger environment. At the same time, we are an essential resource for a large urban population that for over 150 years has enjoyed the singular educational and aesthetic experiences of a majestic hemlock-dominated forest.

Finding balance among stewardship, education, and public service goals, we protect hemlocks that are of sufficient vigor to recover and that grow in conditions that are favorable for treatment and do not present risk of water contamination. HWA is controlled with applications of horticultural oil and, more recently, soil injections of imidacloprid , a treatment now provided to over 40,000 trees at Great Smoky Mountains National Park. We now use this method and pay close attention to ongoing research that monitors for non-target effects and persistence in the environment. Ultimately, it is hoped that these treatments will buy time for the Arboretum's hemlocks until biocontrols or other non-chemical options can offer reliable protection.

An ongoing challenge, symptomatic of ecosystem disturbances on a global scale, is the control of non-indigenous plants that often invade when native habitats are affected by introduced organisms. As hemlock mortality continues, canopy gaps become points of colonization for glossy buckthorn *(Frangula alnus),* Japanese knotweed, and other invasives. Our long-term goal is to promote native hardwood forest where hemlock once grew, and while we actively eliminate invasive vegetation, robust native species, particularly sweet birch *(Betula lenta),* are rapidly dominating large areas.

Adaptive Management

Our HWA management strategy continues to evolve, reflecting the iterative learning process needed to develop effective site-specific responses to invasive species. Gathering data that monitor changing conditions as well as the effectiveness of management actions is essential, as is a willingness to completely revise strategies based on new results.

Our experience speaks to the value of Adaptive Management, a process developed for the management of complex natural systems characterized by uncertainty. Borrowing from scientific method, it relies on carefully assembled hypotheses, field testing of proposed practices,

RESEARCH OPPORTUNITIES

P. DEL TREDICI

Chinese hemlock *(Tsuga chinensis)*, planted in openings on Hemlock Hill, proved highly resistant to hemlock wooly adelgid.

An unanticipated silver lining was found in emerging research opportunities on Hemlock Hill. The severe consequences of HWA infestation pose compelling questions about the ecological changes associated with decimation of a foundation native species. Beginning a four-year investigation in 2004, the Arboretum collaborated with the Harvard Forest to establish six 15-meter by 15-meter research plots in order to measure the changes occurring when hemlock is abruptly removed from the forest system. We removed hemlocks from four of the plots, with the remaining two left unlogged for use as controls. Measurements established baseline data for soil temperature, available nitrogen, organic soil mass, and understory vegetation. Analysis compared nitrogen cycling, decomposition rates, and regeneration across the six plots. Scheduled to conclude in summer 2008, the study is part of a longer-term Harvard Forest effort to assess ecosystem impacts of HWA in southern New England.

A second project examined Chinese hemlock *(Tsuga chinensis)*, a species first grown in North America at the Arnold Arboretum. The research established that Chinese hemlock is cold hardy through at least Zone 6 and is fully resistant to HWA, confirming its suitability as a promising landscape replacement for *Tsuga canadensis*.

and the monitoring of results to inform next steps and ongoing improvement. It is a model for managing disturbed natural systems that lack both predictability and stability, and for which management outcomes may be determined by variables that are unrecognized or unknowable at the outset—in short, much of the world as we now know it. At the Arboretum, we did not set out to adaptively manage; the approach was born of necessity. But with the appointment of a manager of plant health, we now seek to more fully implement its tenets.

Public Awareness

The dramatic losses on Hemlock Hill, roughly 30% of the original hemlock population, offer an important local example of a global phenomenon. To build public awareness, the Arboretum now offers school field studies and special tours that explore the fragility of native ecosystems, disturbance caused by invasives, and the complex challenges that result for environmental stewards. As former evergreen forest converts to deciduous woodland, programs will interpret changes in nutrient cycling and species inter-

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School children examine sweet birch seedlings as part of a new Arnold Arboretum field study investigating the ecological impacts of hemlock woolly adelgid.

actions. Presentations to the community and feature stories appearing in newspapers and on radio and the web have further disseminated the Hemlock Hill story in Boston and southern New England.

