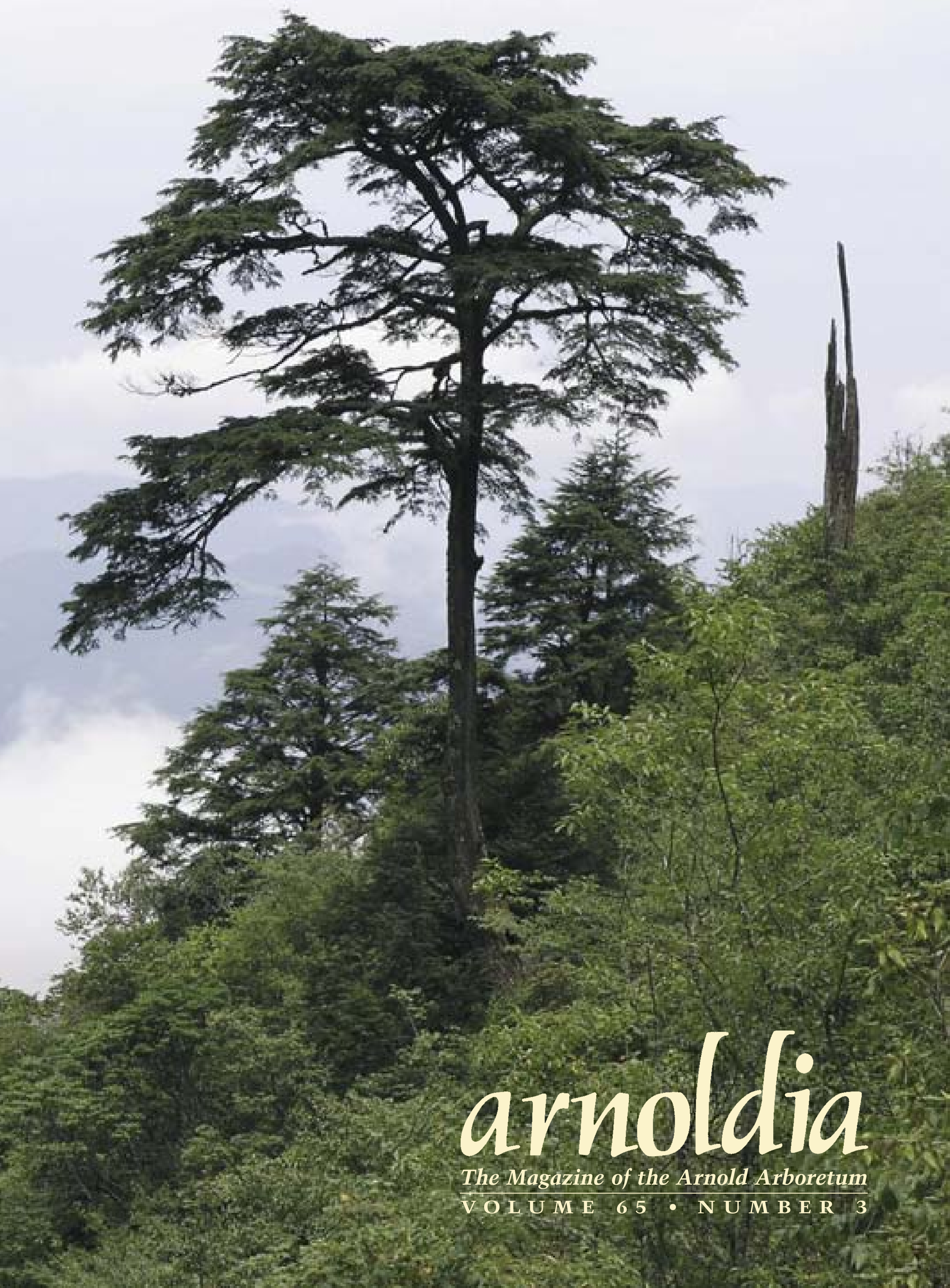

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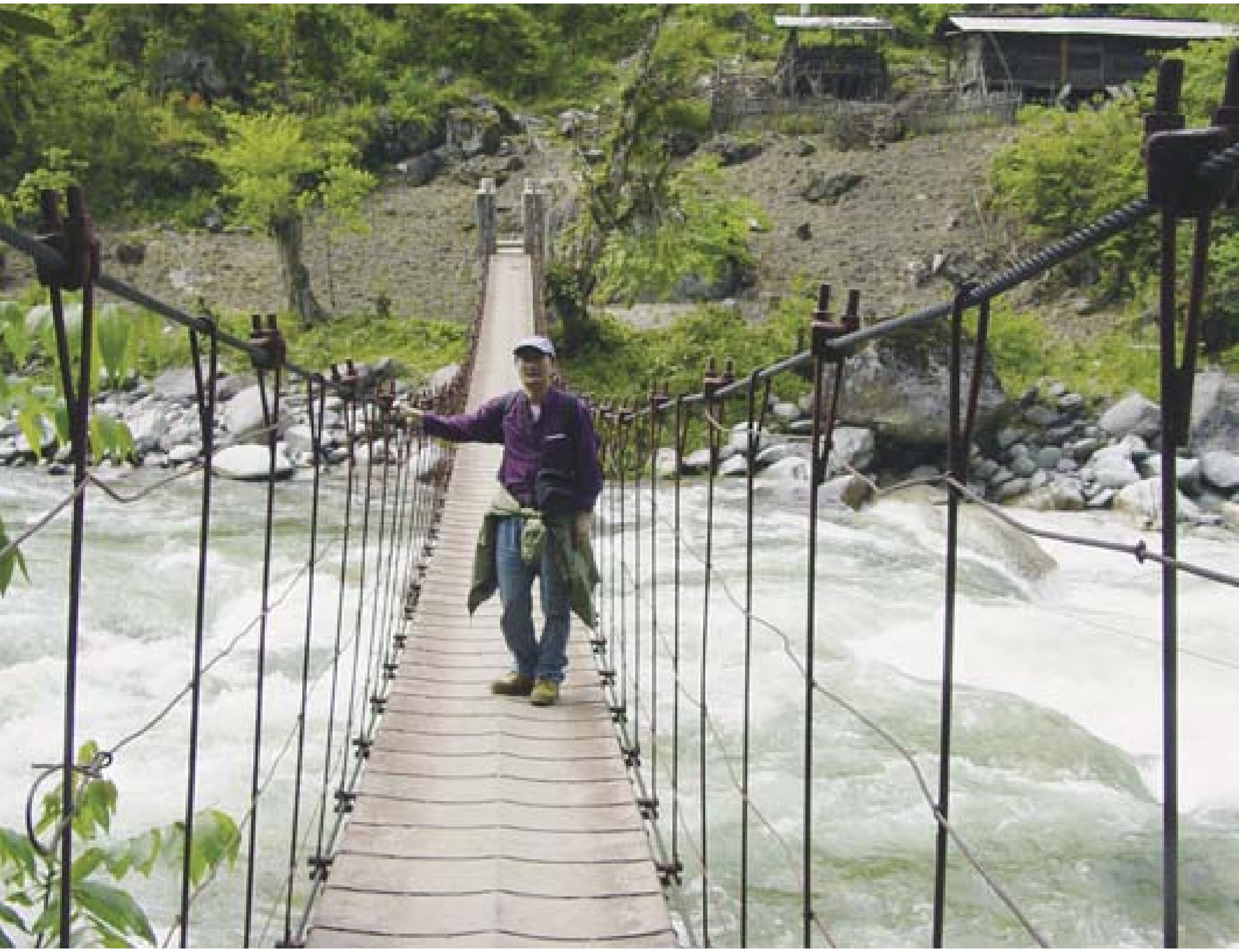

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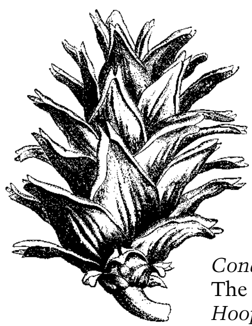
Page

Front and back covers: A stand of *Tsuga dumosa* growing on Luoji Shan, Sichuan Province, China, photographed in August 2005 by Peter Del Tredici.

Inside front cover: Dr. Jianhua Li crossing over a river near Gongxhan Xian, Yunnan Province, China, photographed by Jin Xiaohua.

Inside back cover: The Golden Larch *(Pseudolarix amabilis),* AA #16779-A, in full fall color near Bussey Brook at the Arnold Arboretum, photographed by Michael Dosmann.



