arnoldia

The Magazine of the Arnold Arboretum

VOLUME 68 • NUMBER 2

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VOLUME 68 • NUMBER 2 • 2010

Arnoldia (ISSN 0004–2633; USPS 866–100) is published quarterly by the Arnold Arboretum of Harvard University. Periodicals postage paid at Boston, Massachusetts.

Subscriptions are $20.00 per calendar year domestic, $25.00 foreign, payable in advance. Remittances may be made in U.S. dollars, by check drawn on a U.S. bank; by international money order; or by Visa, Mastercard, or American Express. Send orders, remittances, requests to purchase back issues, change-of-address notices, and all other subscription-related communications to Circulation Manager, *Arnoldia*, Arnold Arboretum, 125 Arborway, Boston, MA 02130-3500. Telephone 617.524.1718; fax 617.524.1418; e-mail arnoldia@arnarb.harvard.edu

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Postmaster: Send address changes to
Arnoldia Circulation Manager
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Boston, MA 02130–3500

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Front cover: Morning in Hong He Gu Forest Park during the 2008 NACPEC expedition to Shaanxi, China. Photo by Anthony Aiello.

Inside front cover: Two young vendors selling hard-boiled eggs cooked in a natural hot spring near Changbai Shan, Jilin, China, in 1997. Photo by Peter Del Tredici.

Inside back cover: Manchurian catalpa (*Catalpa bungei*) bears lovely rose-tinted flowers. Photo by Richard Olsen.

Back cover: Kevin Conrad photographs a specimen of *Viburnum utile* near Wudangshan, Hubei, China. He is assisted by a Chinese official who was assigned to help insure safe travel for this 1994 NACPEC expedition. Though never needed for protection, this friendly young man was a great help in collecting seed and herbarium specimens. Photo by Paul Meyer.

In This Issue

This special issue of *Arnoldia* honors the upcoming twentieth anniversary of the North America–China Plant Exploration Consortium (NACPEC). Initiated in 1991, NACPEC is a unique organization that has had great success exploring and collecting plants within the amazingly diverse flora of China. The collaborative relationship among NACPEC members and with their Chinese colleagues provides an ideal platform for extensive collection, distribution, and evaluation of these plants.

The Arnold Arboretum is a member of NACPEC—fittingly, given the Arboretum's long history of plant exploration in China. Much has changed in the one-hundred-plus years since E. H. Wilson's China expeditions, though some things—the challenge of bad roads, the spectacular scenery, the thrill of finding rare specimens—remain the same. We hope you enjoy learning more about NACPEC's mission and accomplishments in these pages.

The Case for Plant Exploration

Peter Del Tredici

PAUL MEYER

Peter Del Tredici inspecting persimmon seeds during the NACPEC expedition to Wudang Shan, Hubei, China, in 1994.

The history of plant exploration is as old as human history itself. People have been discovering, collecting, and moving plants for eons, and the process is not likely to stop any time soon. Indeed, it is as ancient as the practice of agriculture itself—it's part of our genetic heritage. The challenge plant collectors face today is how to continue their work without causing further problems for our already badly damaged environment. Despite the best efforts of many research scientists, we have yet to develop a truly reliable way of predicting whether an unknown plant will be problematic without actually growing it under a variety of conditions to see how it behaves. Botanical gardens, with their relatively secure perimeters and their commitment to science over commerce, are places where new plant introductions can and should be tested for a variety of traits including their potential invasiveness

As the world environment continues to deteriorate as a result of human-induced phenomena such as acid rain and climate change, there can be little doubt but that we are going to need tough, adaptable plants for our managed landscapes more than ever. Many of our native species—including such familiar trees as American elm, eastern hemlock, sugar maple, and white and green ash—are no longer planted in our cities because of insect, disease, or stress susceptibility. We have a real need to replace them with stress-tolerant, non-invasive species that can survive all the abuse that people throw at them. Some of these plants of the future may be native to North America, but I can guarantee you that some of them—either as species or as hybrids—will come from Central and Eastern Asia.

And that's where the North America–China Plant Exploration Consortium comes in. For the past twenty years this collaborative organization has made it a priority to try to deal with future horticultural problems without creating new ones in the process. The organization is devoted to the collection, propagation, and study of plants in their native habitats, with a potential outcome of selection and eventual introduction. There can be little doubt but that plant diversity—in all its glorious forms—is going to be crucial in keeping the planet habitable, most especially for humans.

Peter Del Tredici is a Senior Research Scientist at the Arnold Arboretum.

The Return to China, Mother of Gardens

Paul W. Meyer

In 1929, Ernest Henry Wilson's book *China, Mother of Gardens* was published, which documented the importance of Chinese plant species to western gardens. Wilson collected plants widely in China between 1899 and 1910. Many of his introductions have become important components of the cultivated flora of our gardens and our cities, and have been used widely in plant hybridization and selection. Wilson's China collections greatly expanded our understanding of the Chinese flora as the richest and most diverse flora in the temperate world and identified the usefulness of many species for cultivation.

However, until recently, many of the most important and useful Chinese species in America were the result of limited seed collections, representing only a narrow slice of the genetic diversity and potential of each species. In some cases, all the plants in this country derived from a single plant or a few seedlings. After multiple generations of propagation from seed, symptoms of inbreeding were being observed.

Since the 1930s, wars and the political situation in China made it difficult, if not impossible, for western scientists and plant explorers to travel, study, and collect plants in China. However, Chinese botanists were hard at work during this time, cataloguing, describing, and publishing detailed accounts of their flora. With the gradual opening of China following President Nixon's visit in 1972, these publications became more available in western botanical libraries. This new information further documented the richness of the Chinese flora and its potential for further plant exploration, evaluation, and introduction. These data also provided additional information on the natural geographic distribution of species, allowing us to target specific areas for collection in particular parts of their range. By doing so, we could potentially maximize adaptability characteristics such as winter hardiness, heat and drought tolerance, and adaptability to special soil characteristics.

Collaboration Breeds Success

Earlier expeditions in South Korea, beginning in the 1960s and 1970s, had clearly demonstrated the diversity of plant species still relatively unknown to western horticulture and the importance of studying intraspecific variation and its potential usefulness to landscape crops. Up until this point, collections had been largely one-time efforts and not part of a comprehensive plan to collect over a large geographic range. In the early 1980s, Barry Yinger, at that time employed by the United States National Arboretum, proposed a series of Korean collecting trips that would facilitate the collection of specific target taxa over separate geographic and climatic ranges. The resulting trips occurred between 1984 and 1989. They were facilitated by the United States National Arboretum in close collaboration with American and Korean botanical institutions and were highly successful. This collaborative approach based on a multi-year master plan became the model on which we began to build a proposal for a long-range plan for plant exploration in China.

Key to the success of the Korean expeditions was the principle of collaboration among institutions as they plan, execute, and follow up on a plant collecting expedition. Most institutions today do not have the financial or human resources to do this work alone. Collaboration allows for the division of responsibilities and of the significant financial commitment needed. It also broadens the range of expertise present in the field. The field work itself is labor

Facing page: **While on a plant collecting trip for the Arnold Arboretum, E. H. Wilson captured this image of an alpine village (elevation 7,500 feet [2,286 meters]) in the mountains of western Sichuan, China, in August 1908. From the Archives of the Arnold Arboretum.**

ANTHONY AIELLO

(Left to right) Kris Bachtell, Chris Carley, and Li Jianjun collect ash seeds (*Fraxinus paxiana* NACPEC08-016) on a road in Hong He Gu Forest Park, Shaanxi.

intensive and it is important to have multiple hands to physically collect the seeds, make and record the field observations, and complete the evening tasks of cleaning seed and processing herbarium specimens. Most important, collaboration provides multiple sites for propagating, growing, and eventually evaluating the collections. Multiple institutions give a variety of testing locales and some level of insurance against seed loss or crop failure. And even if all are successful, it allows for a greater genetic reservoir to be tested and preserved through permanent living collections.

Widening the Pool

Several notable collection successes from the Korean expeditions encouraged us to continue this work in China. In 1984, there were two expeditions to islands off the northwest coast of South Korea. The key target species was *Camellia japonica*. It was believed that populations on these islands would represent the most cold-hardy forms of the species. Seedlings grown in multiple institutions could be selected for hardiness as well as landscape attributes, and ultimately be used in breeding projects, with the ultimate goal being clones well-adapted and reliably cold hardy in USDA Zone 6 (average annual minimum temperature 0 to -10°F [-17.8 to -23.3°C]). Indeed, seedlings grown have demonstrated superior winter hardiness and, after years of testing, a number of named cultivars have been introduced.

Similarly, kousa dogwood (*Cornus kousa*) was a tried and proven landscape plant but most, if not all, kousa dogwoods in the United States at that time (pre-1980) were descended from a narrow genetic pool. Additional collections made in Korea in the 1980s further demonstrated the great variation within that species. By 1990 we were seeing the promise of greater winter hardiness, increased vigor, and interesting variation in flower bract shape and size from these collections. As we reviewed Chinese floras we discovered that Chinese botanists had observed and documented wide variation within this species in China, so much so that they divided what we know as *Cornus kousa* into multiple species. The successes of our Korean collections along with the promise of a richness of intraspecific variation encouraged us to pursue additional collections of these and other species in China.

Another specific plant that motivated us was Chinese hemlock (*Tsuga chinensis*). During the 1980s and 1990s, hemlock woolly adelgid (*Adelges tsugae*) was becoming widespread in the northeastern United States, causing our native eastern hemlock (*Tsuga canadensis*) to decline and often die. At both the Morris Arboretum and the Arnold Arboretum, it was noted that a Chinese hemlock growing near an infested eastern hemlock was resisting infestation. A few other Chinese hemlocks growing in other arboreta were visited and also were showing resistance. This led to a comprehensive plan to re-collect Chinese hemlock from a number of different locales across its natural range in

China to further study its adelgid resistance and explore horticultural variation and adaptabilities within this species.

By the late 1980s, travel to China was becoming more practical and a group of horticulturists who had worked in Korea began to envision a wide-ranging, long-term plan to collaborate with Chinese colleagues. We had already identified a broad geographic arc across northern China that represented areas with a climate parallel to the northeastern United States. We looked at reported mean temperature in both January and July and gave priority to areas with both hot summers and cold winters. Also, we continued to target superior Chinese species already known and grown in the United States that might benefit from new collections and the introduction of greater genetic diversity. We also began the slow process (in the days before email) of establishing contacts with Chinese colleagues and exploring the possibility of meeting with them in China to map a collaborative plan and agreement. Out of this effort, a loose consortium of institutions came together in 1991 to form The North America–China Plant Exploration Consortium (NACPEC). Founding members included Lawrence Lee of the United States National Arboretum (Washington, D.C.), Peter Bristol of the Holden Arboretum (Kirtland, Ohio), and Paul Meyer of the Morris Arboretum of the University of Pennsylvania (Philadelphia, Pennsylvania).

NACPEC, the Early Years

Our overtures were enthusiastically received and in the autumn of 1991 the founding American members traveled to China to visit a number of botanical and forestry institutions in six cities, and to explore the feasibility of future plant exploration trips. Host Chinese Institutions included the Research Institute of Forestry and Beijing Botanical Garden, the Heilongjiang Academy of Forestry in Harbin, the Chang Chun Forest Botanic Garden, Xian Botanic Garden, and Nanjing Botanic Garden. We visited their herbaria and discussed target species and potential area for collection as well as the nuts and bolts of planning future trips and getting official permissions. With the advice and encouragement of our Chinese colleagues, we laid tentative expedition schedules for the next 5 years.

As part of the exchange, NACPEC would assist our Chinese partners by supporting

NANCY ROSE

Kousa dogwood (*Cornus kousa*) has a broad native range and much variation within the species.

RICHARD SCHULHOF

Hemlock wooly adelgids (seen as cottony white dots along the branchlets in this photo) attack native eastern hemlock (*Tsuga canadensis*) but Chinese hemlock (*T. chinensis*) appears to be resistant.

research projects, facilitating and supporting student and professional exchanges, and by procuring wild-collected and cultivated North American germplasm for evaluation by Chinese institutions.

Funding for these expeditions was primarily dependent on the participating NACPEC members' institutions with additional support from the National Plant Germplasm System, a part of the Agriculture Research Service of the United States Department of Agriculture (USDA). The USDA recognizes that the production of landscape plants represents a significant and growing part of American agricultural production and that, in the past, landscape plants were not well represented in the germplasm repository system.

Interest in NACPEC grew following the success of these planning efforts. In 1992, Longwood Gardens (Kennett Square, Pennsylvania) and the Morton Arboretum (Lisle, Illinois), based on their expressed interest and experience, were invited to join NACPEC. Later, the Arnold Arboretum (Boston, Massachusetts) and the University of British Columbia Botanic Garden (Vancouver, British Columbia) joined the collaboration.

PAUL MEYER

(From right, facing camera) Peter Bristol, Lawrence Lee, and He Lin examine herbarium specimens in the Nanjing Botanical Garden Herbarium on the 1991 planning trip. Research in the herbarium was helpful in pinpointing potential sites for future exploration.

PAUL MEYER

In the far north of Heilongjiang, beautiful remnants of the great Manchurian forest remain. The tallest trees are *Pinus koraiensis*, *Picea jezoensis*, and *Abies nephrolepis*. Common deciduous species include *Betula costata*, *Betula platyphylla* var. *mandshurica*, *Fraxinus mandshurica*, *Acer pictum* ssp. *mono*, and *Quercus mongolica*. The Manchurian forest appears quite similar to northern New England forests.

Planning progressed for the first NACPEC full plant exploration trip to the province of Heilongjiang, located in the far northeastern corner of China. We were hosted by Professor Jin Tieshan, a renowned professor of forestry at the Heilongjiang Academy for Forestry. This first expedition to China was a great learning experience for the American visitors and our hosts alike. We mailed much of our equipment over in advance, including herbarium presses, papers and blotters, pole pruners, packing bags, and sphagnum moss for packing and shipping seed. Once we arrived, we had to navigate the protocols of importation of supplies and later the exporting of seed. As with governments everywhere, these procedures are never fast or easy.

We were overwhelmed by the commitment and hospitality of our hosts. They did everything possible to help us professionally

and to look after our safety and human comforts. The modern world had not yet arrived in rural Heilongjiang in 1993 and we had a chance to experience the beauty of the traditional agrarian life in northeast China. In the far north of Heilongjiang, we got to see remnants of the once great Manchurian forest with Korean pines (*Pinus koraiensis*), Yezo spruce (*Picea jezoensis*), and Manchurian fir (*Abies nephrolepis*) towering well over 100 feet (30.5 meters) tall.