Introduced insects and pathogens are here to stay. Looking to the future, warming temperatures will likely enable HWA and other temperature-limited invasives to expand ranges of infestation and more quickly reach lethal densities on host species. The USDA, among other domestic and international agencies, must strengthen efforts to prevent unintended introductions as well as accelerate research programs to better inform management efforts. Institutions such as the Arnold Arboretum, committed to environmental stewardship and with unique expertise, will increasingly contribute to invasive species management. Perhaps more importantly, we can foster awareness, offering our public landscapes as places of witness and learning during a time of remarkable environmental change.

Acknowledgments

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Items in **boldface** *refer to illustrations.*

Silver Wins Gold

Nancy Rose

The tallest tree at the Arnold Arboretum isn't a majestic white pine or a venerable beech, it's a silver maple (*Acer saccharinum,* accession 12560-C). This stately 127-year-old specimen was recently measured at 126 feet (38.5 meters) tall. Its DBH (diameter at breast height) is currently 67 inches (170 centimeters); it takes three people, fingertip-to-fingertip, to encircle the trunk. This tree started its life at the Arboretum in the form of seeds (accessioned under the then-accepted name *Acer dasycarpum*) received from the nursery of Benjamin M. Watson in Plymouth, Massachusetts on June 1, 1881. Two other silver maples from accession 12560 also lived at the Arboretum for over 100 years, but specimen A was removed in 1982 and specimen B was removed late in 1985 after suffering major damage from the winds of Hurricane Gloria.

Acer saccharinum 12560-C displays the typical form of a mature silver maple: a massive trunk that soon divides into multiple upright limbs; thin, pendulous young branches curving up at the tip; and a rounded, spreading crown. The mature bark is characteristically gray-brown, ridged, and scaly. On this tree (and many other old silver maples) the curving bark scales appear to spiral up the massive trunk. The textured bark and impressive girth of *Acer saccharinum* 12560-C are irresistible to many visitors passing by on Meadow Road; no doubt this is one of the most frequently touched trees in the Arboretum.

Acer saccharinum is native to moist woods and river bottoms in much of the eastern half of the United States and a fringe of southeastern Canada. It can grow in drier soils, but may not be as successful or long-lived. Charles S. Sargent noted in *Silva of North America,* "On dry and elevated ground..." silver maple "...is not handsome...the habit is loose and unattractive...." No doubt the vigor, longevity, and stature of *Acer saccharinum* 12560-C is due in part to its ideal growing site in the moist, rich soil of the Arboretum's Meadow area.

Silver maple is often considered highly susceptible to storm damage, but *Acer saccharinum* 12560-C has survived many storms—including the devastating hurricane of 1938—with little damage. Along with other large, old trees at the Arboretum, this specimen is inspected regularly by staff arborists. In 2006, *Acer saccharinum* 12560-C was tested using radar imaging and wood density borings in addition to visual inspection. The tree proved to be amazingly sound for the most part, but the presence of some decay led to a bit of support work; two cables now connect several of the main vertical limbs, which should help reduce the chance of major limb breakage in high winds. As with most mature trees at the Arboretum, pruning on *Acer saccharinum* 12560-C is limited to removal of dead wood. To reduce soil compaction (from its many up-close admirers), mulch is spread in a wide swath around the tree and the soil is periodically loosened with a compressed-air tool.

Silver maple's popularity as a shade tree has waxed and waned over the decades. Its status as a native plant and its ability to grow quickly in a wide range of soil conditions gave rise to widespread planting in some eras. However, it has just as often been shunned for its irregular trunk habit, susceptibility to storm damage, extensive root system, and prolific seed production. Silver maple is not a good choice for small urban lots or narrow planting strips along streets, but in larger sites such as parks its leafy, shade-casting canopy is an asset. *Acer saccharinum* 12560-C certainly shows that silver maple can be a beautiful and impressive tree in the right setting.

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