Cone of Pseudolarix amabilis *from* The Book of Evergreens *by Josiah Hoopes, published in 1868.*

The Role of Arboreta in Studying the Evolution of Host Resistance to the Hemlock Woolly Adelgid

Nathan P. Havill and Michael E. Montgomery

The hemlock woolly adelgid, *Adelges tsugae,* is an introduced pest of hemlock which is, unfortunately, all too familiar to many readers of *Arnoldia.* Adelgids are a small family of sucking insects, related to aphids, which feed only on conifers[1]. Because they are so small and typically not very common, most adelgids usually go completely unnoticed by all but a handful of entomologists that specialize on them. This can change dramatically when an adelgid species is transported outside of its native range into an ecosystem that is not adapted to keeping it in check. In the United States and Canada, this was first experienced with the balsam woolly adelgid, which killed millions of fir trees (genus *Abies*) in first half of the 20th century and continues to severely threaten these ecosystems. We are now seeing similarly devastating effects by the hemlock woolly adelgid (HWA) on eastern hemlock, *Tsuga canadensis,* and Carolina hemlock, *T. caroliniana*[2].

In this article, we will take a worldwide look at the relationship between the adelgid and its various hemlock hosts. While most of our research was done with plants growing in their native habitats, we also made extensive use of cultivated hemlocks growing in various botanical gardens around the world, including the Arnold Arboretum. The living collections and herbaria at these institutions have proved to be an invaluable resource for us in developing an evolutionary context for understanding hemlock resistance to HWA. In addition, the records and herbarium specimens from expeditions sponsored by the Arnold Arboretum—from the time of E. H. Wilson and Joseph Rock through the Sino-American Botanical Expedition of 1980—were invaluable in helping us to pinpoint where to look for hemlock specimens in southwestern China.

Our collaborative research on HWA began in 1999. Nathan had just received his master's degree in entomology from the University of Wisconsin and Mike needed someone to do a field evaluation of a tiny lady beetle *(Scymnus sinuanodulus)* that had been collected three years earlier in China, and had just been released from quarantine for biological control of the adelgid. Going to China to look for biological controls for HWA had been something of a gamble. The adelgid had never been collected from mainland Asia, only from Japan and Taiwan. But the fact that China was home to three of the nine species of *Tsuga* as well as several

ALL PHOTOGRAPHS BY THE AUTHORS

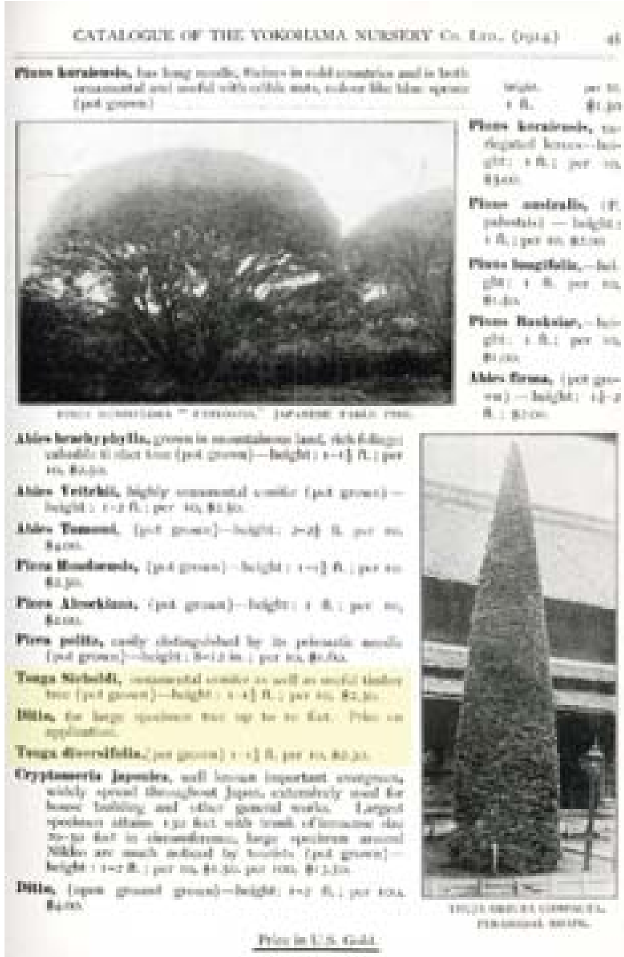
Overwintering hemlock woolly adelgid nymphs settled on eastern hemlock, Tsuga canadensis.

closely related genera (*Nothotsuga, Keteleeria,* and *Pseudolarix*) suggested that hemlock had a long evolutionary history in the region. Such a time span would have provided ample opportunity for stable tri-trophic relationships to have evolved between the host *(Tsuga)*, its herbivores (HWA), and the predators of the herbivores. This hunch has proved correct, as more than sixty species of lady beetles have been collected from the hemlocks in China since the early 1990s, with twenty-five of them being new to science[3].

In 2001, Mike artificially infested every hemlock species at Arnold Arboretum and at the Morris Arboretum in Philadelphia with HWA. These tests confirmed Dr. Peter Del Tredici's observation that Chinese hemlock *(T. chinensis)* growing in the Arboretum were immune to HWA[4]. This seemed odd, because in China we found this hemlock species to be infested by HWA, sometimes with very dense populations. We wondered if there were genetic and behavioral differences among the world's geographic populations of HWA and where the HWA introduced to the eastern U.S. originated. In the fall of that year, Nathan began to address these questions as part of his Ph.D. thesis for the Department of Ecology and Evolutionary Biology at Yale University.

How Did HWA Get Here?

The origin of HWA in North America has been the subject of considerable speculation. Most people have assumed that it arrived from Asia early in the 20th century, first on the west coast and then migrated to the east coast. By doing some detective work with museum specimens and modern molecular technology, we were able to separate fact from fiction. During the 19th and early 20th centuries, exotic hemlock nursery stock and bonsai purchased from Japanese nurseries usually arrived in the United States through ports on the West Coast. Around this same time, China was opening up as a new frontier for plant exploration, and live plants collected by the Arnold Arboretum as well as the United States Department of Agriculture were typically sent to San Francisco and then shipped east by rail. A particularly noteworthy example of this is a seedling of Chinese hemlock collected by E. H. Wilson in Hubei Province in 1910 that is still alive and well at the Arboretum. That imports like these had the potential to bring HWA with them to the U. S. was reinforced during a recent visit to the U. S. National Arboretum where we noticed that an herbarium specimen of *T. dumosa* collected in 1932 by Joseph F. Rock in southwestern China had the distinctive remains of HWA still attached to it.


CATALOGUE OF THE YOKOHAMA NURSERY Co. Ltd. (1914)

Pinus koraiensis

Pinus koraiensis

Pinus australis

Pinus longifolia

Pinus Banksiana

Abies firma

Abies brachyphylla

Abies Veitchii

Abies Tomomi

Picea Hondoensis

Picea Alcockiana

Picea polita

Tsuga Sieboldi

Ditto

Tsuga diversifolia

Cryptomeria Japonica

Ditto

Price in U.S. Gold

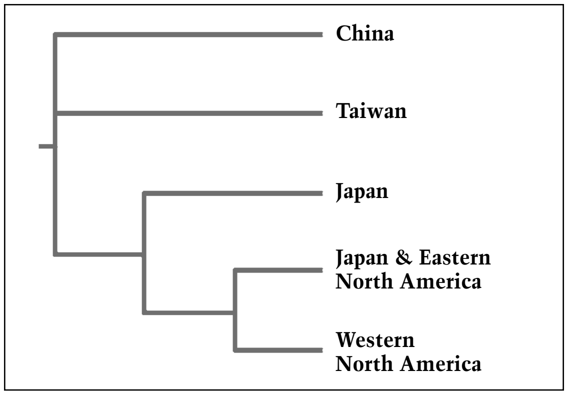
A page from the 1914 Yokohama Nursery catalog showing the availability of live plants of Tsuga sieboldii *and* T. diversifolia *for import to the United States from Japan (from the Archives of the Arnold Arboretum).*

At the U. S. National Collection of Insects in Beltsville, Maryland, we found a specimen collected in 1907 in South Bend, Washington that was not identified as HWA until 60 years later.