By the end of this month-long trip we had collected 112 accessions. Especially notable collections include *Maackia amurensis,* a potentially useful urban street tree; *Pinus koraiensis,* a beautiful and fast growing five-needled pine; and *Abies holophylla,* one of the firs best adapted to areas with hot summers. Where possible, each accession included dried pressed specimens for herbaria of both Chinese and American institutions and seed lots to be grown and evaluated in our institutions. The herbarium specimens serve as an important part of the scientific documentation of each germplasm collection and a permanent record of the occurrence of that species in the wild. This work is especially urgent and important today as China is being developed at an unprecedented pace. Mountainous areas that were largely pristine in the 1980s were being developed with tourist resorts and aerial tramways in the 1990s, putting increased pressure on the already limited natural areas in China. The success of this first expedition energized the team to continue planning for two separate expeditions in 1994 and others in later years. Since that first diplomatic trip in 1991, NACPEC has sponsored a total of 12 plant collecting trips to China.

PAUL MEYER

(Left to right) Sheng Ning , a local host, and Jeff Lynch collect seeds of *Acer triflorum,* a maple valued for its exfoliating bark and brilliant red-orange fall color.

PETER DEL TREDICI

This Chinese man collected a bumper harvest of Korean pine (*Pinus koraiensis*) cones from the local forest in Jilin. After drying in the sun, the edible seeds (commonly called pine nuts) are extracted, cleaned, and packed. Korean pine is the most common source of pine nuts in world commerce because they are relatively large, plentiful, and inexpensive.

A World of Opportunities

The outcome of this work is hard to fully measure as it has affected so many individuals and institutions in so many ways. Over the years, NACPEC plant explorers have had a chance to

visit and study innumerable Chinese plants in their natural habitat and to learn from Chinese colleagues about the plants' economic and folk uses. By seeing a plant growing in its natural habitat, we can glean insights into the growing conditions to which it is best adapted. It has also given our collectors the opportunity to lecture to groups of professionals and amateurs about the importance of conserving our planet's plant resources. Additionally, NACPEC institutions have hosted many Chinese colleagues and students for study visits and extended internships in the United States over the past 20 years, as part of our broader academic exchanges.

Today we are well aware of the dangers of introducing a new invasive species. In many instances we are focused on re-collecting new genetic material of plants that have already proved themselves as well-behaved, handsome landscape plants. When in the field, many potentially invasive plants were left uncollected. Warning signs include an aggressive habit in their natural environment or the existence of related species which have already become unruly in the United States. Back at home, curators keep an eye on plants in the botanic gardens and those showing invasive tendencies are typically removed. With each trip, NACPEC has become increasingly focused on a limited number of target species that address specific emerging needs, such as resistance to the hemlock woolly adelgid or the emerald ash borer, rather than on general collecting.

Over the years, hundreds of plants have been shared with NACPEC members and many other non-member institutions. In all, the database of NACPEC collections lists 1,348 accessions with over 6,000 plants in 9 institutions. Each collector may have their favorites, and individual plants are attracting attention as possible cultivar introductions. But beyond the garden merit of these plants, perhaps one day some "ugly duckling" may be found to contain genes for resistance to some still unknown virulent disease or insect, or may contain a compound effective in the fight against cancer. No doubt the value of these collections will continue to emerge for decades and maybe even centuries to come in ways we cannot yet imagine. NACPEC is probably the most successful, broad-based, and long-lived collaboration of its sort anywhere in the world. And after nearly 20 years of active collecting in its countryside, modern China continues to indeed be the "Mother of Gardens."

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Facing page: **This gateway building is part of the beautiful Taoist temple complex on the slopes of Wudang Mountain in Hubei. Taoist monks find tranquil spirituality in nature. Over the centuries they have helped protect this botanically rich forest, dubbed "horticultural heaven" by NACPEC expedition members. Photo by Paul Meyer.**

Sharing and Enjoying the Joint Botanical Expeditions

He Shanan

After nearly thirty years of isolation from each other, the first modern Sino–American botanical expedition was initiated in 1980, with five American botanists participating in a joint expedition to Shennongjia in China's Hubei province. In a reciprocal activity, five Chinese botanists then joined a field expedition in the United States for more than four months in the spring and summer of 1982. It was a historic expedition—the largest Chinese team to make a field trip outside of China in many years—and it generated a sound mutual understanding and cooperative base for the further development of botanizing activities.

Some ten years later, a series of joint expeditions began in China, organized by NACPEC and a group of Chinese botanical gardens, which have continued for twenty years already. Improving on the first Sino–American botanizing trip, the NACPEC expeditions have covered a very wide range of geographical areas and have had teams composed of members from a number of different disciplines. By all accounts, both the American participants and their Chinese botanical garden hosts have been well satisfied by the efficiency, valuable collections, and the mutually beneficial exchanges of science and technology.

Speaking as a member of the Chinese botanical gardens team, I would like to express my great interest and satisfaction in the project, since it has made a considerable contribution to the ex situ conservation collections in Chinese botanical gardens. First, it increased the accessions and enriched the geographical diversity of the botanical gardens' living collections. These collections typically consist of relatively few individuals of a given species, and they are often collected from only a few geographic localities. According to modern concepts of ex situ conservation, a well-balanced germplasm collection should consist of numerous individuals from multiple locations. Second, these kinds of collaborative projects can save both money and human resources by sharing plant materials collected with other botanical gardens in different regions, thereby reducing the risk of losing precious plant germplasm. And third, this project provides good opportunities for exchanging scientific information, methodology, and experience.

PAUL MEYER

Professor He Shanan in the propagation house at the Nanjing Botanical Garden.

Personally, I am very interested in knowing that most botanical gardens in the United States have the same team doing the collecting activities in the wild, managing the propagation

Herbarium specimens like this one of *Emmenopterys henryi* are permanent scientific records of individual collections that may well last long beyond the living material. In most cases, multiple herbarium specimens were made of each collection for sharing among the Chinese and American institutions.

PAUL MEYER

JESIKA JENNINGS

PETER DEL TREDICI

Emmenopterys henryi **is a rare and endangered tree species native to China. E. H. Wilson first collected this species in 1907 on an expedition for the Arnold Arboretum. He described it as "…one of the most strikingly beautiful trees of the Chinese forests, with its flattish to pyramidate corymbs of pure white, rather large flowers and still larger white bracts." The 1994 expedition to Wudang Shan found and collected** ***E. henryi*** **in Hubei (top photo).Some of the seeds from this collection went to the Nanjing Botanical Garden, and the resulting seedlings are seen growing in the NBG propagation house (bottom right). An herbarium specimen from this collection (previous page) shows the persistent bracts and oblong seed capsules. In cultivation,** ***Emmenopterys henryi*** **is notorious for taking decades to start blooming, though this precocious specimen (bottom left) at the Quarryhill Botanical Garden in California bloomed at just six years of age.**

PETER DEL TREDICI

American and Chinese expedition members shared information and expertise throughout the collection process.

in the garden, and taking care of the resulting collections. Such a unified approach encourages botanical garden staff to have strong feelings of attachment to the collections. In Chinese botanical gardens, sometimes these three activities were conducted by different groups of people; for example, the taxonomists and their technicians conducted the expeditions in the wild, and the horticulturists and gardeners propagated the plants and maintained the introduced materials. It is also helpful for Chinese botanical gardens to learn to emphasize and to standardize the record system both in the wild and in the garden.

Summarizing the achievements of the cooperative projects, it is obviously very positive, especially as we know that there are so many new plants released. More investigations and more collections are critically important as the planet faces the serious challenge of climate change and ex situ conservation becomes the only effective method for saving plants in the face of relentless urban expansion. I would like to suggest that the NACPEC project should continue its development and move ahead with follow-up research on the plants already collected.

Conserve more plants for humanity!

Have great success in the future!

He Shanan was Director of the Nanjing Botanical Garden in Nanjing, China, from 1983 to 1998.

TRAVELING IN CHINA

Clockwise from upper left:

Sharing narrow rural roads with large logging trucks led to plenty of white-knuckle moments in China (top two photos).

A close encounter on the road to Changbai Shan in 1997 turned nearly fatal—by a matter of inches—when an oncoming truck swerved, directing an unsecured log straight toward the NACPEC expedition van. The end of the log neatly peeled off the driver's door like the lid on a sardine tin (above and at left).

Paul Meyer, looking slightly stunned, observes the damage.

Ever the plantsmen, the expedition members identified the offending log as Manchurian linden (*Tilia mandshurica*).

Upper left photo Paul Meyer, all others Peter Del Tredici

Other travel hazards included muddy roads and various waterways as well as sinkholes and road construction (top two photos).

Clockwise from right:

This apple vendor used a low-tech but efficient means of transport, a wooden handcart.

Once at the collection sites, foot power became the required mode of travel. Charles Tubesing leads the expedition members through a patch of *Oplopanax elatus*.

The rewards of hiking included incredible views of the scenery such as Tianchi (Heavenly) Lake at 2,000 meters (about 6500 feet) elevation in the Changbai Shan. Unfortunately, NACPEC expedition members did not see the mysterious monsters that local legend says inhabit this volcanic crater lake.

All photos Paul Meyer

FIELD COLLECTING

Collecting seeds, plants, and herbarium specimens is a team effort on expeditions.

Clockwise from upper left:

Jeff Lynch and Paul Meyer check out an unknown elm species (*Ulmus* sp.) on a hill above the Yalu River, which divides China from North Korea (seen in the background).

Though woody plants dominate among NACPEC collections, some herbaceous plants such as *Paeonia obovata* (held by Sheng Ning) have also been collected. This peony grows in moist, fertile soils in the woodland understory.

The glamorous work of plant explorers includes picking up Manchurian ash (*Fraxinus mandshurica*) seeds along a roadside.

Out on a limb: Mr. Park, "the barefoot guide," balances precariously while collecting branches from a three-flowered maple (*Acer triflorum*).

Chris Carley, Bai Genlu, and Li Jianjun strip seeds from harvested branches of *Acer stachyophyllum* ssp. *betulifolium*.

Photos clockwise from upper left: Peter Del Tredici, Paul Meyer, Kris Bachtell, Peter Del Tredici, Anthony Aiello

Recording detailed data is an essential part of the collection process.

Clockwise from upper left:

In the mountains of the Beijing area, Rick Lewandowski (left) takes notes on location and surrounding flora while Ned Garvey (center) writes out labels for the seeds being packaged by Charles Tubesing (right).

Tools of the collecting trade include extendable pole pruners, held here by Wang Xianli.

Pole pruners are put to use collecting *Fraxinus insularis* in the rain during the 2008 expedition.

A cluster of fruit collected from Farges filbert (*Corylus fargesii*). A thin-shelled nut is held within each tightly wrapped involucre. This species was previously rare in the United States and is a valued addition to the USDA's *Corylus* germplasm collection.

Upper right photo Peter Del Tredici, all others Kris Bachtell

(Continues on page 36)

By the Numbers: Twenty Years of NACPEC Collections

Anthony S. Aiello and Michael S. Dosmann

Beginning with the initial feasibility expedition in 1991, NACPEC has conducted a total of 12 botanical expeditions to China (Table 1). These represent a concerted effort to systematically investigate and explore varying climatic areas, habitats, and ecosystems across a wide geographic range. Although quite comparable in land mass, China has much greater plant diversity than the United States. Target areas for NACPEC expeditions were determined based on climate information and cover a broad arc from central China where the Qinling mountain range forms the continental divide separating north and south China (the Yellow and Yangtze River systems), through the mountain ranges west of Beijing, to the far north and northeast of the country in the provinces bordering Russia and North Korea. Although there is a fascinating and diverse flora in Sichuan and Yunnan, these provinces have not been primary targets because plants from this warmer region of China have not performed particularly well in the climates of most NACPEC members.

The goals of each NACPEC trip have varied—on many trips we collected broadly, working from a large list of target plants, while on other trips we focused on specific taxa (e.g., *Tsuga* in 1998 and 1999, and *Fraxinus* in 2008). (See map on page 26 for locations covered on each trip.) The contributions from these trips have resulted in a wealth of knowledge about the characteristics and ecology of Chinese plants, represented by copious collection notes and herbarium specimens. And, by bringing germplasm back to North America and integrating it into the living collections spread among all of the members of the consortium, we collectively learn how these individuals respond under cultivation to our diverse growing conditions. The expeditions are summarized in separate trip reports that are housed in the libraries of the participating institutions and generally consist of two parts: a trip journal and the field notes. The journal recounts the daily activities of the trip and also sets out the context for the various plant collections. The detailed field notes provide extensive information on all of the collections for an expedition. These trip reports provide a resource for current and future exploration efforts.

Sifting the Statistics

As more NACPEC collections were propagated, distributed, and evaluated, it became clear that we should report on the results of the NACPEC expeditions. Our goal with this article is to provide information on the successes and challenges of collecting in this modern era, and to evaluate the significance

PETER DEL TREDICI

Detailed notes are taken for each collection. Here, Paul Meyer records a collection location from a GPS (global positioning system) device.

Sunrise in Xia Ban Si (Cloud Sea), Shaanxi. The photograph was made at an elevation of over 9,000 feet (2,743 meters), the highest point reached on the 2008 expedition. Photo by Anthony Aiello.

of NACPEC collections to botany, plant conservation, and ornamental horticulture. A similar case study was published by Dosmann and Del Tredici in their review (2003) of the 1980 Sino–American Botanical Expedition (SABE), another collaborative trip that yielded abundant herbarium and germplasm collections from Hubei. We wanted to know if there were any similarities or differences between the SABE and the NACPEC trips, and if there were lessons learned that could be applied not only to future collecting trips, but to living collections management in general.

NACPEC members regularly combine and update lists of their expedition holdings into a complete plant survey, and this was most recently completed in late 2009 (for online access to this information see the Data Base of Asian Plants in Cultivation [DAPC] http://www.quarryhillbg.org, the BG-Base Multi-Site Search page http://www.bg-base.com, and the individual institutions' websites). This combined inventory aids curatorial decisions among the collaborating institutions, helps to find missing or unusual collections, and focuses future collecting efforts. We used this combined inventory as the basis for the descriptive statistics provided in this article. These statistics include all of the collections made on the 12 NACPEC expeditions, as well as seeds collected in 1994, 1997, and 2001 by Professor Cui Tiecheng (formerly of the Xi'an Botanic Garden), and a few sets of seeds received as exchanges. Living germplasm data came from the NACPEC institutions, plus the holdings at the Dawes Arboretum. A very recent inclusion in this survey is the University of Idaho Arboretum and Botanical Garden, which received a seed distribution following the 1993 Heilongjiang and 1994 Beijing expeditions (see page 24).