The first published account of an adelgid causing damage to North American hemlocks is from 1916 in Vancouver, British Columbia[5] and the formal description of HWA as a new species was based on insects collected in 1922 from Oregon and California[6]. In contrast, the first report of HWA in the eastern United States was not until 1951, from eastern hemlocks growing in Maymont Park in Richmond, Virginia. This 100-acre municipal park had formerly been part of the estate of Major James and Sallie Dooley (see http://www.maymont.org). Mrs. Dooley was an avid horticulturalist who collected plants from around the world. In 1911, with the help of the master Japanese gardener known simply as Muto, she created a traditional Japanese-style garden that was in vogue at the time. While we cannot be certain that HWA arrived on the east coast on nursery stock ordered by the Dooleys from Japan, its slow spread from a small area to several states is typical of introductions of non-native species.

Based on all of the circumstantial evidence, it seemed reasonable to assume that HWA had arrived on the west coast from Asia early in the 20th century. But we were not satisfied with this speculation and decided to look into the matter more deeply. Between 2002 and 2004, we collected samples from the mountains of Yunnan, Sichuan, Shaanxi, and Hubei provinces in China and throughout Honshu Island in Japan. Several collaborators sent us additional samples from eastern and western North America to include in our study.

When we compared DNA sequences from HWA collected in the different locations we found an exact match between HWA in eastern North America and HWA in southern Japan[7,8]. On the east coast, there was only a fraction of the natural variation found in Japan, which is characteristic of a recently introduced species. We also found that DNA sequences from HWA on the west coast do not match HWA from either the east coast or Asia, and that there was much more genetic variation in HWA on the west coast than on the east coast. These results suggest that HWA from western North America is a separate endemic lineage that has been diversifying there for thousands, or even millions of years. And finally, we were able to show that HWA in China is genetically divergent from HWA in Japan and North America and should probably be considered an entirely separate species.

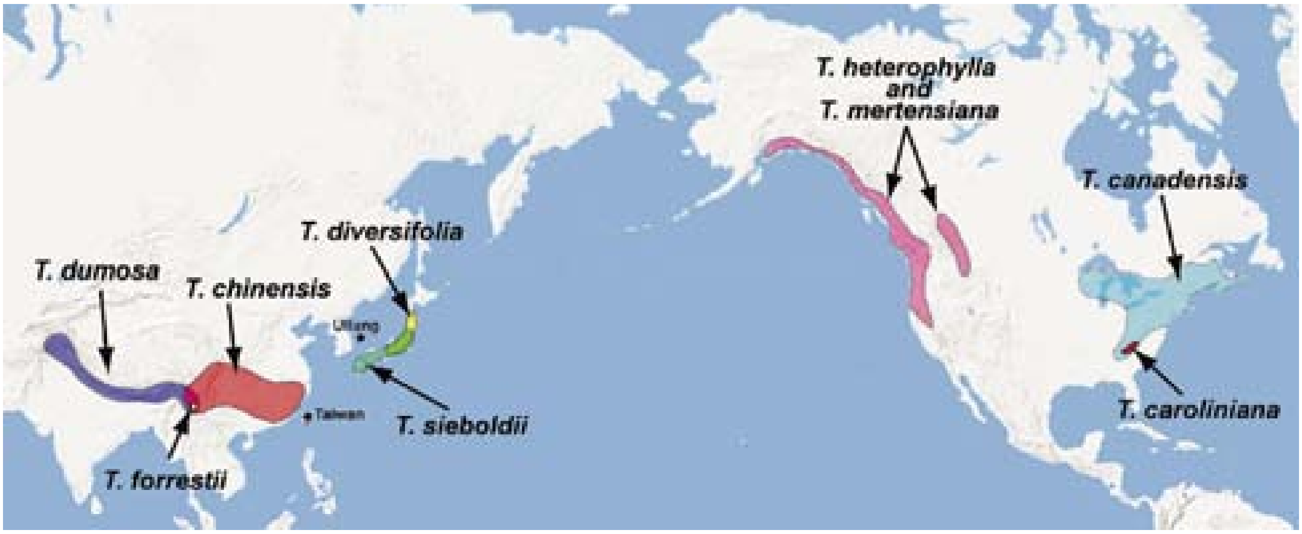


Phylogenetic relationships among geographic lineages of the hemlock woolly adelgid inferred using mitochondrial and nuclear DNA sequence data. Adelgids from China and Taiwan are different enough that they may be different species from the one that was introduced to eastern North America from Japan. There is a second lineage in Japan that is not the source of the introduction, and hemlock woolly adelgids in western North America are a separate lineage that appears to be native, not introduced as some have assumed (Figure based on the results of Havill et al. 2006, and Havill et al. 2007).

Hemlock Biogeography

In conjunction with this research on HWA genetics, we have also been exploring the evolutionary relationships among hemlock species around the world. Both of these studies were supported by grants from the USDA Forest Service, the Yale Institute for Biospheric Studies, and the Arnold Arboretum's Deland Endowment. We have also enjoyed the invaluable collaboration of colleagues in China and Japan, including Guoyue Yu, Li Li, Jianhua Zhou, and Shigehiko Shiyake.

Most plant taxonomists recognize nine species of hemlock worldwide[9]. There are four species in North America and five in Asia. There are no hemlocks native to Europe but the fossil record tells us that hemlock was once widespread on that continent but went extinct somewhere around one million years ago because of climate change and repeated glaciations[10]. There are two species of hemlock in eastern North America. The eastern hemlock, *T. canadensis,* is widely distributed from southern Canada to the Great



Map showing the worldwide distribution of the genus Tsuga *(Reprinted from Havill et al., in press).*

Lakes and New England down through the Appalachians into Georgia. The other species in the east is the Carolina Hemlock, *T. caroliniana,* which is native to the Blue Ridge Mountains from Virginia to Georgia. In western North America, there are also two species—western hemlock, *T. heterophylla,* usually found at low elevations, and the mountain hemlock, *T. mertensiana,* which grows at high elevations. There is a similar pattern in Japan, with *T. sieboldii* occurring mostly in the south and at low elevations, and *T. diversifolia* mostly in the north and at high elevations. There are three other hemlock species in Asia—*T. chinensis* has several described varieties and is widely distributed in China; *T. dumosa,* occurs in a narrow band from southwestern China along the Himalayas to Nepal; and *T. forrestii,* overlaps with the two other species in Yunnan and Sichuan provinces in southwestern China.

Our research has given us the pleasure of observing hemlocks growing in a variety of natural habitats in China and Japan. In both countries, hemlock occurs where it is cool and wet in the summer, such as the fog belt of high mountains. They are in the transition zone between deciduous hardwoods and boreal conifers and are often a climax species in diverse forests. The hemlocks may rise above the canopy, often with broad, domed, or flat crowns which is very different from the conical or pyramidal crowns of the North American species. The understory of a Chinese hemlock forest not

Dr. Nathan Havill standing next to a large T. forrestii *in Lijiang, Yunnan Province, China.*

Tsuga chinensis *var.* tchekiangensis *growing on Mount Maoer in Guangxi, China.*

Tsuga sieboldii *in the background with fir in the foreground growing on Mount Tsurugi, Shikouku, Japan.*

only contains *Rhododendrons* and other genera of plants commonly found in the forests where eastern hemlocks grow, but also has species of camellia, bamboo, peony, primrose, and other Asian plants which we only find here in cultivated landscapes.

In southwestern China, the range of hemlock and the panda overlap, and ancient hollow conifers are used as maternity dens by the panda. *Tsuga* is a Japanese word meaning "mother tree" and is the highlight of several national parks in Japan. Standing in a hemlock stand in east Asia, the opening lines of the poem *Evangeline* by Henry Wadsworth Longfellow comes to mind:

> *This is the forest primeval. The murmuring pines and the hemlocks, Bearded with moss, and in garments green, indistinct in the twilight,*

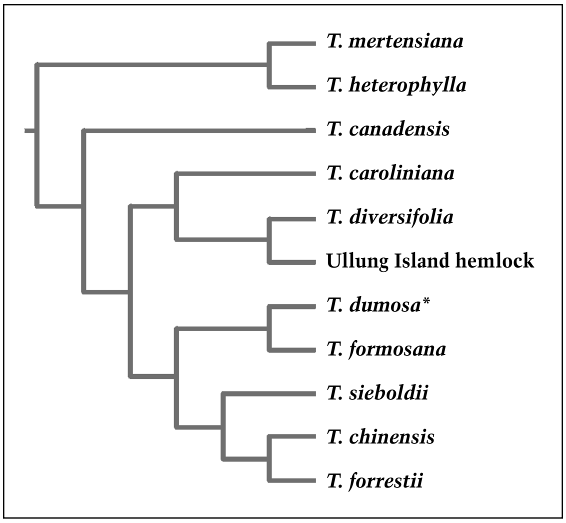
Modern Taxonomy Reveals Ancient Relationships

With the help of colleagues at Yale University, the University of Maine, the Academy of Natural Sciences in Philadelphia, and the University of Memphis, we used DNA sequences to reconstruct the evolutionary relationships and biogeographic history of hemlock, in part to see what this could tell us about how to manage HWA. We assembled multiple samples of each hemlock species, either collected by us in the field or from the living collections at Arnold Arboretum, the U.S. National Arboretum, Hangzhou Botanical Garden in China, and the Royal Botanic Garden in Edinburgh.