NACPEC: Who We Are and What We Do

SINCE its inception, NACPEC's efforts have been motivated by a number of goals, including:

- **Broadening the genetic pool of species already in cultivation, with particular emphasis on extending cold hardiness and increasing vigor, improving adaptability to stressful environments, and increasing insect and disease resistance.**
- **Conserving rare species.**
- **Selecting improved ornamental forms.**
- **Evaluating and introducing appropriate new species.**
- **Increasing our understanding of botanical diversity throughout China.**
- **Collaborating with key institutions in the national and international botanical community.**

NACPEC consists of eight member institutions plus partner organizations that contribute to the success of our collecting efforts and the wide distribution of valuable germplasm. Each location not only has unique growing conditions that are favorable for certain types of taxa or those from specific parts of China, but the individual missions and collections policies of each institution are novel. Such diversity is truly an asset. The NACPEC members are:

- **The Arnold Arboretum of Harvard University, Boston, MA**
- **The Holden Arboretum, Kirtland, OH**
- **Longwood Gardens, Kennett Square, PA**
- **The Morris Arboretum of the University of Pennsylvania, Philadelphia, PA**
- **The Morton Arboretum, Lisle, IL**
- **United States National Arboretum, Washington, DC**
- **University of British Columbia Botanical Garden, Vancouver, BC**
- **USDA Woody Landscape Plant Germplasm Repository, Beltsville, MD**

KRIS BACHTELL

Viburnum betulifolium

Other partners in these efforts include the Dawes Arboretum in Newark, OH as well as several Chinese botanical institutions listed in Table 1.

What's a Collection?

VISITORS to public gardens may associate the word "collection" with groups of living plants, often labeled with signs such as "Maple Collection" or "Conifer Collection." But on NACPEC expeditions, we use the word collection in a different way. A *collection* results from one specific act of collecting and may comprise one or more products. Each NACPEC collection receives a unique alpha-numeric code for identification. For example, on the 2005 trip to Gansu we collected seeds from a *Cercidiphyllum japonicum* and also collected herbarium specimens from the tree. A single collection number, NACPEC05-059, was assigned to both the seeds and herbarium specimens, and any associated data also carry that collection number.

Once a NACPEC collection (in the form of seeds, cuttings, plants, or herbarium specimens) arrives at a botanical garden or arboretum, it is typically assigned an *accession* number unique to that institution. The *Cercidiphyllum* collected in Gansu is accession AA # 126-2007 at the Arnold Arboretum and MOAR # 2005-192 at the Morris Arboretum, but both institutions can track their accessions back to the original NACPEC collection, which makes ongoing evaluation and reporting easier and more accurate. Any institution that receives clonally propagated plants of that NACPEC collection in the future may give it their own accession number but will also retain the original NACPEC collection number in their records.

This *Cercidiphyllum japonicum* growing at the Arnold Arboretum is identified by the Arnold Arboretum accession number 126-2007-A (letters identify individual specimens within the accession group), but the label information also includes the original NACPEC collection number, NACPEC05-059.

There have been a total of 1,350 unique NACPEC collections since 1991 (Table 2). Of these, 71% (961 collections) are represented by herbarium specimens and 93% (1,250 collections) were originally collected as germplasm (primarily seeds but occasionally seedlings or cuttings); most collections comprised both germplasm and herbarium vouchers. Of the 1,250 germplasm collections made, more than half (56%) are currently represented by living plants among the various member gardens, a percentage somewhat greater than the 1980 SABE (258 of initial 621, or 41%).

Certainly, as in the 1980 SABE, an inability to successfully propagate some germplasm collections led to their initial failure. For example, in the case of some taxa such as *Acer* (maples), seeds collected may be empty and therefore not viable. Similarly, seeds of other taxa may germinate but only grow into weak plants that do not make it out of the propagation/production phase. And there are also those taxa that make it out onto the grounds only to perform poorly and eventually die. Thus, a "success rate" of around 50% is not uncommon. In directly comparing the NACPEC and SABE collections, we wondered what the contributing factors might be for the slightly higher rate among NACPEC collections (56% versus 41%). Certainly, some of the more recent NACPEC collections are still going through the pivotal propagation/production phase, which contributes to the higher

PAUL WARNICK, UNIVERSITY OF IDAHO

RICHARD NASKALI

A number of NACPEC collection plants grow on the vine arbor at the University of Idaho Arboretum and Botanical Garden, including, *Clematis mandshurica* HLJ-073 and *Vitis amurensis* BJG-039, top, and *Actinidia arguta* BJG-025 (male flowers), bottom.

Got NACPEC Plants?

WHILE writing this article, we happened upon information that added significantly to our inventory and the compilation of our statistics. Charles Tubesing, curator at the Holden Arboretum, forwarded to me a newsletter from the University of Idaho Arboretum and Botanical Garden. In that newsletter, Paul Warnick wrote about the development of an arbor to hold vines that they had grown from seeds collected by NACPEC. In further correspondence with Paul, I learned that their institution holds 246 NACPEC plants representing 55 taxa and 64 collections. These include 5 collections that previously existed at only one institution, 3 collections that previously existed as a single plant at a lone institution, and 2 collections that we previously thought were dead altogether.

While we knew that NACPEC collections had been distributed far and wide, this one instance illustrated just how pivotal distributions outside the NACPEC network can be. In light of this information, we would be very interested in hearing if any other organizations have NACPEC collections in their gardens. If so, please contact Anthony Aiello at aiello@upenn.edu . We would be happy to include your records in future NACPEC inventories. —ASA

success rate. However, we believe that the overwhelming reason for the greater success is due to the unique nature of NACPEC: wide initial distribution of germplasm—and continuing distribution of surplus plants and vegetative propagules—to a network of gardens and arboreta with unique growing environments. Lighty (2000) described several barriers to successful expeditions, one of them being the "too-rapid rate of entry of plants into the system" that then overwhelms staff and facilities. Because of its distributive and collaborative nature, NACPEC may have found a way to break this barrier.

Notable Successes

There are some remarkable success stories from the trips of the early 1990s, with 62% of the 1993 Heilongjiang collections and 69% of the 1994 Beijing expedition plants still alive today. What might have contributed to these successes? Germplasm from these trips was widely distributed to numerous NACPEC institutions, and by and large it was well-adapted to these varying climates. And even though the 1999 trip to Sichuan has a fairly low percentage of living germplasm (40%), significant collections resulted from this expedition, most notably *Tsuga chinensis* var. *oblingisquamata* (Table 3).

Another important statistic revealed in our assessment is the level of duplication among collections. Of those unique germplasm collections that are currently alive, approximately 60% grow in at least two different institutions. This duplication insures against the loss of valuable material and also provides opportunities for broader evaluation and study across a number of different growing sites.

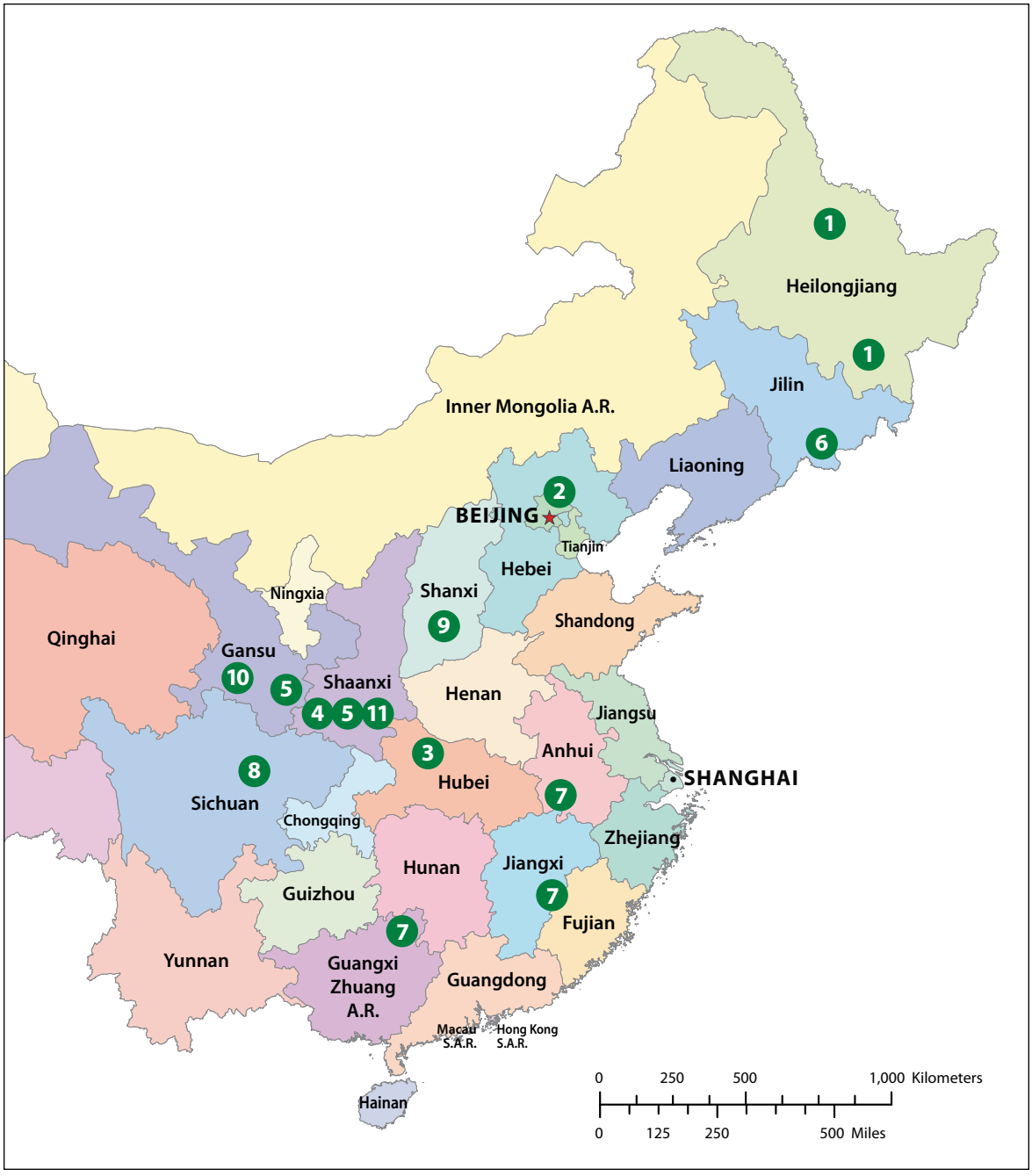
The numbers do not always tell the whole story, however. For example, there are only 15 living collections (out of an initial 30) from the 1995

NANCY ROSE

Collaborative distribution of seed and plant collections helps prevent individual NACPEC member institutions from reaching "propagation overload."

ERIC LA FOUNTAINE

Chimonanthus praecox **(the cultivar 'Grandiflorus' is seen here) bears fragrant yellow flowers in late winter or early spring.**



NACPEC EXPEDITION LOCATIONS

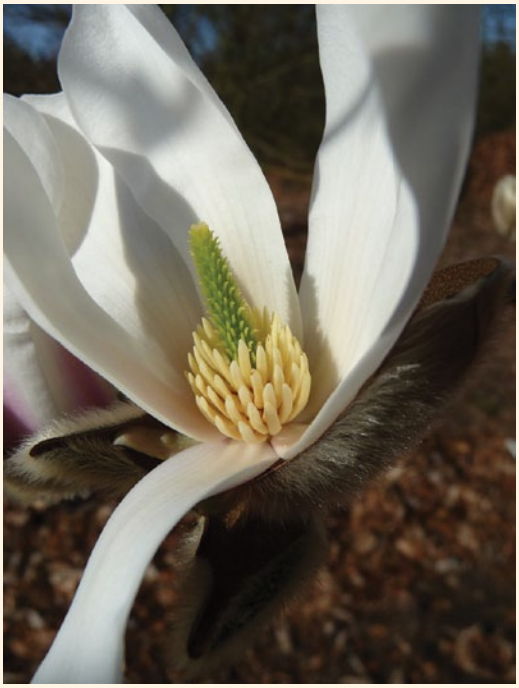
1. 1993 Heilongjiang
2. 1994 Beijing
3. 1994 Hubei
4. 1995 Shaanxi
5. 1996 Shaanxi and Gansu (Qinling Mountains)
6. 1997 Jilin (Changbai Shan)
7. 1998 Anhui, Guangxi, and Jiangxi
8. 1999 Sichuan
9. 2002 Shanxi
10. 2005 Gansu
11. 2008 Shaanxi

Shaanxi expedition. One of these is *Chimonanthus praecox* (SHX033), a shrub noteworthy for its fragrant flowers in early spring. This plant is well known horticulturally, but as far as we can determine, this is the *only* wild-collected collection in North America. It is represented by only five plants at the Morris Arboretum and is an example of a collection growing at only one institution.

This type of collection, held at only one institution, illustrates one of the challenges facing NACPEC as well as others engaged in germplasm acquisition. Forty percent of the NACPEC collections grow in just a single place. Even though most of these exist as multiple plants (as in the *Chimonanthus*), they are potentially at risk and need to be prioritized for distribution. But at even greater risk are those collections that exist as just a single plant in a single institution. For the NACPEC collections, 15% fall into this category. While they are clearly the most tenuous collections and the highest targets for propagation and distribution, this is considerably lower than the 45% of single-plant collections surviving from the SABE. Again, the unique collaborative and distributive nature of NACPEC contributes to this lower number. The annual inventory of combined holdings is the first step in alerting NACPEC members of the rarity of their own holdings.

A PRIME example in the category of a single plant is *Magnolia biondii* (QLG062A) collected in 1996 in the Foping Nature preserve in Shaanxi. This rare magnolia is a close relative of *Magnolia stellata* and is growing as a single individual at the Morris Arboretum. In light of its high conservation value and its rarity in cultivation, it becomes a very important target for propagation and distribution to other botanic gardens.

KOEN CAMELBEKE



PHILIPPE DE SPOELBERCH

These photographs show the distinctive long carpel (in center of flower) and long fruit structure with red-ariled seeds of *Magnolia biondii* specimens growing at the Arboretum Wespelaar in Belgium.


PAUL MEYER

A large specimen of *Acer pictum* ssp. *mono* growing in Heilongjiang.

In contrast to these sparsely represented taxa, there are a number of collections that are widely held among the NACPEC members. There are 13 collections grown in at least seven institutions, making them ideal candidates for further evaluation for broad adaptability as well as uniformity. Topping this list is *Acer pictum* ssp. *mono* BJG141, held by nine institutions, followed by *Acer davidii* ssp. *grosseri* (BJG017) and *Corylus fargesii* (QLG231), each held at eight gardens. It is difficult to know why some plants are grown more successfully and widely compared to others, but factors include initial quantities, broad original distribution, seed viability, curatorial interest, and broad adaptability to an array of growing conditions.

In combined NACPEC holdings, *Acer* is the most frequently collected genus—not surprising given that China is the center of diversity for maples, with 99 of the 129 species worldwide occurring there. Keen member interest in *Acer* (five of the NACPEC members and partners—the Arnold, Dawes, Morris, and Morton Arboreta, and UBC Botanic Garden—are members of the North American Plant Collections Consortium's multi-site *Acer* collection), combined with the great natural diversity has led to the extensive holdings in this genus. There have been 106 distinct collections of maple, representing 33 taxa. Of these, 73 (10% of all living NACPEC collections) are represented by living germplasm for a total 29 taxa and 585 plants among all of the member institutions. Among these are garden-worthy plants such as *Acer davidii* (including ssp. *grosseri*), *A. pictum* ssp. *mono,* and *A. triflorum;* plants rarely grown in North American botanic gardens such *A. ceriferum* and *A. sterculaceum* ssp. *franchetti* (*A. tsinglingense*); and plants of high conservation value, including *A. griseum, A. miyabei* ssp. *miaotaiense,* and *A. yui.* These collections represent a significant increase in the diversity of maples collectively held not only by NACPEC members, but among other North American institutions due to redistribution.

After *Acer,* other frequently collected taxa include *Viburnum* (20 taxa), *Quercus* and *Euonymus* (15 each), and *Rhododendron* (13). Of special significance are the 26 total collections representing 11 taxa of *Fraxinus.* Some of these ash taxa, such as *F. insularis* and *F.*

PAUL MEYER

ANTHONY AIELLO

NANCY ROSE

Upper left, Rick Lewandowski measures the diameter of an impressively large specimen of paperbark maple (*Acer griseum*); upper right, *Acer ceriferum* growing in the wild in China; lower, A cultivated specimen of three-flowered maple (*Acer triflorum*).

paxiana, may eventually hold the key to solving the emerald ash borer epidemic that is devastating native and planted populations of North American ash species.

Tsuga is another genus that stands out among the collections, not because of the diversity of taxa but for the number of collections made. Representing a classic case of a genetic bottleneck, *T. chinensis* had been introduced as a single individual into the United States in 1910. Starting in the 1990s, *Tsuga chinensis* became a prime target for NACPEC collecting expeditions because of the immediate threat to North American hemlocks by hemlock wooly adelgid (*Adelges tsugae*). A total of 33 collec-

Chinese hemlock (*Tsuga chinensis*) in its native habitat. Photo by Kris Bachtell.

tions of the adelgid-resistant *T. chinensis* and its varieties were made from across its native range, 19 of which are represented by living plants (Table 3). The original collections—mostly by seed but in some cases as seedlings or even cuttings—were made from several provinces from southeast China through the northwestern limit of its range in southern Gansu. Of the 18 seed collections, 17 are represented by at least one plant; none of the cuttings and few of the seedling collections are extant. Because of their high priority, these plants have been widely distributed among the NACPEC members and show that targeted collecting (instead of broad, opportunistic collecting) can greatly increase the diversity of germplasm among our collective holdings. These plants have been widely distributed among other North American botanic gardens, aiding in research on and wider introduction of Chinese hemlock.

What Have We Learned?

After nearly 20 years of collecting germplasm and herbarium specimens, we can draw a number of important conclusions. Overall these statistics point out the importance of collaboration in sustaining the NACPEC collections. Without the combined efforts of the member organizations, it is difficult to imagine how these expeditions would have occurred, let alone how the plants would have been subsequently propagated and maintained over a period of time. In total the herbarium specimens and living collections represent material of horticultural, botanical, and conservation significance. The sum of the consortium work is certainly greater than its individual parts, leading to significant scientific contribution and a deeper understanding of the Chinese flora as well as its horticultural potential. This is an important point to emphasize—NACPEC's goals are broader than simply introducing garden-worthy plants. First and foremost is the primary scientific documentation of botanical diversity.

Additional lessons learned include the need for sustained and repeated collecting within varied geographic, climatic, and ecological ranges, and the importance of vision and long-term planning. Looking forward, this analysis will prove a useful tool as we focus on additional

Table 1. List of NACPEC expeditions, abbreviations, participants and dates.

Trip Name	Abbreviation	Participants	Dates
1991 Initial Feasibility Expedition (Beijing, Heilongjiang, Jilin, Shaanxi, Jiangsu)	LL	Bristol, Peter; Holden Arboretum Lee, Lawrence; U.S. National Arboretum Meyer, Paul; Morris Arboretum	10 Oct – 2 Nov 1991
1993 Expedition to Heilongjiang	HLJ	Bachtell, Kris; Morton Arboretum Bristol, Peter; Holden Arboretum Meyer, Paul; Morris Arboretum Gao Shi Xin; Heilongjiang Academy of Forestry Jin Tae Shan; Heilongjiang Academy of Forestry Liu Jun; Heilongjiang Academy of Forestry	25 Aug – 28 Sep 1993
1994 Expedition to Beijing	BJG	Bachtell, Kris; ; Morton Arboretum Lewandowski, Rick; Morris Arboretum Garvey, Edward; U.S. National Arboretum Tubesing, Charles; Holden Arboretum Liu Mingwang; Beijing Botanical Garden IBCAS	13 Sep – 3 Oct 1994
1994 Expedition to Hubei	WD	Conrad, Kevin; U.S. National Arboretum Del Tredici, Peter; Arnold Arboretum Meyer, Paul W.; Morris Arboretum Thomas, R. William; Longwood Gardens Hao Riming; Nanjing Botanic Garden Mao Cailaing; Nanjing Botanic Garden	6 Sep – 11 Oct 1994
1995 Expedition to Shaanxi	SHX	Garvey, Edward; U.S. National Arboretum Lewandowski, Rick; Morris Arboretum Cui Tiecheng; Xi'an Botanic Garden	31 Mar – 17 Apr 1995
1996 Expedition to Shaanxi & Gansu (Qinling Mountains)	QLG	Ault, James; Longwood Gardens Conrad, Kevin; U.S. National Arboretum Lewandowski, Rick; Morris Arboretum Kim Kunso; Norfolk Botanical Gardens Cui Tiecheng; Xi'an Botanic Garden	30 Aug – 18 Oct 1996
1997 Expedition to Changbai Shan (Jilin)	NACPEC97 (CBS)	Bachtell, Kris; Morton Arboretum Del Tredici, Peter; Arnold Arboretum Lynch, Jeffrey; Longwood Gardens Meyer, Paul W.; Morris Arboretum Tubesing, Charles; Holden Arboretum Wang Xian Li; Shenyang Institute of Applied Ecology Cao Wei; Shenyang Institute of Applied Ecology Sheng Ning; Nanjing Botanical Garden	25 Aug – 27 Sep 1997
1998 Expedition to E. & SE. China (Anhui, Guangxi, Jiangxi)	NACPEC98 (TS98)	Lewandowski, Rick; Morris Arboretum Garvey, Edward; U.S. National Arboretum Li Weilin; Nanjing Botanical Garden Wang Qing; Nanjing Botanical Garden	5 Oct – 22 Oct 1998
1999 Expedition to Sichuan	NACPEC99 (TS99)	Belt, Shawn; U.S. National Arboretum Garvey, Edward; U.S. National Arboretum Stites, Jerry; Longwood Gardens Wang Qing; Nanjing Botanical Garden	1 Oct – 20 1999
2002 Expedition to Shanxi	NACPEC02	Aiello, Anthony; Morris Arboretum Bachtell, Kris; Morton Arboretum Bordelon, Carole; U.S. National Arboretum Bristol, Peter; Holden Arboretum (Chicago Botanic Garden) Tang Yudan; Beijing Botanical Garden IBCAS	9 – 30 Sep 2002
2005 Expedition to Gansu	NACPEC05	Aiello, Anthony; Morris Arboretum Bachtell, Kris; Morton Arboretum Scanlon, Martin; U.S. National Arboretum Wang Kang; Beijing Botanical Garden Sun Xue-gang; Forestry College of Gansu Agricultural University	14 Sep – 12 Oct 2005
2008 Expedition to Shaanxi	NACPEC08	Aiello, Anthony; Morris Arboretum Bachtell, Kris; Morton Arboretum Carley, Chris; U.S. National Arboretum Wang Kang; Beijing Botanical Garden	16 Sep – 8 Oct 2008

NANCY ROSE

***Acer davidii* is much admired for its striped bark. This specimen at the Arnold Arboretum (AA#666-94-A) was grown from seed collected during the 1994 expedition to Hubei (NACPEC collection #WD 040).**

Table 2. Collections totals for formal NACPEC expeditions and other associated collections. Trip abbreviations follow Table 1.

TRIP	Year	Total	Herbarium collections		Germplasm		Living germplasm		Exists at only one institution*		Exists as a single plant**	
			#	%	#	%	#	%	#	%	#	%
LL	1991	25	0	0	24	96	9	38	5	56	3	33
HLG	1993	112	96	86	102	91	63	62	20	32	5	8
BJG	1994	144	130	90	138	96	95	69	26	27	11	12
WD	1994	194	149	77	171	88	83	49	40	48	21	25
SHX	1995	33	0	0	30	91	15	50	11	73	5	33
QLG	1996	263	235	89	234	89	120	51	48	40	22	18
NACPEC 97	1997	143	122	85	139	97	91	65	22	24	7	8
TS 98	1998	42	0	0	42	100	19	45	17	89	11	58
TS 99	1999	33	29	88	27	82	11	41	6	55	1	9
NACPEC 2002	2002	78	71	91	71	91	48	68	20	42	2	4
NACPEC 2005	2005	90	85	94	85	94	60	71	29	48	4	7
NACPEC 2008	2008	51	44	86	45	88	43	96	20	47	4	9
Expedition total		1208	961	79	1108	91	657	59	264	40	96	15
Other***		142	0	0	142	100	47	33	36	77	15	32
Grand Total		1350	961	71	1250	93	706	56	294	42	109	15

* A germplasm collection that exists at only one institution; may be of one or multiple plants
** A germplasm collection that is represented by a lone plant at one institution
*** Include collections made during tourist visits, as well as those collections made through contract

NANCY ROSE

Acer pseudosieboldianum is another garden-worthy small maple collected on several of the NACPEC expeditions.

CHRIS CARLEY

Bai Genlu (back to camera), Wang Kang (white hat), Li Jianjun, and Anthony Aiello examine *Acer caesium* ssp. *giraldii* (NACPEC08-014) in Hong He Gu Forest Park, Shaanxi.

collecting efforts, and will allow us to focus our efforts on propagating and distributing plants of horticultural, botanical, and conservation significance.

Lastly, and perhaps most importantly, we acknowledge the cultural exchange that has occurred among the American and Chinese institutions and the individuals involved. Without these lasting relationships none of these expeditions or the resultant collections would have occurred. The end result is a mutual affinity and deep appreciation for the relationships that have ensued.

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Table 3. List of NACPEC *Tsuga* collections.

Taxon	Coll. #	How Material was Collected	Province of origin	Collection alive?	Number of Institutions growing this collection	Total plants among all institutions
Tsuga chinensis	Cui 97-053	Seed	Shaanxi	yes	4	24
	Cui 97-054	Seed	Shaanxi	yes	4	26
	NACPEC05022	Seed	Gansu	yes	3	12
	NACPEC05063	Seed	Gansu	yes	4	12
	QLG013	Seed	Shaanxi	yes	3	7
	QLG188	Seed	Shaanxi	yes	6	20
	QLG190	Seed	Shaanxi	yes	7	18
	QLG193	Seed	Shaanxi	yes	6	23
	QLG216	Seed	Shaanxi	yes	2	9
	QLG217	Seed	Shaanxi	yes	3	17
	SHX017	Seedling	Shaanxi	yes	1	1
	XBG s.n.	Seed	Shaanxi	yes	1	5
Subtotal	12			12 living (100%)		174
Tsuga chinensis var. *oblongisquamata*	TS 99-018	Seed	Sichuan	yes	4	22
	TS 99-022	Seed	Sichuan	yes	5	11
	TS 99-025	Seed	Sichuan	yes	2	22
	TS 99-026	Seed	Sichuan	yes	3	9
	TS 99-027	Seed	Sichuan	yes	4	9
	TS 99-033	Seed	Sichuan	no	0	0
Subtotal	6			5 living (83.3%)		73
Tsuga chinensis var. *tchekiangensis*	TS 98-046F	Seedling	Jiangxi	yes	1	2
	TS 98-058B	Seed	Guangxi	yes	1	1
	TS 98-035E	Seedling	Jiangxi	no	0	0
	TS 98-036E	Seedling	Jiangxi	no	0	0
	TS 98-040H	Seedling	Jiangxi	no	0	0
	TS 98-042C	Seedling	Jiangxi	no	0	0
	TS 98-043E	Seedling	Jiangxi	no	0	0
	TS 98-044F	Seedling	Jiangxi	no	0	0
	TS 98-051B	Seedling	Guangxi	no	0	0
	TS 98-051C	Cuttings	Guangxi	no	0	0
	TS 98-052B	Seedling	Guangxi	no	0	0
	TS 98-062B	Seedling	Guangxi	no	0	0
	TS 98-066B	Seedling	Guangxi	no	0	0
	TS 98-066C	Cuttings	Guangxi	no	0	0
	TS 98-069	Seedling	Zhejiang	no	0	0
Subtotal	15			2 living (13.3%)		3
Grand Total	33			19 living (57.6%)		250

(Continued from page 19)

PROCESSING

Freshly collected seeds and herbarium specimens must be processed promptly to prevent spoilage. These tasks occupied many evenings for all of the expedition members.

Clockwise from upper left:

Soft-fleshed fruits are soaked and sieved to remove any pulp before the seeds are dried and packed. Rick Lewandowski cleans seeds at a trough sink during the 1994 expedition to the Beijing region.

Pressed herbarium specimens must be dried quickly or else mold may set in. During a rainy spell, Peter Del Tredici and Mao Cailaing resorted to burning charcoal under the herbarium press to help dry the specimens.

Air-drying seeds and herbarium samples.

Kris Bachtell and Martin Scanlon begin processing cones of *Tsuga chinensis*.

Dry fruits like these maple samaras are winnowed, carefully cleaned, and sorted before they are packed in labeled bags.

Photos clockwise from upper left: Kris Bachtell, Paul Meyer, Peter Del Tredici, Anthony Aiello, Kris Bachtell

FOOD

Expedition members enjoyed many elements of Chinese cuisine on their travels.

Clockwise from upper left:

A vendor at a market in Harbin sells fruit including round Asian pears native to this region and warty, orange, ripened bitter melons.

Graduate student Zhang Wei and an expedition driver, Mr. Liu, eat spicy noodles in a restaurant in Min Xian, Gansu.

This noodle vendor in Xi'an served up bowls of piping-hot seasoned noodles.

In Shanxi's Pangquangou National Preserve, this "mushroom lady" was collecting a type of edible mushroom known to grow on *Populus davidiana*.