As with the HWA, some of the relationships among the hemlocks were a surprise to us[11]. One interesting result of this study was that the two hemlock species in eastern North America are not closely related to each other. *Tsuga caroliniana* is more closely related to the Japanese species *T. diversifolia* than to *T. canadensis.* Despite this close affinity, *T. caroliniana* is susceptible to HWA damage, while *T. diversifolia* is resistant.

Moss covered T. dumosa *trunk in Laojun Shan in Yunnan, China.*

Tsuga chinensis *with hanging lichens growing near Danba in Sichuan, China.*



Phylogenetic relationships among Tsuga *species inferred using chloroplast DNA sequence data. Analysis using the nuclear ITS region agreed with this except that* T. dumosa *was sister to the rest of the Asian species plus* T. caroliniana. *This discordance may have resulted from an ancient hybrid origin of* T. dumosa *(Figure modified from Havill et al., in press).*

Since the two species in eastern North America have different ancestries, their susceptibility to HWA probably arose independently in each species. Perhaps this resulted from living in a region where there are only a few inconsequential sucking insects that specialize on hemlock and where there was more selective pressure from chewing insects. Many studies have shown that plants have different defensive reactions to sucking versus chewing insects. Before HWA was introduced, the major pest of hemlock was a defoliator, the hemlock looper caterpillar. Recent chemotaxonomic studies of hemlock species and cultivars growing at the National Arboretum, Morris Arboretum, and Longwood Gardens suggest that the two hemlocks in eastern North America have adapted their terpenoid chemistry to provide protection against chewing insects, which seems to have made them vulnerable to non-native sucking pests such as HWA and the elongate hemlock scale[12, 13]. Out of thirteen cultivars of *T. canadensis* examined, the two with white-tipped foliage, 'Albo-spica' and 'Snowflake' grouped closer to the Asian species than to the "wild" *T. canadensis.* Careful testing is still needed to examine whether these cultivars are more resistant to HWA and more susceptible to native chewing pests such as hemlock looper caterpillars.

Another surprising and very exciting discovery from the *Tsuga* phylogeny project involves two hemlocks growing at Arnold Arboretum (AA #1251-83). These trees were grown from seed collected on Ullung Island, South Korea in 1982 by an expedition from the Chollipo Arboretum. Ullung is a small, isolated volcanic island in the Sea of Japan—equidistant between Korea and Japan—that hosts many endemic plant species. Based on morphological characteristics, the hemlocks on Ullung Island have always been identified as *T. sieboldii,* the low-elevation Japanese species. DNA sequences from the trees growing in the Arboretum, however, consistently grouped, not with *T. sieboldii,* but with *T. diversifolia,* the other Japanese species that grows at higher elevations. To confirm this unexpected result, we obtained a fresh sample of Ullung hemlock from Dr. Nam Sook Lee at Ewha Womans University in Seoul. This sample, like those from the Arnold, independently verified that the Ullung hemlocks are closely related to, but distinct from, *T. diversifolia* rather than *T. sieboldii* as previously thought. A detailed study comparing the morphology of Ullung Island hemlock with *T. diversifolia* still needs to be done to decide whether it should be considered a new species.

Adelgid Resistant Hemlocks

Previously, it was reported that *T. chinensis* and *T. diversifolia* had high resistance to HWA. Researchers at the National Arboretum have been able to produce viable hybrid crosses between *T. chinensis* and *T. caroliniana*[14]. These hybrids have been established in a field trial to evaluate their HWA resistance and growth characteristics. Recent expeditions to China have resulted in collection of hemlock seed from five provinces and more than 20 accessions are growing in experimental nurseries at the National, Morris, and Arnold Arboreta. It seems that the cultivation of *T. chinensis* and its hybrids may be an option available to gardeners in the foreseeable future.

Without the resources and expertise at the Arnold Arboretum, the U.S. National Arboretum, Morris Arboreum, Longwood Gardens,

A hemlock from Ullung Island, Korea growing at the Arnold Arboretum (AA #1251-83B). At 24 years of age, the tree was 8 meters tall by 6 meters wide. Ullung hemlocks have traditionally been identified as T. sieboldii *based on morphology, but DNA analyses show that it is closely related to* T. diversifolia *and may be a new species (Photograph by P. Del Tredici, December 2007).*

Chollipo Arboretum, Hangzhou Botanical Garden, and the Royal Botanical Garden at Edinburgh, this research would not have been possible. By highlighting the vital contributions that botanical gardens have made to the development of ways to control this devastating pest, hopefully we have reinforced the need for their continued commitment to research.

Endnotes:

1 Havill, N. P. and R. G. Foottit. 2007. Biology and evolution of Adelgidae. *Annual Review of Entomology* 52: 325–349.

2 Ward, J. S., M. E. Montgomery, C. A. S.-J. Cheah, B. Onken, and R. S. Cowles. 2004. *Eastern Hemlock Forests: Guidelines to Minimize the Impacts of Hemlock Woolly Adelgid.* USDA Forest Service, Morgantown, WV.

3 Yu, G., M. E. Montgomery, and D. Yao. 2000. Lady beetles (Coleoptera: Coccinellidae) from Chinese hemlocks infested with the hemlock woolly adelgid, *Adelges tsugae* Annand (Homoptera: Adelgidae). The Coleopterists Bulletin 54: 154–199.

4 Del Tredici, P. and A. Kitajima. 2004. Introduction and cultivation of Chinese hemlock *(Tsuga chinensis)* and its resistance to hemlock woolly adelgid *(Adelges tsugae). Journal of Arboriculture* 30: 282–286.

5 Chrystal, R. N. 1916. The forest insect problem in Stanley Park. *Proceedings of the Entomological Society of British Columbia* 9: 63–66.

6 Annand, P. N. 1924. A new species of *Adelges* (Hemiptera, Phylloxeridae). *Pan-Pacific Entomologist* 1: 79–82.

7 Havill, N. P., M. E. Montgomery, G. Yu, S. Shiyake, and A. Caccone. 2006. Mitochondrial DNA from hemlock woolly adelgid (Hemiptera: Adelgidae) suggests cryptic speciation and pinpoints the source of the introduction to eastern North America. *Annals of the Entomological Society of America* 99: 195–203.

8 Havill, N. P., R. G. Foottit, and C. D. von Dohlen. 2007. Evolution of host specialization in the Adelgidae (Insecta: Hempitera) inferred from molecular phylogenetics. *Molecular Phylogenetics and Evolution* 44: 357–370.

9 Farjon, A. 1990. Pinaceae: Drawings and Descriptions of the genera *Abies, Cedrus, Pseudolarix, Keteleeria, Nothotsuga, Tsuga, Cathaya, Pseudotsuga, Larix,* and *Picea.* Königstein, Germany, Koeltz Scientific Books.

10 LePage, B. A. 2003. A new species of *Tsuga* (Pinaceae) from the middle Eocene of Axel Heiberg Island, Canada, and an assessment of the evolution and biogeographical history of the genus. *Botanical Journal of the Linnean Society* 141: 257–296.

11 Havill, N. P., C. S. Campbell, T. F. Vining, B. A. LePage, R. J. Bayer, and M. J. Donoghue. In press. Phylogeny and biogeography of *Tsuga* (Pinaceae) inferred from nuclear ribosomal ITS and chloroplast DNA sequence data. *Systematic Botany.*

12 Lagalante, A. F. and M. E. Montgomery. 2003. Analysis of terpenoids from hemlock *(Tsuga)* species by solid-phase microextraction/gas chromatography/ion-trap mass spectrometry. *Journal of Agricultural and Food Chemistry* 51: 2115–2120.

13 Lagalante, A. F., M. E. Montgomery, F. C. Calvosa, and M. N. Mirzabeigi. In press. Characterization of terpenoid volatiles from cultivars of eastern hemlock *(Tsuga canadensis). Journal of Agricultural and Food Chemistry.*

14 Bentz S. E., L. G. H. Riedel, M. R. Pooler, and A. M. Townsend. 2002. Hybridization and self-compatibility in controlled pollinations of eastern North American and Asian hemlock *(Tsuga)* species. *Journal of Arboriculture* 28: 200-5.

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Ancient and Notable Trees of Japan: Then and Now

Richard Primack and Tatsuhiro Ohkubo

Ernest Henry Wilson (1876–1930) visited Japan in 1914–1915 to collect woody plants for the Arnold Arboretum, principally conifers, azaleas and cherries. Many of the special plants that he brought back to the United States are still widely cultivated. During this expedition he photographed hundreds of trees and landscapes, which are now stored in the Arnold Arboretum archives and available online.

These photographs show the appearance of the trees and landscapes in Japan 93 years ago. In December 2006 and January 2007, we visited some of the same locations as Wilson, and tried to find the same trees. Most of the places that he visited were famous locations that were easy to track down. In most, but not all, cases the trees were still alive. Other sites were not described in sufficient detail to be readily located.

These trees and places have been associated with some of the major events in Japanese history, so the trees can be regarded as "witness trees" that can tell a story. And the trees themselves have a history in terms of how they have grown and been taken care of through this time. Let's now look at some of these trees as they were in the past and as they are today, starting with the famous Ship Pine of Kyoto.

The Ship Pine of Kyoto.

Kyoto was the capitol of Japan from A.D. 794 to 1185. Even after the government moved first to Kamakura and then Tokyo, Kyoto remained important to Japanese society for its many

The Ship Pine of Kyoto (Pinus parviflora) *in 1914, photographed by E. H. Wilson (#AAE-00292 from the Arnold Arboretum Archives). Note the latticework supporting the prow.*

R. B. PRIMACK

The Golden Temple of Kyoto. Photographed in 2007.

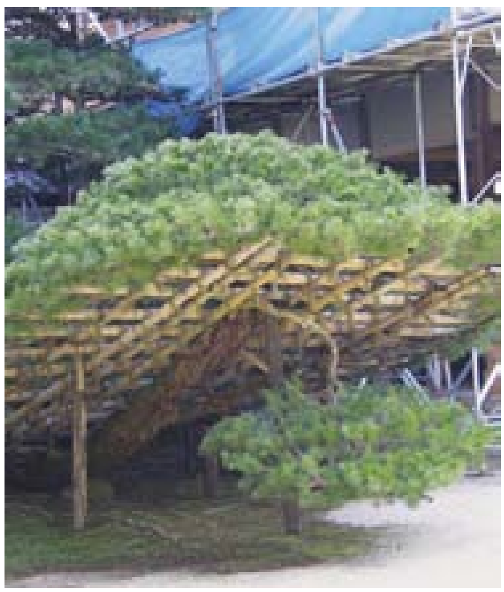
important Buddhist temples which are still in active use and frequetly visited by foreign tourists. The most well known of these is Kinkakuji Temple, also known as the Golden Temple because of the stunning metallic-yellow color of its main shrine. A small pond acts as mirror in front of the temple, creating an added effect and rocks are positioned deliberately to create a seacoast effect. This coastal imagery is further enhanced by the nearby Ship Pine, a white pine (*Pinus parviflora* Sieb. & Zucc.), known in Japanese as the "Rikushu-no-matsu", and is one of three famous pines in Kyoto. This tree was originally a bonsai trained in the shape of a ship, and belonged to the Shogun, or military ruler, Ashikaga, who was a great patron of the Temple.

After the Shogun's death in the mid-1300s, the ship pine was planted at this spot approximately 650 years ago. One of Wilson's photos from 1914 shows the tree planted in front of temple buildings. The lower branches have been trained in the shape of the hull and prow of a sailing ship, supported by a bamboo frame. The trunk of the tree appears as the mast, with approximately 22 side branches trained

R. B. PRIMACK

The Ship Pine in 2007.

R. B. PRIMACK



Bamboo latticework supporting the prow of the Ship Pine. Photographed in 2007.

as short, flattened surfaces suggesting sails. The horizontal branches are also supported by a framework of bamboo. Careful pruning of shoots over hundreds of years have been needed to create this precise shape.

Today the buildings in the background are still the same, showing the tree has remained in the same place, though the large building to the right is being renovated. The tree is approximately 20 feet (6 m) high and 30 feet (9 m) long. The horizontal "sail" branches and "prow" are still supported by bamboo frames. The Ship Pine is evidently in good health and essentially the same in shape after more than ninety years. The present pruning regime appears to be less precise that before, with the outlines of the prow and sails now appearing more diffuse.

The Shogun's Ginkgo Tree

The site of the present day Koishikawa Botanical Gardens, Graduate School of Science, The University of Tokyo was originally the medicinal plant garden of the Tokugawa Shogun, the military ruler that unified Japan in 1603. The large *Ginkgo* tree that grows there was planted approximately 300 years ago. In 1868 ownership of the garden was transferred from the Shogun to the new imperial Meiji government. This government was unpopular with many of the samurai, the traditional military class of Japan, because the Meiji government was eliminating their hereditary privileges in its drive to bring Japan into the modern age. To demonstrate their dislike of the new government, the samurai cut down some of the large trees on the day before the transfer was to take place. They started to cut down this ginkgo tree but did not complete their vandalism. However, even today evidence of the axe cuts remain at shoulder height on the trunk.

This tree is also linked to an important scientific discovery. In 1896, teaching assistant Sakugoro Hirase of the Botanical Institute of the Imperial University, using material collected from this tree, uncovered the previously

E. H. Wilson's photograph of the Shogun's Ginkgo *from 1914 (#AAE-03304 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The Shogun's Ginkgo *tree in 2007.*

E. H. Wilson's 1914 photograph of the black pine forest (Pinus thunbergii) *on the Kamakura coast (#AAE-03392 from the Arnold Arboretum Archives).*

unknown sexual secrets of this unusual gymnosperm. He discovered that the male gametophyte, when it is mature, releases two large spermatozoids with multiple flagella, one of which fertilizes the ovule. This was a widely reported scientific discovery at the time, and a plaque at the base of the tree commemorates this finding.

Today the tree looks remarkably similar to its appearance in Wilson's photograph. Only the branches on the left side are now somewhat more pendent than before. The current tree height of 80 feet is virtually unchanged since Wilson's visit. It is remarkable that the tree survived at all, as the site was heavily damaged by firebombs dropped by American aircraft in World War II. And from 1945 to 1955 much of the surrounding garden area was used to grow food for the devastated population.

Black Pines on the Kamakura Coast

One of Wilson's photos shows an elegant group of Japanese black pines (*Pinus thunbergii* Parl.) growing on the grounds of the Kaihin Hotel near the Kamakura seashore. The trees are

R. B. PRIMACK

Only a few of the black pines from 1914 remain in 2007, surrounded by a parking lot.

being bent to the right by the sea-winds and salt spray.

Today the site is occupied by a tennis club. Sandwiched between tennis courts and houses, only four pine trees remain from the original stand, and have now become part of a parking lot. These trees are about 30 feet (9 m) tall

The Chinese linden (Tilia miqueliana) *growing on a hillside above Lake Biwa, photographed in 1914 by E. H. Wilson (#AAE-04480 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The Chinese linden in 2007.

and 6 feet (2 m) in girth, with the bottoms of their trunks encased in asphalt. The fate of this coastal pine stand is typical—less than 1% of the original coastal pine stands remain intact as these sites are prime sites for the residential and industrial development.

The Ancestor of Chinese Lindens in Japan

Most of Wilson' pictures show well-formed trees. In contrast, the pictures he took at the Takakannon Gonshoji Temple near Kyoto show a Chinese linden (*Tilia miqueliana* Maxim.) with a massive knobby trunk, ending abruptly at perhaps 10 to 12 feet (3.7 m) high, out of which grows a dozen or so shoots. Behind the tree is a flattened ledge with benches. In the distance, a town can be viewed below with an indistinct horizon. According to the literature at the site, this tree was carried to Japan as a sapling by a Buddhist priest from China named Eshinsozu, who founded the temple in 904 A.D. This story would make the tree over 1100 years old. In Japan, the Chinese linden tree is held sacred to Buddhists in the same way that the Bo tree is held sacred by Buddhists elsewhere in tropical Asia. According to local tradition, this particular tree is not only the oldest Chinese linden tree in Japan, but it is regarded as the probable parent tree of all Chinese linden trees in Japan. Even today, pilgrims to the temple stop to collect seeds from this tree to plant back home.