Photos clockwise from upper left: Paul Meyer, Kris Bachtell, Anthony Aiello, Kris Bachtell

GETTING TO KNOW CHINA

Beyond collecting plants, the NACPEC expeditions have provided an opportunity for participants to see and learn more about China's people and landscapes.

Clockwise from top:

Tall, blond expedition members Bill Thomas and Paul Meyer attracted a lot of attention in the streets of Wudang Shan City, Hubei.

This Tibetan woman was harvesting *Anemone tomentosa* plants to feed to her pigs.

Chinese colleagues hosted a birthday celebration for Kris Bachtell in September 2005 (left to right: Anthony Aiello, Kris Bachtell, Zhang Zuoshuang, He Shanan, and Zhang Aoluo and his wife).

Opposite page, clockwise from upper left:

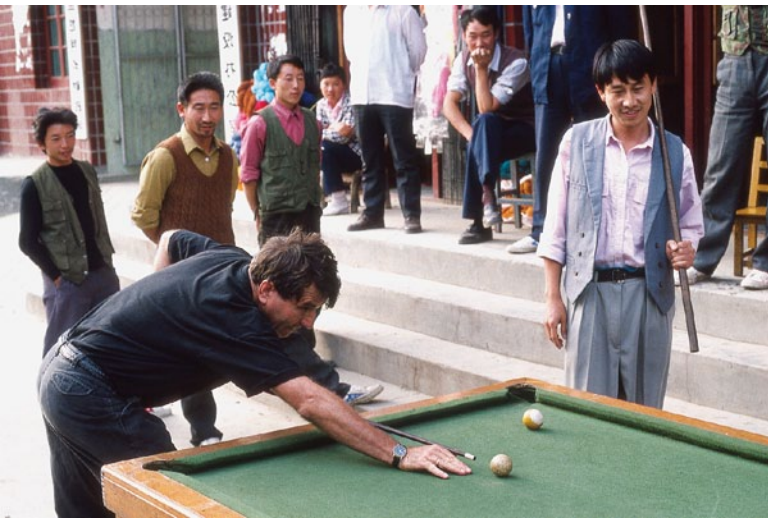
Peter Del Tredici shoots pool with the locals on a street in the Wudang Shan area, Hubei.

Children give pig riding a try, to the amusement of onlookers in a small village in the Mo Gou Forest area in Gansu.

A misty view of the Seven Sisters, a set of peaks in the Tai Bai Shan reserve in Shaanxi.

Photos this page, clockwise from top: Peter Del Tredici, Kris Bachtell, Kang Wang

Photos opposite page, clockwise from upper left: Paul Meyer, Kris Bachtell, Anthony Aiello



Planning Future NACPEC Plant Exploration: Challenges and Opportunities

Kunso Kim, Kris Bachtell, and Kang Wang

The North America–China Plant Exploration Consortium (NACPEC) is an innovative partnership formed in 1991 between American and Chinese institutions to organize and conduct plant explorations in China. Since its inception, this collaborative effort has been successful in collecting many botanically and horticulturally important plants including paperbark maple (*Acer griseum*), Farges filbert (*Corylus fargesii*), and Chinese stewartia (*Stewartia sinensis*). During the two decades of its existence, NACPEC has witnessed dramatic changes occurring around the globe that have profoundly affected the consortium's collecting efforts, most notably the Convention on Biological Diversity, the complexity of ex situ plant conservation, the impacts of climate change, the spread of invasive species, and the tightening of import/export regulations. These issues have challenged us to rethink the way we plan and organize plant explorations as the consortium moves forward into the next decade.

CURRENT ISSUES AND CHALLENGES

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is an international treaty signed at the United Nations Conference on Environment and Development (also called the "Earth Summit") in Rio de Janeiro, Brazil, in 1992. The key component relevant to NACPEC activities is Article 15, Access to Genetic Resources (CBD 1999). This provision endorses the sovereign rights of countries over their biological resources. The article not only offers countries an opportunity to revamp their efforts in conservation of biodiversity and sustainable uses, but also gives them leverage over their natural resources. In essence, the possibility of conducting any plant exploration in China rests upon consent from the host country based on mutually agreed terms. As a consequence, the consortium may see increasing restrictions imposed by the Chinese government on certain collecting areas including national parks and reserves that are often biologically rich. Described in the same article is another provision called "Access and Benefit Sharing" that requires the consortium to establish a clear understanding of how the benefits should be shared. Participating countries are required to share with the host country any benefits arising from commercialization or other utilization of the genetic resources. In the past, NACPEC has made good faith efforts to honor this provision by training Chinese students in plant curation and database management, hosting a number of Chinese scientists during their extended visits to the United States, supporting BG-Base and BG-Map at the Beijing Botanical Garden (IBCAS), supporting field work inside China by a number of Chinese botanists, and by sharing a portion of the royalties from the sale of plants through the Chicagoland Grows® Plant Introduction Program.

Ex Situ Plant Conservation

Conserving rare species has always been one of the objectives in the consortium's collecting trips (Meyer 2000). Despite the high priority given to horticulturally important plants, the consortium's annual inventory survey includes 52 accessions that are on the current *IUCN Red List of Threatened Species*. Should future explorations emphasize collecting red-listed plants as the major goal? As habitat loss in China continues to increase and more public gardens are responding to the plea to participate in ex situ

Facing page top: **Farges filbert (*Corylus fargesii*), a promising tree species for landscape use, was collected in this river terrace habitat in Gansu. *Bottom:* A temple within the Lingkongshan Chinese pine (*Pinus tabuliformis*) national preserve, one of a number of botanically rich national preserves in China. Photos by Kris Bachtell.**

When human development encroaches on the habitat of threatened plant species, ex situ conservation may be the key to preventing species extinction. Here, the "suburbs" of a village in Hubei expand up a steep terraced slope. Photo by Peter Del Tredici.

plant conservation, there is an opportunity for the consortium to renew its efforts and play a more active role in acquiring threatened species and sampling species from different populations to get a better representation of genetic diversity. The consortium is uniquely positioned to expand its ex situ conservation role. It has established successful collaborations with Chinese institutions, gained invaluable field experience, and established a high standard of documentation that holds important information for breeding, evaluation, and conservation purposes (Bachtell 2000). Capitalizing on its experience and collaborations, future explorations can contribute to advancing the goal of preserving 60% of threatened plant species in accessible ex situ collections as laid out in the Global Strategy for Plant Conservation Target 8 (CBD 2005). Future plant exploration with conservation in mind will need to priori-

ROBERT MAYER

Some widely grown landscape plants of Asian origin have become invasive in parts of North America. One example is winged euonymus (*Euonymus alatus*), a popular shrub also known as burning bush because of its bright carmine red fall color.

tize species by conservation concern and sample multiple populations in order to maximize genetic diversity. When sampling from within populations, care must be taken to collect sufficient germplasm to maximize the capture of genetic diversity for long-term seed storage, or clonal stands for taxa that have recalcitrant seeds.

Introducing Horticulturally Superior Plants

This was at the heart of initial NACPEC plant exploration efforts and remains an important goal for the consortium. The definition of a superior plant in the early days of NACPEC plant exploration often meant that a plant should have increased cold hardiness, tolerance to stressful conditions (including urban landscapes), and resistance to pests and diseases. Exciting plants with such traits are in the process of being introduced and others are being developed through breeding and selection programs utilizing the rich germplasm of plants the consortium has assembled.

While the above criteria are still valid, biological invasiveness has emerged as an area of concern. The need to screen introduced plants for non-invasive characteristics has become a high priority for the consortium, which has stepped up its efforts by excluding from expedition target taxa lists any potentially invasive species. At the same time, participating gardens need to develop vigorous risk assessment protocols to determine the invasive potential of lesser known species from the pool of plants that are maintained in living collections before they reach reproductive stage. Use of reliable predictive modeling to assess invasive risk can allow the consortium to avoid time-consuming screening and expensive processing in the field (Widrlechner 2009).

Climate Change

Climate change has a huge implication for biodiversity and consequently on the consortium's future collecting initiatives. Major vegetation

PAUL MEYER

Large expanses of forest in China have been cut down and burned to make way for ginseng cultivation.

PETER DEL TREDICI

PETER DEL TREDICI

Ginseng requires shade to grow, so the forests are replaced with vast expanses of low shade structures, seen here in the Changbai Shan area.

shifts are predicted by various climatic models. Hawkins (2008) states three different possibilities: (1) some plants will adapt to new climate conditions through selection or plasticity; (2) some plants will move to higher latitudes or altitudes; or (3) other plants may become extinct. It is predicted that continued climate change will ultimately drive many plants to extinction. An average world temperature rise of 2 to 3°C over the next 100 years will result in up to 50% of the 400,000 or so higher plants being threatened with extinction (Hawkins 2008). How should NACPEC's future plant explorations respond to climate change? Studying climate analogues has provided the most useful information to NACPEC in planning the potential target areas in China. The consortium considers seasonal rainfall, mean seasonal temperatures, and summer high and winter low temperatures to identify the target areas (Meyer 2000). Will it be necessary for NACPEC to reconsider expanding the collecting zones towards warmer regions or lower altitudes and latitudes in response to anticipated vegetation shifts?

Import/Export Regulations

NACPEC members who participated in past plant explorations are familiar with the complexity of obtaining collecting permits in China. Compliance with rules governing col-

Emerald ash borer (*Agrilus planipennis*). Photo by David Cappaert, Michigan State University, Bugwood.org.

The 2008 NACPEC expedition focused on collecting Chinese ash species. This large specimen of *Fraxinus insularis* grows near a country house in Shaanxi. Photo by Kris Bachtell.

lecting permits and germplasm importation is absolutely necessary, yet it is one of the most cumbersome aspects of any plant exploration. With the CBD recognition of countries' sovereign rights over their natural resources, it is possible that the consortium will see more limited issuance of collecting permits and increased restrictions on collecting in special areas. Adding to the challenges, there are new rules on importation of plant germplasm into the United States. Even clean seeds with phytosanitary certificates attached do not guarantee an easy entry. Some people mistakenly think that the possession of an import permit issued by USDA APHIS for small lots of seeds means free passage, but it only eliminates the requirement to obtain a phytosanitary certificate from the exporting country (USDA 2008). In view of recent insect and disease outbreaks such as emerald ash borer (*Agrilus planipennis*), Asian longhorned beetle (*Anoplophora glabripennis*), and sudden oak death (*Phytophthora ramorum*), it is understandable that the USDA is increasingly tightening the rules. The threat posed by invasive plant species is another issue that has contributed to stricter importation rules.

STRATEGIC PLANNING FOR FUTURE COLLECTING EFFORTS

Past plant exploration efforts focused on collecting a broad range of species and a large number of accessions. Priority taxa lists are carefully developed during the trip planning process, but inevitably non-target taxa are added to the list

along the way, resulting in increased collections. This practice of collecting a broad range of species will need to change. The current issues and challenges described above necessitate that future plant explorations become more sharply focused. This can be accomplished by the annual survey inventory which examines total living accessions accumulated over the last two decades and shows which institutions hold what accessions. The survey results have helped NACPEC understand gaps in its collections and will help with planning future trips. Based on an analysis of past results, a trip could target a single genus or a few genera depending on the purpose or priority of the taxa. More focused collecting trips allow the initiation of new research projects in response to rapidly changing environmental conditions such as those posed by invasive species. The 2008 Shaanxi expedition was an example of a goal-driven and therefore more focused collecting trip. This USDA-funded trip was specifically for collecting ash (*Fraxinus*) species that are not well represented in American botanic gardens and arboreta. A percentage of the seeds collected were seed banked within the USDA's National Plant Germplasm System. The resulting progenies are to be incorporated into a feeding preference study to test the ash species' resistance to the emerald ash borer.

TOWARDS GREATER COLLABORATION

Modern day plant explorers are facing a different set of challenges than did earlier plant explorers. The impact of climate change on vegetation is one obvious reason for the consortium to take a more active role in conserving plants. The CBD has helped focus our attention on how to balance the needs for access to genetic resources and benefit sharing, with the ultimate goal of conservation of biological resources through preservation and sustainable use. In spite of the tremendous success NACPEC has experienced in collecting and introducing plants, there is a need for the consortium to focus future plant explorations on collecting a more narrowly defined list of target plants, paying particular attention to preventing accidental introduction of plants with invasive potential. NACPEC has succeeded largely through the close collaborative work between the American and Chinese member institutions. The issues listed above present opportunities for NACPEC to help meet the challenges presented by our changing world.

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Facing page: **A view across the Wudang Mountain range from atop Wudang Mountain in Hubei. The building in the foreground is part of the Taoist monastery and temple complex for which this mountain is famous. Photo by Paul Meyer.**

During NACPEC expeditions plant species are targeted for collection for a range of reasons including environmental adaptabilities, conservation value, and ornamental features. Presented here are thirteen profiles of notable plants collected on these expeditions.

Paperbark Maple
Acer griseum

Paul W. Meyer

Paperbark maple is an iconic Chinese species with beautiful exfoliating cinnamon-colored bark that never fails to grab attention. It is frequently highlighted in public gardens and connoisseurs' gardens throughout the temperate world. It was first introduced to the United States by E. H. Wilson through the Arnold Arboretum in 1907.

In addition to its stunning bark, this species is widely admired for its clean, fine-textured foliage, orange-red fall color, and relatively small stature, usually under 35 feet (10.7 meters) tall. It is believed that until recently, all or most paperbark maples in the United States derived from the genetically narrow 1907 Wilson introduction—it consisted of only two plants. Some contemporary seedlings lack vigor, a possible sign of inbreeding over the past century. The re-collection of paperbark maple to introduce greater genetic diversity has been a high priority from the very beginning of NACPEC planning.

Of the many hundreds of plants I have observed and collected in China, none were more exciting than finding a grove of wild paperbark maples on Wudang Mountain in Hubei in 1994. Wudang is the site of a famous Taoist temple, and the forests on its slopes have been relatively well protected. On September 21st, 1994, the Hubei expedition team was especially excited to find a scattering of paperbark maples in the understory of a rich, diverse forest at an elevation of 836 meters (2743 feet). It was one of the most biologically diverse habitats that any of us had ever experienced. Dubbed "horticulture heaven" by the collectors, we found many choice species including *Stewartia sinensis, Cornus kousa, Cornus controversa, Ilex pernyi,* and many others growing naturally on this mountainside.

The paperbark maples growing on Wudang Mountain were relatively small, growing on a west-facing slope in thin, rocky soil. Being in the understory, most were leggy and the foliage was high off the ground. With careful observation though, we spotted the winged samaras in the upper canopy. Using pole pruners, we were able to collect herbarium specimens and a small seed sample.