The temple remains today perched on a steep hillside, above the pale blue waters of Lake Biwa, the largest lake in Japan. On the flat ground between the hills and the lake, lies the densely settled town of Otsu, though now with more tall buildings than shown in the old photo. Right in front of the temple is the same Chinese linden tree shown in the Wilson photos, but without the massive trunk. The 15 foot (5 m) tall tree consists of 16 vigorous shoots, the largest of which are covered with the distinctive helicopter-like fruit. A local resident told us that 40 years ago a typhoon broke off the trunk and washed away the bank beyond the tree. The tree base re-sprouted, as is typical for lindens, forming the tree that we see today, which is now on the edge of the road.

The Giant *Ginkgo* at the Tsurugaoka Hachimangu Shrine in Kamakura

A massive ginkgo tree, in full leaf is shown in this photo from July 28, 1905, taken by John George Jack, another collector who worked for the Arnold Arboretum. To the right of the tree is a wide set of stairs leading upward to the Tsurugaoka Hachimangu Shrine, which is above and out of sight. There is a courtyard in the foreground and a traditional building on the right. A second picture shows a Japanese man standing between the base of the tree and the stairway. The immense size of the tree is indicated by the relative size of people in both pictures.

On January 2, 2007, the courtyard was packed with a dense crowd of people waiting to visit the shrine to say their New Year's prayers. Afterwards they buy a "Omikuji", or written prediction for the coming year, and have the chance to buy a special white arrow called "Hamaya" for keeping away unhappiness. Police and special officials were carefully regulating traffic up the temple steps to prevent injuries. As a result, we were unable to measure the size of the tree. A sign at the base of the tree today states that it is over 1000 years old, approximately 100 feet (32 m) tall and 23 feet (7 m) in girth. The ginkgo tree still dominates the courtyard area, though

The giant Ginkgo *tree at the Tsurugaoka Hachimangu Shrine, photographed by J. G. Jack in 1905 (#AAE-00114 from the Archives of the Arnold Arboretum).*

R. B. PRIMACK

The giant Ginkgo *at the New Year's celebration in 2007.*

The base of the giant Ginkgo *at the Tsurugaoka Hachimangu Shrine, photographed by J. G. Jack in 1905 (#AAE-00115 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The base of the giant Ginkgo *tree in 2007.*

on this winter day the tree was leafless. The tree had been heavily pruned recently to help it regain a symmetrical shape following heavy typhoon damage three years ago. The trunk was encircled by a stylized rice straw rope called "Shimenawa", a traditional symbol showing the boundary of the shire sanctuary.

Giant Witness *Ginkgo* in Tokyo

In the crowded, chic Tokyo neighborhood of Azabu stands the Zenpukuji Temple, founded in 824 A.D. According to legend, a famous Buddhist priest visited the temple in 1232 A.D. and planted his staff in the ground. The staff later put forth buds and grew into the giant *Ginkgo* tree photographed in 1914 by Wilson. The tree was declared a national monument in 1926, and is among the oldest in Tokyo. Wilson records it as being 50 feet (16 m) in height and 30 feet (9 m) in diameter, which is probably close to its size today. The tree has seen lots of history: in 1859, the Temple was used as the first American embassy in Japan, and the assistant ambassador was assassinated nearby by angry samurai just few years later.

The basic shape of the tree is still the same as it was in the past. The main trunk is apparently formed by the fusion of multiple trunks which then broke off about 12 feet (4 m) from the ground. A secondary trunk formed from this main trunk, and was itself later broken off at about 36 feet (12 m) from the ground. There are now about ten additional secondary trunks developing both from the top of the trunk and the base of the tree. Many of the older branches are covered with "chichis" or "hanging breasts." These stalactite-like structures are downward growing shoots that are typical of ancient ginkgos throughout Asia. Some of these chichis are quite impressive, measuring more

The Ginkgo *tree at Zenpukuji Temple in Tokyo, as photographed by E. H. Wilson (#AAE-03739 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The massive trunk of the Zenpukuji Ginkgo *in 2007.*

R. B. PRIMACK

The cemetery grounds in 2007 with the Ginkgo *in the background and a statue of a Buddhist priest to the left.*

An unusual side branch of the Zenpukuji Ginkgo *showing its prominent chichis (Wilson photo #AAE-03700 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The unusual side branch, shown above, photographed in 2007.

than 6 feet (2 m) in length and 15 inches (37 cm) in diameter at the base. The trunk has many rotting holes and a bamboo is sprouting from the top of the split trunk. During World War II, the tree trunk was badly damaged by bombs, with burn marks still visible on the trunk.

In Wilson's photo, the area around the tree appears to be fairly open. However, today there is a wall blocking the view to the temple buildings on the left, there are trees planted in the courtyard, and there is a profusion of gravestones. Facing the main entrance to the cemetery is a greenish copper statue of a Buddhist priest, with a large sign that requests visitors to go to the temple to make a donation before paying their respects at family gravestones.

The Ghosts of Ancient Trees at Nara

Wilson photographed a series of ancient trees in Nara, the former capital near Kyoto. Nara Park near the city center is filled with winding paths, temples, and gardens. The park has a peculiar quality because of large numbers of tame deer that roam freely, and the black plastic netting which covers many tree trunks to prevent deer from stripping off the bark. We readily located the Kofukuji Temple and pagoda where a magnificent black pine had grown before and was photographed by Wilson. According to tradition, this tree was planted in the 9th century. Unfortunately the tree was gone, and a memorial plaque announced that the tree had died in 1937.

We next visited a bridge extending over a ravine, with a small shrine on the right side. A Wilson photo shows a giant Sugi tree (*Cryptomeria japonica* (L. f.) D. Don) on the left. On the right side a Chinese juniper (*Junipers chinensis* L.) leans slightly to the right with a Sugi tree growing out of its split trunk, and leaning slightly to the left. In 2007, the scene looked surprisingly similar, except that the damaged bridge is now being supported by a network of poles. Unfortunately all three trees are now dead though their trunks are still visible; two poles support the leaning trunk of the juniper tree.

The final Wilson picture from Nara shows a massive oak (*Quercus gilva* Blume), described as 90 feet (27.4 m) in height and 30 feet (9.1 m) in diameter. The tree has large buttresses

The magnificent pine of Nara photographed by E. H. Wilson in 1914 (#AAE-03350 from the Arnold Arboretum Archives). The tree died in 1937.

The bridge and shrine at Nara with the two Cryptomerias *and one* Juniper *photographed by E. H. Wilson in 1914 (AAE-03351 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The Cryptomeria *bridge in 2007 with the trunks of the dead trees still standing on either side of the small red hut.*

A massive Quercus gilva *at Nara photographed by E. H. Wilson in 1914 (#AAE-03359 from the Arnold Arboretum Archives).*

R. B. PRIMACK

The presumed stump of Wilson's Quercus gilva, *with massive buttresses similar to the ones visible in the original photo.*

coming out from the trunk and sweeping to the left. After considerable searching failed to locate this distinctive tree, we did locate a huge tree stump cut off at about 3 feet (1 m) from the ground. Based on the sheer size of the stump and the distinctive buttresses still present, this is almost certainly the remains of this ancient tree. In the end, none of the ancient trees from Nara that Wilson photographed are still alive.

Japanese White Pines on the Rocky Island in Lake Towada

The Ebisudaikoku Island is named after two shrines, Ebisu and Daikokuten. They are the gods of wealth and commerce, two of the seven deities of good fortune. The island, which is located in Lake Towada, in northern Honshu, originated as part of central cone of the Towada volcanic caldera. On October 10, 1914, Wilson noted that Japanese white pine trees (*Pinus parviflora* S. & Z.) dominated the island and were between 45 to 50 ft (14–16 m) tall and 2 to 4 ft (0.6–1.3 m) in circumference. The pine canopies completely covered the Daikokuten shrine at that time and the understory vegetation was sparse. In today's photograph, taken on July 2, 2007, some of the past canopy trees have died. The heights of the pines that are still alive are remarkably similar to what they were in Wilson's day. The shrine buildings are now exposed to direct sunlight, and the understory shrubs are more abundant than in 1914. This is the typical pathway of vegetation succession following the death of canopy pines.

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Wilson's 1914 photograph of the Japanese white pines on the island in Lake Towada (#AAE-03642 from the Arnold Arboretum Archives).

SHINGO NARA

The island in Lake Towada, photographed on July 2, 2007.