The following year, in April 1995, NACPEC team members Rick Lewandowski, Teicheng Cui, and Ned Garvey spotted an incredible specimen of paperbark maple in the Baxiam Forest Station in Shaanxi, less than 200 kilometers (124 miles) west of Wudang Mountain. They spotted the tree from afar; its leaves had not yet emerged, and they were struck by a distinct warm orange glow reflecting from the tree's bark. The collectors wrote in their journal, "Holy Hannah! We encountered the biggest specimen we ever saw of *Acer griseum.* This was incredible… We can't describe the impact of the bark color and the massive stem—the effect was overwhelming." This tree measured 81.4 centimeters (32 inches) in diameter at 3 meters (9.8 feet) above the ground. It was estimated to be about 27 meters (88.6 feet) tall. Though no collections of living germplasm resulted, the herbarium specimens, descriptions, and photographic documentation of this individual tree have redefined our thinking about the potential of this species.

Paperbark maple is known to frequently produce empty samaras with no viable seeds. That was the case with the Hubei collections. After cutting open many samaras, we found a few (less than 5 percent) with seemingly viable seeds. Fortunately, there were also small seedlings growing under the trees, some of which were

RICK LEWANDOWSKI

The "Holy Hannah!" specimen of paperbark maple spotted during the 1995 expedition to Shaanxi.

PAUL MEYER

Paperbark maple is noted for its beautiful bark and red-orange autumn foliage color.

carefully dug bare-root, stripped of their senescing leaves, and packed in moist sphagnum moss. The seeds never germinated, but these dormant seedlings were brought home successfully and 13 are growing at NACPEC institutions. Though this lack of viability is frustrating to a propagator, the upside is that this species has little potential of becoming invasive.

I live on the grounds of the Morris Arboretum and two of the Wudang Mountain paperbark maples are growing in my garden. One is an especially fine specimen. It is a very vigorous individual and in its youth it grew more than 1 meter (3.3 feet) a year. Today it stands over 8 meters (26.2 feet) tall and has a diameter of 27 centimeters (10.6 inches) measured 30 centimeters (11.8 inches) from the ground, just below the first branch. Perhaps because of its strong growth, its bark is especially beautiful, with heavy exfoliation.

Morris Arboretum propagator Shelly Dillard took cuttings of this tree in 1998, 1999, 2000, and 2001 while the tree was still juvenile. None rooted successfully. In 2001, I rooted a low branch of the tree in my garden by layering, resulting in the only successful propagation of this individual. This layered plant has the same vigorous habit as its parent, and in July 2010 it had a 6.2 centimeter (2.4 inches) diameter measured 30 centimeters (11.8 inches) from the ground and stood about 3.5 meters (11.5 feet) tall. Four other individuals of this Hubei accession are growing at the Morris Arboretum and each year we watch them, hoping that one might produce some fertile seed for growing on and further evaluation.

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Beautybush
Kolkwitzia amabilis

Michael Dosmann

It was in the late summer of 1901, while exploring the mountains northwest of Ichang, Hubei, China, that Ernest Henry Wilson encountered a shrub which would become one of his favorite introductions: *Kolkwitzia amabilis.* At the time, he wasn't even quite sure what it was—his notes for collection #1007 simply state that the unnamed plant was 5 feet (1.5 meters) tall, had been free-flowering, with possibly red blooms, and had spinose fruits. The seeds were sent to Veitch Nursery in England where they germinated and grew. In November 1907, plants (labeled as *Abelia* sp.) were sent to the Arnold Arboretum—the species' first introduction to North America.

Shrubs (now under the correct moniker *Kolkwitzia*) flowered at the Arboretum for the first time in June 1915. Their early-summer displays of pink blossoms, profusely borne on arching branches, so impressed Wilson and others that it was christened beautybush. Thereafter, in early to mid June, the Arboretum's *Bulletin of Popular Information* routinely included a glowing snippet about the blooming *Kol-*

MICHAEL DOSMANN

Beautybush bears a profusion of pink blossoms in early summer.

PETER DEL TREDICI

Kevin Conrad stands next to a visually unimpressive but botanically important specimen of beautybush, which was collected from during the 1994 Hubei trip.

kwitzia, how big they were getting, and which specimen in the Arboretum was faring best. In fact, the species' merits were lauded to such an extent that in 1927 Wilson noted that the original plant on Bussey Hill had "been much mutilated for propagation purposes, and from it, either by seeds or cuttings, has originated the whole stock of this plant in America."

Not everybody agreed with Wilson's endorsement, however, with some even suggesting that plants were not as gorgeous in flower as claimed, or that the plants didn't flower at all. His dander up, Wilson sought to set the record straight on several occasions. His statement on June 7, 1930, (a few months before his untimely death) sums it up: "There is a foolish rumor abroad that this plant when raised from seed does not blossom. The story is ridiculous since the original plants were raised from seed and the particular plant on Bussey Hill Road is also a seedling... Another canard in circulation is that it is an acid-loving plant. As a matter of fact, it will do equally well on a moderately acid soil or on limestone." Nobody could doubt his love for the plant, for in the same passage he states "Among the deciduous-leaved shrubs that central and western China has given to American gardens *Kolkwitzia* stands in the front rank."

Amazingly, it was not until September 25, 1994, that this beautiful and elusive species was collected again, about 100 miles north of Wilson's original collection site in Hubei. The participants on the NACPEC expedition to Wudang Shan discovered multiple plants on a hillside near Yan Chi He, and collected ample seed (collector number WD 122). The germinated seedlings at the Arnold Arboretum grew vigorously, and within 18 months were about 0.5 meter (1.6 feet) tall. Unfortunately, all of these plants were sold by mistake at the Arboretum's plant sale in 1997. This was a striking loss, but fortunately seeds of this collection were grown at other institutions also. In the spirit and interest of sharing material, the Arnold Arboretum received cuttings from 3 plants at the Morris Arboretum in 2008. They have rooted and will eventually be planted out.

Almost everything we know about this species in cultivation can be traced to Wilson's single introduction event, so we are curious to see how this new collection compares to the original germplasm. No formal studies or evaluations have taken place so far, but there are some preliminary observations that are worth further investigation. Phenological data from the Morton Arboretum from the past 8 years show that the Wilson material on average reaches peak bloom about 1 week earlier than the Wudang Shan material. Perhaps only a minor difference, but this is worth further study. If it holds true, it would be worth selecting for later blooming in self-pollinated F1 and F2 generations of the Wudang Shan germplasm.

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Henry's Viburnum
Viburnum henryi

Carole Bordelon

Viburnum henryi, commonly known as Henry's viburnum, was discovered by Augustine Henry and introduced to the west by E. H. Wilson in 1901. Native to central China, *V. henryi* is relatively rare in cultivation in the United States, existing primarily in public gardens. When this plant was discovered during the fall 1996 NACPEC expedition to the Qinling Mountains in China's Shaanxi province, the team of collectors considered this find a high point of their trip. They were impressed by its beautiful dark green foliage and its large clusters of glossy red fruit. The seeds were collected and propagated for trialing, and fourteen years later, *V. henryi* is still an impressive plant growing at the United States National Arboretum and the Morris Arboretum.

Henry's viburnum is an evergreen shrub, typically growing 7 to 15 feet (2.1 to 4.6 meters) tall, and is hardy in USDA Zones 7 to 10 (average annual minimum temperature 0 to 40°F [-17.7 to 4.4°C]). Its growth habit is lax, especially when young, but its spreading, arching branches can be pruned into a small upright tree, if desired. Otherwise, little aesthetic pruning is required (any pruning should be done after flowering).

PAUL MEYER

DANIEL MOSQUIN, UBC BOTANICAL GARDEN

The attractive foliage and flowers of Henry's viburnum.

DANIEL MOSQUIN, UBC BOTANICAL GARDEN

CAROLE BORDELON

Henry's viburnum bears fruit that turns from red to black in late summer. It has an upright, open growth habit.

This handsome plant has year-round ornamental interest as well. In the spring months, the new foliage emerges with a bronzy cast that matures to a glossy dark green, which is held throughout the growing season. The narrow, 2 to 5 inch (5 to 13 centimeters) long leaves are serrated above the middle of the leaf and may sport attractive red petioles. During the fall, the leaves may take on a purplish-red hue—depending on sun exposure—that persists into winter. During winter, the grayish brown bark is revealed. *V. henryi* blooms in June, displaying slightly fragrant white flowers that occur in panicles that are 2 to 4 inches (5 to 10 centimeters) tall and wide. The flowers are attractive to both bees and butterflies. In July, terminal clusters of glossy red fruit appear, covering the entire plant. As the summer wanes, the red fruit matures to black.

Henry's viburnum grows best in full sun or part shade and prefers a well-drained, slightly acid, moist soil. It is not a heavy feeder, but it can be fertilized in late winter and after flowering. Applying a mulch such as composted leaves reduces the need for supplemental watering and fertilizer. No disease or insect problems causing substantial damage to the plant have been noted. The ideal propagation method is by semi-hardwood cuttings some time between late May and late June. Propagation by seed is also possible, but requires at least one cycle of warm/cold stratification and may take up to several years to germinate.

Viburnum henryi is easy to grow and fits into a variety of landscapes. It is recommended for gardens in the southeastern and northwestern sections of the United States but, since it has also performed well in the Washington, D.C., area, it is worth testing in protected sites in Zone 6 areas. Henry's viburnum makes a worthy addition to gardens and may be a more common sight in the future.

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Manchurian Fir
Abies holophylla

Paul W. Meyer

Firs are among the most beautiful of landscape conifers. However, since firs are mainly native to cool northern areas or high elevations, many of them do not grow well south of New York City or in regions where summers can be very hot. The Manchurian fir, *Abies holophylla,* is among the most heat tolerant firs and has proven itself well adapted to midwest and mid-Atlantic states. It is also one of the most handsome firs, with distinctive bright green foliage color and a wide-spreading horizontal branching pattern with age (it is more pyramidal in youth). In addition to its heat tolerance, it is exceptionally winter hardy, capable of withstanding temperatures to -30°F (-34°C).

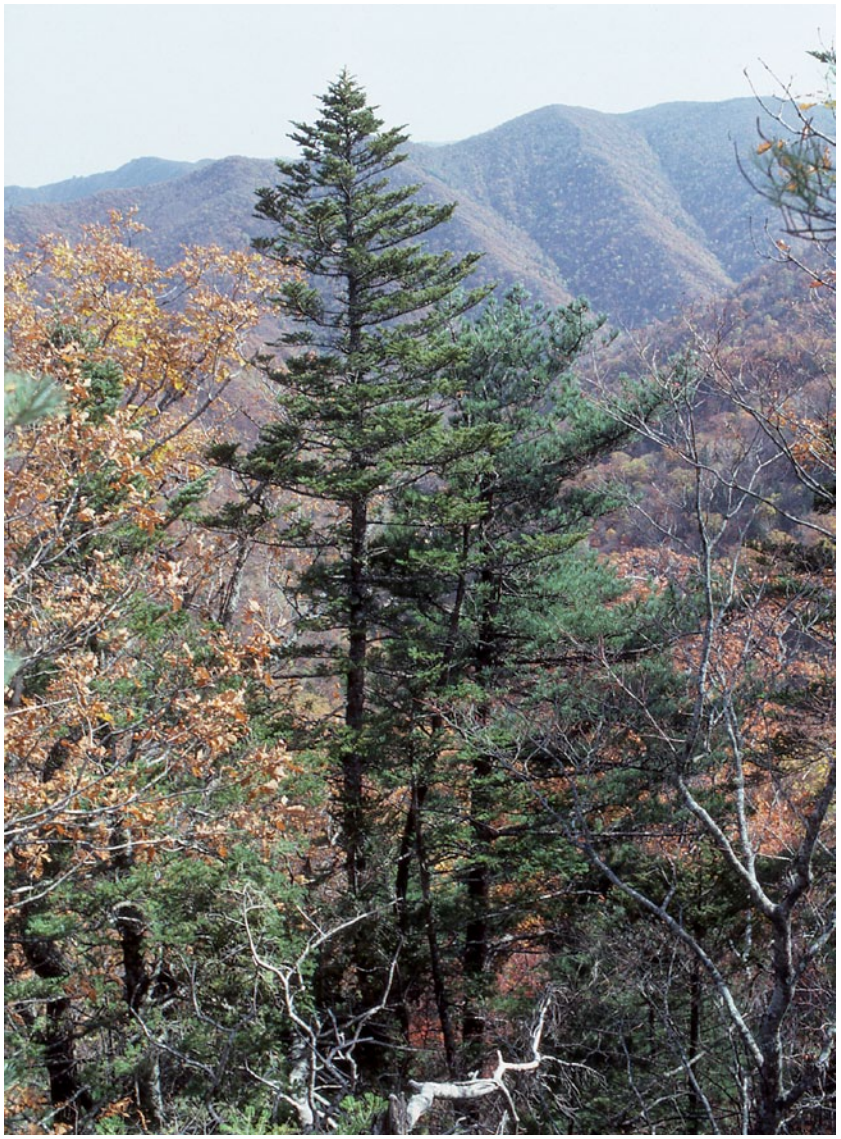
In nature, the Manchurian fir grows not only in the mountains but also at lower elevations and in valleys where it is exposed to hot summer temperatures. Its range includes North and South Korea, northeastern China, and far southeastern Russia. It often grows in association with Korean pine (*Pinus koraiensis*), Mongolian oak (*Quercus mongolica*), purplebloom (or Korean) maple (*Acer pseudosieboldianum*), and three-flowered maple (*A. triflorum*). It is among the tallest trees in the forest canopy, often exceeding 100 feet (30.5 meters). In China its wood is valued for use in construction and furniture, though it is not considered as high quality as the wood of *Pinus koraiensis.*

In the northeastern United States, with the decline of eastern hemlock (*Tsuga canadensis*) and the overuse of white pine (*Pinus strobus*) and Norway spruce (*Picea abies*), we have a need for a greater diversity of attractive, well-adapted conifers. Since it was first introduced in 1905, Manchurian fir has proven itself to be a useful, non-invasive, and adaptable landscape plant. But unfortunately it is still little known

PAUL MEYER

The growth habit and foliage of Manchurian fir.

PAUL MEYER



This tall specimen of Manchurian fir was photographed in South Korea, part of its native range.

outside of arboreta and botanic gardens. Until recently the germplasm represented in this country was narrow, not fully representing the species' geographic range in its natural habitats. Through the work of collaborative expeditions to Korea in the 1980s by institutions that later formed NACPEC, followed by the 1993 and 1997 NACPEC expeditions to Hielongjiang and Jilin Provinces, the genetic representation in North America has been expanded.

Seedlings grown from accessions collected in Korea in 1981 are thriving and are now over 25 feet (7.6 meters) tall and 22 feet (6.7 meters) across at the ground. Seedlings from other accessions collected in China in 1993 are just hitting their stride, now standing 4 feet (1.2 meters) tall. At the Morris Arboretum, seeds were treated with cold stratification for 60 days at 41°F (5°C) before sowing. The seeds then generally germinated reliably within a few weeks. We have found that the seedlings are very slow growing for the first few years, but as they get established can grow over 18 inches (45.7 centimeters) a year.

Several specimens of *Abies holophylla* have been growing well at the Morris Arboretum since before 1933. These mature specimens are over 70 feet (21.3 meters) tall and have taken on a distinctive broad-spreading horizontal habit. A prized specimen at the Morton Arboretum in Lisle, Illinois, was planted in 1939 and is considered one of their best firs. Curator Kunso Kim reports young plants from the NACPEC expeditions are also performing well at the Morton Arboretum. He observes that the Manchurian fir is relatively shade tolerant, although plants have a more open habit in the shade. Heavy clay or poorly drained soils can be problematic for firs, so planting on higher, well-drained sites is recommended.

Landscape-sized Manchurian firs are difficult to find in nurseries, but small plants are sometimes listed by specialty mail order nurseries. A diligent and patient collector will certainly be rewarded with a fine growing specimen.

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Qinling Maple, *Acer tsinglingense;* or Franchet's maple, *Acer sterculiaceum* subsp. *franchetii*

Douglas Justice

China serves up an enormous variety of plants for our gardens and landscapes, so much so that the plant explorer Ernest Henry "Chinese" Wilson famously called China "the mother of gardens." One need only think of the numbers of cultivated *Viburnum, Rhododendron,* and *Magnolia* species that hail from China to get an idea of the magnitude of temperate plant diversity there. While impressive in number, many Chinese species are too tender for cultivation in much of North America. So when a "new" cold-hardy Chinese maple comes along, it is cause for gardeners to sit up and take note. Such is the case with a maple collected in the Qinling (Tsingling) Mountains of Gansu Province during the 1996 NACPEC trip: the Qingling maple (*Acer tsinglingense*)—or Franchet's maple (*Acer sterculiaceum* subsp. *franchetii*) as it's being called in North America.

DOUGLAS JUSTICE

By either name, this maple may be a promising addition to North American landscapes.

Qinling maple is native to the mountains of Shaanxi, Henan, and Gansu provinces in north central China at elevations of 1200 to 1500 meters (3940 to 4920 feet). This area of China is an important biodiversity hot spot, with many endemic plant and animal species. Two parallel mountain ranges—the Qinling and the Daba—trend east-west, dividing the moist, subtropical to warm temperate south and the drier, cold temperate north. The northern boundary is defined by the Qinling Mountains, where temperatures are considerably cooler than in the southern Daba Mountains at the same elevation. According to the collection notes from the 1996 expedition, this species was found grow-

DOUGLAS JUSTICE

Autumn foliage color of Qinling (or Franchet's) maple.

ing on a steep stream bank alongside a variety of familiar temperate plants including *Carpinus* (hornbeam), *Malus* (crabapple), and *Cornus* (dogwood), a good indication that it should be relatively cold hardy.

Franchet's maple is found to the southwest of the Qinling Mountains but there is some debate about whether the two species are truly separable. North American botanists generally consider them the same species; however, distinctions have been noted among some individual specimens growing in cultivation. The question is, are the distinctions clear enough to warrant a split (as recommended in *Flora of China*)? According to the *Flora of China* account, *A. tsinglingense* displays three-lobed leaves with wide-spreading side lobes, while the leaves of *A. sterculiaceum* subsp. *franchetii* are of a thicker texture and have forward-pointing lobes. The young branches of Qinling maple are described as light brown (vs. darker for Franchet's), and the inflorescences, individual flowers, and samaras are smaller in Qinling maple. In gardens, *A. tsinglingense* appears to be a robust, medium-sized maple with a strong branch structure that produces an upright-spreading crown. Leaves have a papery texture and turn beautiful shades of apricot and red in autumn.

It is worth noting that cultivated plants of *A. tsinglingense*—specimens at the United States National Arboretum and the Morris Arboretum—have often been described as handsome or attractive, while those of Franchet's maple are widely dismissed as dull or coarse. Most European accounts list *A. sterculiaceum* subsp. *franchetii* as having little ornamental value, and plants at the University of British Columbia Botanical Garden grown from older seed collections made in Hubei and Sichuan Provinces (to the south and west of the Qinling collections) could also easily be described in this disapproving light. On the other hand, the response of maples to the climate in eastern North America is often manifested in neater, more compact growth and autumn leaves with more saturated colors. This could explain much of the difference, but until a wider sample—representing trees from the Qinling and beyond—are grown under the same conditions, these questions will go unanswered. Whether we are seeing a minor variant of Franchet's maple or a bona fide species in Qinling maple is an open question. More research is required to settle the science, but judging by the plants in gardens, this fine-looking maple appears worthy of wider cultivation, at least in eastern North America.

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Chinese Stewartia
Stewartia sinensis

Peter Del Tredici

PETER DEL TREDICI

This young specimen of Chinese stewartia displays multi-colored bark.

In perusing my handwritten journal from the 1994 NACPEC trip to Wudang Shan in Hubei Province, China, I found the following entries regarding the Chinese stewartia, *Stewartia sinensis:*

Monday, September 19, 1994: "The other highlight [besides finding *Acer griseum*] was to see *Stewartia sinensis*—the biggest plant I've seen of any *Stewartia*—about 30 inches [76 centimeters] in diameter at the base and 50 feet [15 meters] tall, with a clear bole for the first 20 to 30 feet [6 to 9 meters]. The bark was a buff/tan color—carried high up into the crown—and absolutely smooth with little or no flaking. Certainly the most magnificent tree I saw on Wudang Shan. It should also be noted that a spot right next to the *Stewartia,* above it to be precise, was selected as a site for a public toilet—and it was disgusting to the point that no one but me dared to go near the tree. Perhaps that is the secret to its vigor."

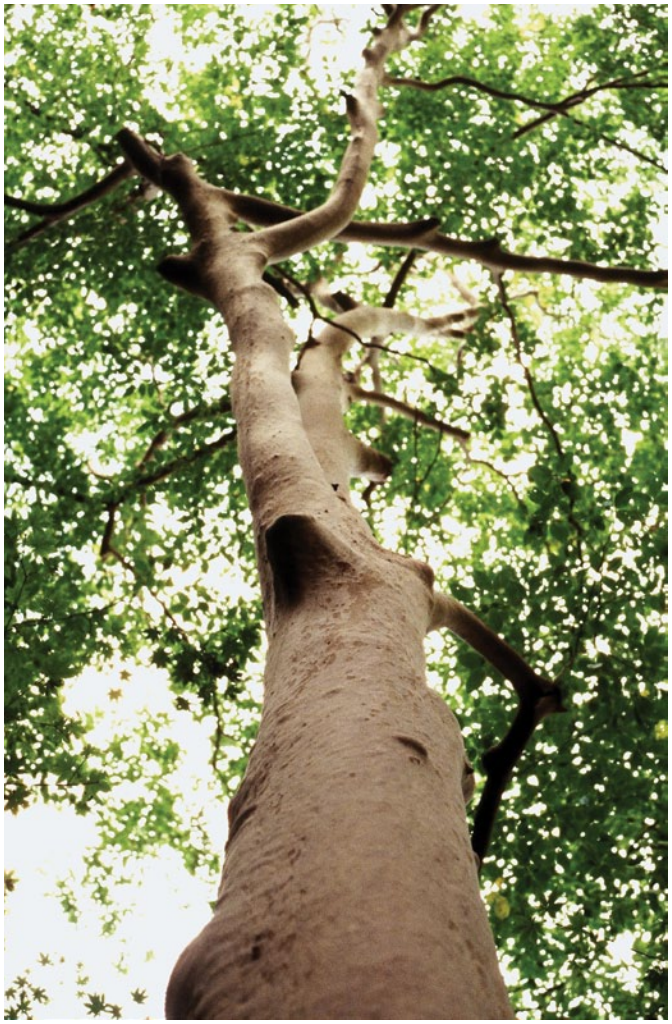
Tuesday, September 20, 1994: "Up the mountain again, then a quick turn to the east at about 1300 meters [4,265 feet] and off into the woods. It was misty and rainy the whole day, giving the whole place a great air of mystery… The rain and heavy fog limited our visibility pretty much to what was immediately beside the path—but there was so much. After about an hour or so on the path, we came upon an incredible house nestled under the cliffs. It looked like it had been there forever—no one was around so I took a few pictures. It really felt like the same China that Wilson saw. A little ways beyond the house and garden we came to a bend in the road where it looped back into a ravine. Our guide, Mr. Zeng, a collector of medicinal plants among other things, pointed out a beautiful specimen of *Stewartia sinensis,* and then we saw another, both with the beautiful, rich, smooth, cinnamon-red bark—a wonder to behold and to touch! *Cornus kousa* was there too, and a small (4 inch [10 centimeter] diameter) specimen of *Acer griseum.* All within the narrow space of ten square meters—I felt as though I'd died and gone to horticultural heaven. The only thing missing, sadly, was seeds on any of the plants. The conditions were moist and shady and steep, with an oak overstory."

It was in this location—Hubei Horticultural Heaven we called it—that I noticed a small *Stewartia* seedling, about 20 centimeters (8 inches) tall with a distinct kink at its base, growing along the edge of the path. I immediately stopped and dug it up while the other

PETER DEL TREDICI

Chinese stewartia blooms in midsummer.

PETER DEL TREDICI



A mature specimen in China shows smooth, sandstone-colored bark.

members of the party went on ahead. At the end of the expedition, the plant was washed clean of soil and packed in moist sphagnum moss for shipment back to the United States. The plant passed inspection at the USDA inspection station at Beltsville, Maryland, and, after 48 days on the road, arrived at the Arnold Arboretum on November 7, 1994. It was immediately potted up, assigned the accession number 691-94, and left to overwinter in a cool greenhouse.

The seedling was moved to the outdoor nursery in spring 1996, and it grew to a height of 1.1 meters (3.6 feet) by the end of July. In spring 2000, it was moved from the nursery to the grounds, where it has proved to be completely hardy. By the end of the 2009 growing season, the plant was 4.7 meters (15.4 feet) tall and 4.1 meters (13.5 feet) wide with two co-dominant trunks arising from the stout base which is 14 centimeters (5.5 inches) in diameter. The plant flowered for the first time in the summer of 2002 and has gone on to flower every year since. The flowers, which are produced from the end of June through mid July, are 6 to 7 centimeters (2.4 to 2.8 inches) across with beautiful light lemon yellow anther filaments and short pedicels, indicating that it is *S. sinensis* var. *sinensis* according to the *Flora of China*. In Boston, the new leaves emerge in early May and are distinctly hairy and tinged with red anthocyanin pigment; both features disappear within a week or so. The bark is cinnamon-red where it is not exfoliating and olive-green where the bark has peeled off in fine, papery flakes. Over time, I'm sure the tree will develop mature bark that is "smooth as alabaster and the colour of weathered sandstone" (to quote W. J. Bean), like the magnificent specimen we saw on Wudang Shan.

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Chinese Chinquapin
Castanea henryi

Sandra L. Anagnostakis

ARCHIVES OF THE ARNOLD ARBORETUM

E. H. Wilson made this photograph of a large *Castanea henryi* growing in Hubei Sheng, China, on June 22, 1910.

Charles Sprague Sargent wrote a beautiful description of this chestnut tree in his *Plantae Wilsonianae* in 1917. He also revised the taxonomy to the name that we still use today. Here is an excerpt from his article:

> "This very distinct species is distributed from the neighborhood of Ningpo through the valley of the Yangtsze River as far west as Mt. Omei. On the mountains of western Hupeh and of eastern Szech'uan it is common in woods. This chestnut grows to a larger size than any other Chinese species and trees from 20 to 25 meters [66 to 82 feet] tall with trunks from 1 to 3 meters [3.3 to 9.8 feet] are common. Occasionally trees 30 meters [98.4 feet] tall and 5 meters [16.4 feet] in girth of trunk are met with. The leaves are green on both surfaces and entirely glabrous except for a few appressed hairs on the underside of the primary and secondary veins. The leaves are without lepidote glands except on the upper surface of the very young leaves, from which they disappear very early. Although variable in size the leaves are very characteristic; they are always caudate-acuminate and broadest below or at the middle, and the secondary veins are projected in long aristate points. The shoots are dark-colored and quite glabrous and the winter-buds are brownish, short, broadly ovoid, obtuse or subacute and are glabrous or nearly so. The styles vary in number from 6 to 9, and the fruit may be solitary or two or three on a short spike. The spines of the ripe involucre are sparsely villose. All the fruits we have seen contain a solitary nut, but it is probable that occasionally two occur, as they do in the American *C. pumila*."

My interest in this species was piqued when I saw a large planting of it at Callaway Gardens in Hamilton, Georgia. Founder Cason J. Callaway was very interested in chestnuts, and in 1935 he began planting chestnut trees from Asia procured by the United States Department of Agriculture's plant exploration and importation program. Over a period of eight years, he planted 2,192 chestnuts, and among them were 202 *Castanea henryi* from eight different locations in China. I visited the chestnut plantings at Callaway Gardens in 1993 with Dr. Jerry Payne and Ann Amis from the USDA. We noticed that most of the chestnuts were badly damaged by the Asian chestnut gall wasp that Dr. Payne had discovered and described in 1976, shortly after a chestnut grower accidentally brought it to central Georgia. Within one

PAUL MEYER

This Morris Arboretum specimen of *Castanea henryi* (WD-069) was grown from seed collected in Wudang Shan on the 1994 Hubei expedition. It flowers heavily and bears sweet-tasting nuts that are quickly devoured by squirrels, deer, and other wildlife.

PAUL MEYER

Developing nuts are enclosed in prickly involucres.

of the plantings we came to a block of what I thought were Japanese chestnuts (*C. crenata*) and noticed that there were no galls. A check of the planting plan revealed that these were *C. henryi*, and all plants that we saw of this species had either very few or no galls.

Finding a chestnut species that was clearly resistant to gall wasp presented an opportunity to breed resistance into our orchard and timber chestnut lines (*C. henryi* is also resistant to chestnut blight). We have one mature *C. henryi* here at the Connecticut Agricultural Experiment Station, but others planted over the years have not been winter-hardy enough to survive. Seeds that Wilson collected were planted at the Arnold Arboretum, but no trees from this accession (AA-551) now survive. However, one open-pollinated offspring (a probable cross with a nearby Chinese chestnut, *C. mollissima*) is still alive and well (AA-623-32).

Since that discovery of gall wasp resistance in Georgia, I have been including *C. henryi* in my crosses to produce better timber and nut-producing chestnut trees for our northeastern forests and orchards. We don't know what pest or disease of chestnuts will next be brought into the United States, but it is clear that imported chestnut species will be called into use in hybridization to combat these new threats. All the more reason to say "Keep exploring, NACPEC!"