The Search for Two Rare Maples

Jianhua Li

For most people in eastern North America, the first maple trees that come to mind are native species such as sugar maple *(Acer saccharum)*, red maple *(A. rubrum)*, or the box elder *(A. negundo)*. When it comes to introduced species, the most familiar ones are widely planted Japanese maple *(A. palmatum)* and Norway maple *(A. platanoides)*. From a worldwide perspective, maples occur across all temperate areas in the Northern Hemisphere, with a slight extension to the subtropics and tropics of Southeast Asia. Of the approximately one hundred and fifty species that have been described, over two-thirds of them occur in Asia. The vast majority of maples are deciduous, and justifiably famous for producing brilliant fall color, but a few of the Asian species are evergreen.

From an evolutionary perspective, the genus *Acer* has been around for at least 40 million years, during which time it has undergone extensive speciation and extinction. From a more modern perspective, the genus *Acer* was established by Linnaeus in 1753, and since then more than 200 species of maple have been described, of which about 150 are commonly recognized by botanists. Some of them have extremely wide geographic distributions, such as box elder which grows across most of North America, while others are restricted to a single, remote location. Because roughly two thirds of maples occur in China and because one of my research focuses has been on elucidating the maple "family tree," I have been collaborating with colleagues in China for the past few years to visit the areas where maples grow and to collect herbarium specimens and DNA samples. More recently, I have been anxious to obtain material of two very rare species—*Acer yangjuechi* and *Acer wardii*—to fill in some prominant gaps in my taxonomic study. Below is the story of my search of these elusive species in their native habitats.

Acer yangjuechi

The species name of this maple, "yangjuechi," is derived from the local name of the plant, which literally translates as "sheep's horn" and refers to the similarity of the shape of seeds to the horns of a sheep. It was first described in 1979 based on specimens collected from Mt. Tianmu in Zhejiang Province in eastern China (Fang, 1979). It is similar to Miaotai maple *(A. miaotaiense)*, a species in southwestern Shaanxi and southern Gansu Provinces, but differs by virtue of its larger fruits and hairy branchlets and leaf undersides. Sheep-horn maple also resembles the Japanese species, *A. miyabei* but differs in its overall hairiness.

ALL PHOTOGRAPHS BY THE AUTHOR

Figure 1. Acer yangjuechi *in cultivation on Tian Mu Mountain, Zhejiang Provence, China.*

Figure 2. The seeds of Acer yangjuechi.

Figure 3. Acer acutum *on Tian Mu Mountain.*

Figure 4. Acer maximowiczianum *on Tian Mu Mountain.*

Figure 5. Stewartia sinensis *on Tian Mu Mountain.*

Upon arriving at the Mt. Tianmu Reserve in April 2007, we learned from our official guide, Mr. Mingshui Zhao, that only a few sheep-horn maples were still alive. Mt. Tianmu is located about 60 miles (100 kilometers) west of Hangzhou and is famous for the gigantic trees of *Ginkgo biloba* and *Cryptomeria fortunei* (Del Tredici et al., 1992). In an effort to preserve genetic resources of this species in case the plants disappear from natural or artificial causes, my students—Jinhuo Jiang and Mimi Li—and I spent a day with Mr. Zhao looking for specimens of the sheep-horn maple. Mr. Zhao had seen the species a few years before, but was not certain whether it still existed today. To make sure that we obtain genetic material of the species, we first visited two trees cultivated in the resort village located at the foot of the mountain (Figure 1). The trunk was grayish and covered with moss and the yellowish-green leaves had three to five lobes with coarsely toothed margins. The plants were covered with immature samaras with reddish wings spread out at a nearly horizontal disposition (Figure 2).

Around 8:30 in the morning, we took a tourist van up the mountain to the entrance of the nature reserve not far from the Old Temple, a landmark building on Mt. Tianmu at an elevation of about 900 meters. Near the entrance to the Temple we saw two other maple species, both young saplings without fruits. The first was the pointed-leaf maple *(A. acutum),* which belongs to the Norway maple group which produced 6 to 7-lobed leaves with sharply toothed margins (Figure 3) and a drop of the milky sap oozes when the leaf stalk was broken. The other species was the Tianmu maple *(A. sinopurpurascens)* with beautifully veined 3 to 5-lobed leaves, which is similar to the devil maple *(A. diabolicum)* of Japan.

Figure 6. Mr. Zhao next to the largest specimen of Acer yangjuechi *on Tian Mu Mountain.*

Figure 7. The crown of Acer yangjuechi.

While the main path leads people up to the summit from the Old Temple, we followed the trail down the mountain and then veered off into the woods to look for the sheep-horn maple. Here we saw several saplings of another maple species with trifoliate leaves which were densely hairy on their undersides *(A. maximowiczianum)* (Figure 4). A few other plants were in bloom or fruiting including *Helwingia japonica, Stachyurus chinensis, Daphniphyllum macropodium, Arisaema sikokianum,* and an unidentified *Iris* species.

After eating our lunch in the woods, we climbed up to a mountain ridge and were greeted by some azaleas *(Rhododendron simsii)* blooming in various shades of red, white, and light blue. I was particularly pleased to see a large specimen of Chinese stewartia, *Stewartia sinensis,* that looked very much like the one growing at the Arnold Arboretum that had been sent from the Nanjing Botanical Garden in 1934 (Figure 5). Given that I have been working on the phylogeny of *Stewartia* for several years, it was particularly exciting to see this tree—covered with flower buds—growing in the wild.

From the mountain ridge we had to go downhill to find the sheep-horn maple. The understory vegetation was different here from the other side of the mountain, the dominant plant being a bamboo in the genus *Indocalamus.* Since bamboos are tall and form interlocking thickets, it took some effort to get through it. Mr. Zhao led the way but had to stop frequently to find his direction. Three years earlier he searched for the sheep-horn maple but ended up getting lost, so I kept my fingers crossed that we would have a better luck this time around. After about an hour or so of plowing through bamboo, Mr. Zhao shouted out that he found the tree. I pushed my way through the thicket and saw him standing next to a stately tree with a grey trunk (Figure 6). We searched the surrounding area for seedlings or saplings of sheep-horn maple but could only find those of a different species with three leaflets *(Acer henryi).* The lack of seedlings is probably due to a number of factors including intense competition from the bamboo and predation by insects.

After finishing our search of the area, I finally took a break to examine the old sheep-horn maple closely. The task filled me with a mixture of excitement and sadness because the tree, which was 20 meters tall with a diameter of 30 centimeters at the breast height, was decidedly unhealthy (Figure 7). The trunk had a gaping hole in it and insects have so damaged the foliage that it failed to produce any fruits. Luckily, we did manage to get a few undamaged leaves to preserve the genetic blueprint of this rapidly disappearing species. We left the area filled with a great sense of accomplishment, thankful that the time spent trekking around the mountain through bamboo thickets and winding pathways in the hazy and humid weather had not been wasted.

Upon our return to Hangzhou, Mimi Li, one of graduate students at Zhejiang University, obtained some DNA sequence data from both chloroplast and nuclear genomes of the sheephorn maple. Our preliminary analyses indicate that it is indeed closely related to the Japanese species *A. miyabei,* but we need to include another Chinese species, *A. miaotaiense,* in our analysis in order to determine what its closest relative is.

Acer wardii

The quest for the next maple brought me to Yunnan Province in the southwestern part of China, an area long considered the botanical treasure land of the country. More than sixty species of maples occur naturally in Yunnan, and so it is no surprise that Ward's maple *(Acer wardii)* should also be one of them. This rare species, whose leaves have only three lobes, was named by W. W. Smith in 1917, to honor Frank Kingdon Ward (1885–1958) the English plant hunter who first collected it in Upper Myanmar (the country formerly known as Burma). The species also grows in Assam, India and in Yunnan and Xizang Provinces, China. Ward's maple was first introduced to England by George Forest at the end of 19th century. Unfortunately the plant did not survive, and it is probably still not in cultivation in the West.

In early May of this year I was fortunate to visit Mt. Gaoligong in northwestern Yunnan with a group of researchers from the Kunming Institute of Botany (KIB). Prior to the trip, I had gotten a few specks of leaf tissue of Ward's maple from Peter Wharton of the University of British Columbia Botanical Garden and had been able to extract DNA sequences of the sample for several genome regions. Despite this limited success, it was still unclear which group of maples *Acer wardii* was most closely allied with. Based on morphological features alone, it seemed to stand between the Japanese maple and the American stripe bark maple *(A. pensylvanicum).* The primary goal for my trip, therefore, was to collect specimens to further resolve the question of its affinity to other maples.

I flew to Kunming from Hangzhou on the afternoon of April 30 and early the next morning our van left for Mt. Gaoligong with 15 people on aboard, all from KIB except for myself and Dr. Jin Xiaohua, who was from the Beijing Institute of Botany. Since the week of May 1st was a vacation week in celebration of the World Labor Day the highway teemed with buses, cars, and vans. However, the bustling traffic did not dampen my spirits: I had not visited the area for about fifteen years and was excited at the prospect of seeing how everything had changed. Whereas before there was no highway between Kunming and Dali, the one-way trip took an arduous twelve hours, but with the new road, the time travel between these two cities

Figure 8. Acer oligocarpum.

Figure 9. Leycesteria formosa *in fruit.*

Figure 10. The foliage of Acer wardii.

Figure 11. The distinctive leaves and unopened flower buds of Acer wardii.

was reduced to four hours. Change was clearly happening as rapidly in Yunnan as it was everywhere else in China.

Be that as it may, it still took us nearly two days to get from Dali to Gongshan Xian, the town where we were to begin our hike. By the time we reached our destination, the long and tiring journey had taken its toll on me and I was feeling pretty sick. I was also worried that it would not get better and would hold up the rest of the group. Xiaohua suggested that I stay in the inn for the day to rest up while he went out to look for the maple with the guide. However, no one but me knew what the plant looked like and I hated to miss the opportunity to find the plant after coming such a long way. So we compromised by taking a taxi instead of hiking the first half hour of the trip.

We went down to the valley from the dirt road where the taxi dropped us off, crossed a suspension bridge (see inside front cover), and hiked along the river. Not far from the bridge we saw a Schneider maple *(A. schneiderianum)* with five, deeply lobed leaves. Several yards from it was a semi-evergreen maple, *A. oligocarpum* (Figure 8), with simple, entire leaves and aborted terminal buds similar to those of the Japanese maple. We found a plant of the Himalayan honeysuckle, *Leycesteria formosa* (Caprifoliaceae), with many young fruits (Figure 9) and we saw patches of a common orchid in bloom with greenish yellow flowers. We also found the giant *Cardiocrinum* lily in its vegetative state with large leaves and immature flower. By noon we were still four hours from where the specimen of *Acer wardii* had been collected and I did not feel any better. Following the guide's advice we decided to turn back. It was clearly a good decision since just climbing up the hill from the valley to where the taxi dropped us off took more than half an hour. It was getting dark when we got back to the inn.

The next morning we drove back to Liuku town for the night. The next day our van followed the winding mountain road to the summit pass called Pianmayakou where we saw many interesting plants including *Ranunculus* (buttercup), *Lindera* (spicebush), and *Arundinella* (bamboo) and the top of the mountain was covered with rhododendron thickets. After half an hour botanizing at the summit we went back to the winding road and drove downhill to the other side. About noon we got to the city of Pianma bordering Myanmar. Here we visited a museum housing a United States C-53 cargo aircraft which had been restored from wreckages that were discovered near the border in 1996. It was built as a memorial to the hundreds of US pilots who died while transporting supplies between New Dehli and Kunming (known as the "hump") during World War II. I found the display deeply moving because it reminded me of the great sacrifices the American people made in helping the Chinese defend their country against the Japanese invasion.

While our van took the others back to the pass where we had collected specimens in the morning, Lianming Gao (a researcher at KIB), Xiaohua, and I walked back up the mountain botanizing and collecting. My focus was again on finding *Acer wardii* since this area is part of Mt. Gaoligong. The maples were easy to spot because the reddish color of their emerging leaves made them stand out like flames against the mountain. Unfortunately, almost all of the maples we saw had leaves with five lobes. To my surprise and great joy, however, I spotted a small tree with red, three-lobed leaves next to a maple with five-lobed leaves growing on a ten-foot high cliff above us in full sun. Xiaohua climbed up and threw a small twig down to me. It was clearly *Acer wardii*, with each of its leaf lobes terminating with a long, sharp-pointed tip. The flowers were typical for a maple, but were not yet open. We saw a few more individuals in the area, which were absolutely beautiful under the blue sky with their reddish leaves (Figures 10 and 11). Finding *Acer wardii* was the highlight of my brief trip to Mt. Gaoligong, and seeing how beautiful it was in the wild makes me believe that Ward's maple would make a great ornamental tree, albeit somewhat tender and in need of protection in areas with a harsh winter.

Maples are one of the most diverse tree groups in the Northern Hemisphere and they play an important role in both natural and man-made forest ecosystems. It is important to conduct detailed studies on the diversity, geographic distribution, ecology, evolution, and biology of maples in their native habitats before they disappear forever. Such information will not only help to preserve and protect endangered species, but will also help people learn how to use maples in a sustainable manner.

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References

Fang, W. 1979. Praecursores florae Aceracearum sinensium. *Acta Phytotaxonomica Sinica* 17: 60–86.

Del Tredici, P., H. Ling, and G. Yang. 1992. The Ginkgos of Tian Mu Shan. *Conservation Biology* 6: 202–209.

Smith, W. W. 1917. Diagnoses specierum novarum. *Notes of the Royal Botanic Garden, Edinburgh* 10: 8.

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A Golden Afternoon

Michael Dosmann

Nestled at the base of the conifer collection and straddling the banks of Bussey Brook stands one of the most picturesque plantings in the Arboretum: a grove of mature golden larches, *Pseudolarix amabilis.* In the winter, one marvels at their stately, flat-topped form; girthy branches defying gravity. Each spring, from small branch spurs, new leaves flush greenish-yellow before turning dark green by mid-summer. But, it is in autumn that the species takes on its true majesty, when the leaves seem to be on fire, becoming the intense golden-yellow that gives the species its common name.

Pseudolarix is a monotypic genus (i.e., it has but one species), and is a moderately rare tree of east-central China. It resembles the true larches (Larix) by having both long- and short-shoots (spurs) and deciduous leaves, however the male cones are borne in clusters at the ends of the short shoots as are the solitary female cones, which resemble miniature artichokes before disintegrating as they release their seeds.

Robert Fortune, the famous Scottish plant explorer responsible for innumerable horticultural introductions from Asia, first collected seeds of *Pseudolarix* in modern-day Zhejiang Province, China, in the autumn of 1853. Some of the massive trees he found in the wild reached impressive sizes, oftentimes exceeding 35 meters (115 feet) in height. Although he collected seeds, germination was very poor and most of the plants first in cultivation in the west were seedlings brought back in the infamous Wardian cases.

By the 1870s, cultivated European trees began producing seeds, and many nurseries in the UK were offering young plants for sale. However, it was not until May of 1891 that the Arboretum received its first plants from the English firm of Veitch and Sons. These two individuals, accessions 3656-A and 3565-B, were planted on opposite banks of Bussey Brook. They continue to thrive, and 3656-B stands tallest in the collection, with a height of 24.5 meters (80 feet) and a DBH of 80 centimeters (2.5 feet). In 1896, the Arboretum received seed from the Hunnewell Pinetum in Wellesley, Massachusetts, which was collected from a mature tree Horatio Hollis Hunnewell had purchased from Veitch back in 1866. Two plants of this 1896 seedlot, accessions 16779-A (see facing page) and 16779-B, also grow on the banks of Bussey Brook; 16779-B has the stoutest stem of any in the collection, with an impressive diameter at breast height of 91.4 centimeters (3 feet). A bit higher up on the slope stands accession 10764-A, another plant received from the Hunnewell's on April 22, 1921 with the moniker *Pseudolarix amabilis nana.* However, this tree did not live up to its dwarf name, for by 1946 it was at least 9 meters (30 feet) tall, prompting Heman Howard to note in the records: "nothing 'nana' about this plant." By coincidence, the Arboretum's archives contain a photograph taken by Alfred Rehder on June 21, 1921 of a 'dwarf' *Pseudolarix* growing in a container; most likely the same individual. Despite being 30 years younger than the two oldest specimens, this tree is nearly as tall, with a height of 21.1 meters (70 feet). The only wild-collected golden larches in the Arboretum came from Tian Mu Shan, Zhejiang Province, and are represented by 5 plants in accession 187-94. Plant A of this accession was planted in the Bussey Brook grove in 2000 and has grown very well, already reaching 8.2 meters (27 feet) in height.

The next time you come to the Arboretum, be sure to visit the grove of golden larches—each season reveals a bit of its personality. As you stroll Conifer Path and cross the bridge over Bussey Brook, you can admire their majesty and reflect upon their history.

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