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ERRATUM 15 December 2010: The specimen shown in the two images above has been identified as a *Castanea* hybrid rather than straight species *Castanea henryi.*

Epimediums *Epimedium* spp.

Carole Bordelon

CAROLE BORDELON

***Epimedium stellulatum* bears starry white flowers.**

CAROLE BORDELON

***Epimedium lishihchenii* has long-spurred yellow flowers.**

Although the vast majority of the plants targeted for collecting by NACPEC are trees and shrubs, several genera of herbaceous plants have been targeted as well. Since China is the major area for the diversity of epimediums (*Epimedium* spp.), it made perfect sense to target this group of adaptable perennials. Thirteen accessions of epimedium were collected during NACPEC trips, several of which are highly ornamental and should be recognized as worthy plants for the shade garden.

In the fall of 1994, members of the NACPEC expedition to the Wudang Shan mountain range located in central China (which is famous for its exceptionally rich and diverse flora) collected several noteworthy accessions of epimedium. This was a historically significant trip as there were many new species of epimedium being described in China at the same time. With the help of Darrell Probst, an expert in the collection, identification, and introduction of epimediums, those 1994 Wudang Shan epimedium accessions were correctly identified and, more importantly, several of them proved to be new species not represented in the NACPEC members' institutional holdings. *Epimedium lishihchenii* and *Epimedium stellulatum* are just two of the species identified from that trip.

Epimedium lishihchenii is an attractive plant hardy to at least USDA Zone 4 (average annual minimum temperature -20 to -30°F [-28.9 to -34.4°C]). It has a running habit and reaches 12 inches (30.5 centimeters) in height. The large evergreen leaflets are leathery and sustain little damage in the winter months. It has bright yellow flowers with elongated spurs, and blooms in late April or early May. Although the flowers are attractive, this plant's best quality is the

foliage. It remains fairly clean throughout the growing season. In the winter, the foliage may be tinged with an attractive burgundy color.

Like *Epimedium lishihchenii*, *Epimedium stellulatum* is an evergreen species hardy to Zone 4. It has a clumping habit and is smaller in stature than *Epimedium lishihchenii*. *E. stellulatum* blooms early in the season, revealing small white starlike flowers that are held above the leaves on erect stems. Though it is considered to be evergreen, it has sustained more winter damage to the foliage at the United States National Arboretum than *Epimedium lishihchenii*. During the 1996 NACPEC expedition to the Quinling Mountains, several additional accessions of *Epimedium stellulatum* were collected. These additional accessions have leaflets that are slightly larger and narrower than the 1994 *Epimedium stellulatum* collection.

The epimediums that hail from China occur primarily in woodlands in temperate hilly or montane regions. Keeping this in mind, they do best in moderately cool and half shady conditions. They thrive best in a moist but well drained soil and will tolerate periods of drought provided their roots are not exposed. They benefit from being mulched with leaf mold. Epimediums are best propagated by division.

Epimediums make excellent landscape plants because they can grow in a variety of situations and are easy to care for. Depending on the species, they thrive in sun or full shade and can provide year-round interest in gardens.

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CAROLE BORDELON

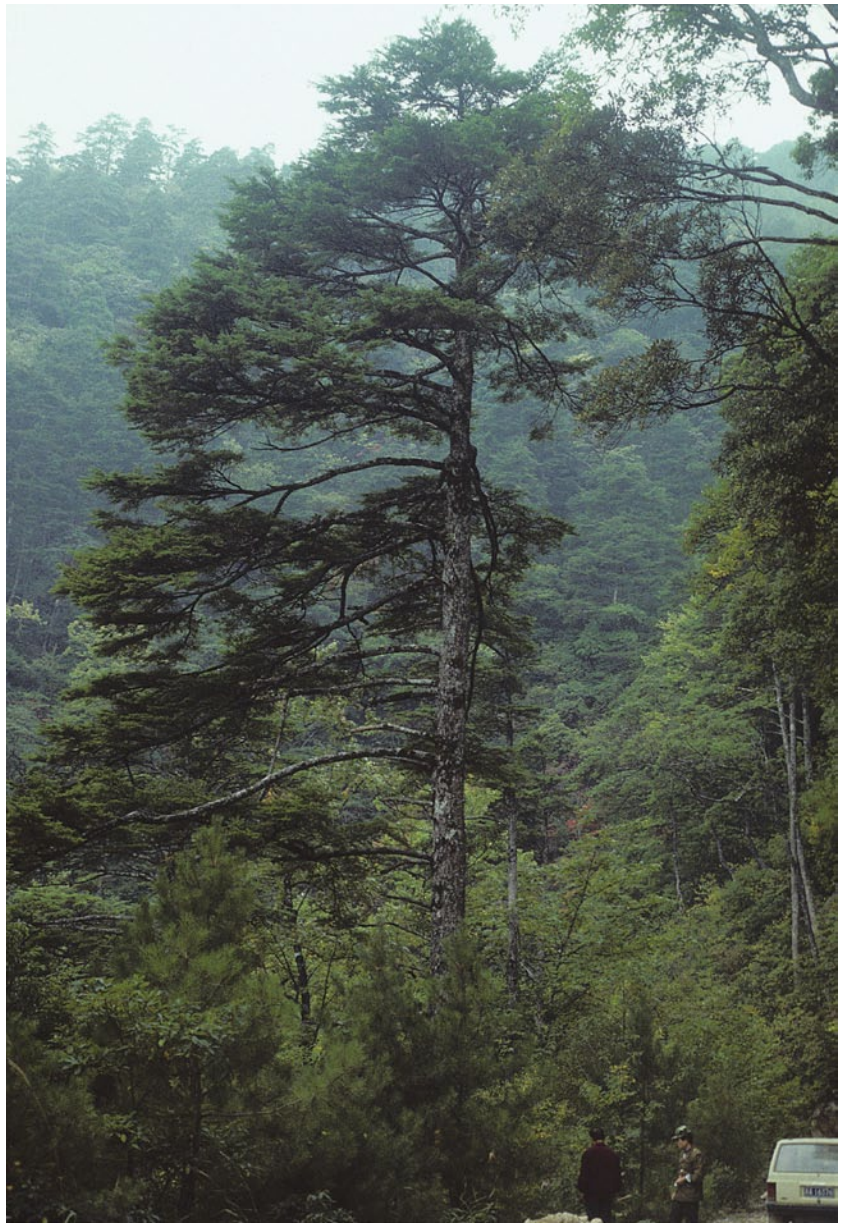
Glossy, leathery foliage is an ornamental feature of *Epimedium lishihchenii*.

Chinese Hemlock
Tsuga chinensis

Peter Del Tredici

One of the most important of all NACPEC collections is the Chinese hemlock (*Tsuga chinensis*). Prior to 1979, this species appears to have been successfully introduced into North America only once—a single seedling collected by E. H. Wilson in Hubei, China, in 1910 that is still alive today. This accession has been frequently propagated and widely distributed by the Arnold Arboretum. The lack of Chinese hemlock diversity became a significant factor when horticulturists began to notice that the species was highly resistant to the Japanese strain of hemlock woolly adelgid (HWA) that was ravaging native stands of eastern hemlock (*Tsuga canadensis*) throughout the central and southern portion of its range in eastern North America.

Working through its various Chinese contacts, NACPEC began a concerted effort to acquire Chinese hemlock germplasm in order to facilitate research on its growth rate, habitat tolerances, and resistance to HWA. The collections began in 1994 with seeds provided by the Xian Botanical Garden and peaked in 1996 with 6 separate collections from various habitats in the Qinling Mountains in Shaanxi Province, the northern part of



RICK LEWANDOWSKI

A specimen of *Tsuga chinensis* var. *tchekiangensis* growing in Jiangxi.

PETER DEL TREDICI

***Tsuga chinensis* growing in montane habitat.**

its range. In all, some 33 different collections of three different varieties of the species were made. Representatives from 19 of these collections—totaling some 250 plants—are growing at various NACPEC gardens. The largest of them is at the Morris Arboretum and has reached 4.9 meters (16 feet) in height with DBH (diameter at breast height) of 9 centimeters (3.5 inches) after 10 years of growth. True to initial reports, Chinese hemlock has so far proved completely resistant to HWA in a wide variety of North American locations. It is fully cold hardy into USDA Zone 5 (average annual minimum temperature -10 to -20°F [-23.3 to -28.9°C]) and is relatively fast growing—the mean height of 38 seedlings growing under variable conditions on Hemlock Hill at the Arnold Arboretum was 169 centimeters (66.5 inches) at 10 years of age.

I observed Chinese hemlock at the Arnold Arboretum during the 2009 growing season and noted that the species both began growing and stopped growing about two weeks earlier than eastern hemlock. Interestingly, the new growth on vigorous terminal shoots was the same for both species—about 45 centimeters (17.7 inches)—which was the greatest among the seven hemlock species measured. Compared to eastern hemlock, Chinese hemlock is a bit

PETER DEL TREDICI

Slightly drooping branch habit on a young Chinese hemlock.

PAUL MEYER

Attractive foliage of Chinese hemlock.

"droopier" during the growing season, seems to be comparably shade tolerant (although this trait has not actually been quantified), is less cold hardy—Zone 5 versus Zone 3 (average annual minimum temperature -30 to -40°F [-34.4 to -40°C])—and, as mentioned, has the great advantage of adelgid resistance. It is a terrific plant for replacing adelgid-killed eastern hemlocks under cultivated conditions.

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Amur Maackia
Maackia amurensis

Paul W. Meyer

One of our most important plant exploration goals is collecting tree species that demonstrate stress tolerance and are therefore likely candidates for evaluation as urban street trees. *Maackia amurensis* is outstanding in its promise as a tough and useful urban tree. It is native over a wide geographic area including Japan, the Korean peninsula, northeast China, and far eastern Russia. It is a member of the legume family (Fabaceae) and it is one of the relatively few trees that support nitrogen fixing bacteria on its roots. Although it was introduced to the United States in the late nineteenth century, it is still relatively rare here.

In cultivation *Maackia amurensis* is a medium-sized tree reaching 45 feet (13.7 meters) or more (we were surprised to see specimens in China growing well up into the forest canopy, taller than the species is usually reported to grow). It has compound leaves similar to its relative, black locust (*Robinia pseudoacacia*). As the leaves emerge in the spring they are covered with silky hairs which give the tree a silvery-gray appearance.

PAUL MEYER

A 40-foot tall specimen of Amur maackia at the Morris Arboretum.

PAUL MEYER

This Amur maackia in China managed to survive in difficult soil conditions with highly variable moisture levels, an indicator that the species may perform well as an urban street tree.

PAUL MEYER

Newly emerged foliage of Amur maackia has a silvery sheen.

Upright racemes of small cream-colored flowers appear in July, a time when few other trees are blooming. Amur maackia's bark is slightly exfoliating with handsome shades of copper and tan. It is especially striking when backlit.

Professor Jin Tieshan of the Heilongjiang Academy for Forestry reported that Amur maackia's dark-colored wood is very valuable and in the 1990s it was commonly exported to Japan. He also pointed out that on twigs the young sapwood is a light greenish tan, while the older heartwood takes on a dark brown color. The wood is exceptionally hard and rot resistant; traditionally, it has been used for fencing in China, similar to the use of black locust wood in the United States.

NACPEC explorers collected 3 accessions of this species in 1993 in Heilongjiang. Collection HLJ085 was made along Jiang Po Lake, where it grew along the high water line in thin, sandy soils overlaying rock. It was clear that the trees had to tolerate wet soils when the water levels were high and then very droughty conditions when the water level dropped. Adaptability to these kinds of natural conditions suggests that this species might also be adapted to the periodic root flooding and droughts that plague urban street trees. At another site in Heilongjiang, small, stunted Amur maackias were growing on a rocky, ancient lava flow along a stream edge. This area was subject to alternating periods of flooding and drought. Few other woody plants could survive there, but these trees were able to withstand the difficult environment, growing out of fissures in the rock.

We tried two different treatments to soften the hard outer coats of Amur maackia seeds from collection

PAUL MEYER

Amur maackia bears upright racemes of creamy white flowers in midsummer.

PAUL MEYER

Clean green foliage and exfoliating bark add ornamental appeal to Amur maackia.

HLJ051. One group of seeds was given a 24-hour soak in hot water and a second group of seeds was scarified in sulfuric acid before being sown. Both treatments resulted in excellent germination.

Three 16-year-old specimens are growing near my home on the grounds of the Morris Arboretum. These Amur maackias stand 18 feet (5.5 meters) tall and are 5 inches (12.7 centimeters) DBH (diameter at breast height). They have attractive foliage, flowers, and bark, and are handsome in every season of the year. They are growing on a hot, sunny, south-facing slope and have never exhibited stress in times of drought. *Maackia amurensis* is certainly proving itself to be a handsome, tough, adaptable shade tree that should be used more widely in stressful urban sites.

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Farges Filbert
Corylus fargesii

Anthony S. Aiello

One of the goals of plant exploration is to introduce new species into cultivation, and it is a rare and exciting opportunity for any plant collector to do so. *Corylus fargesii* (Farges filbert) was first described in China by Western botanists in the late 1800s and early 1900s. Although herbarium specimens were collected during this "golden age" of plant exploration, there is no evidence that living specimens were grown in arboreta and botanic gardens from these early collections. The first NACPEC collection of *C. fargesii* occurred on the 1996 expedition to Shaanxi and Gansu, and it was collected again on the 2005 expedition to Gansu (identified by collector numbers QLG-231 and NACPEC05-047, respectively). Until the introduction of Farges filbert seeds to the United States in 1996, little was known or written about this species.

ANTHONY AIELLO

The attractive pyramidal form of Farges filbert.

Of the many taxa collected by NACPEC over the past twenty years, few arouse more excitement than *Corylus fargesii.* The trees display exfoliating tan and copper bark that rivals the most attractive birches and is especially reminiscent of river birch, *Betula nigra.* According to the *Flora of China,* Farges filbert grows to 40 meters (131 feet) tall and occurs naturally in mountain valley forests at elevations from 800 to 3000 meters (2,625 to 9,843 feet) in southern Gansu, Guizhou, Henan, Hubei, Jiangxi, southern Ningxia, Shaanxi, and northeast Sichuan (Chengkou Xian). During the 1996 expedition, Farges filbert was collected in eastern Gansu at the Xiao Long Shan Forest Bureau, Dang Chuan Forest Station. In their field notes, the collectors described it as a truly beautiful tree with exquisite bark. The parent trees had reached 12 to 15 meters (39 to 49 feet) tall and were found growing among rocks in sandy silt loam soil approximately 2 meters (6.6 feet) above a stream in open woodland.

ANTHONY AIELLO

Farges filbert displays exfoliating bark similar to that of river birch.

On the 2005 NACPEC expedition to southern Gansu, on a morning when we shared our hike through pastures and woodland with numerous cattle, we were fortunate to encounter and collect *C. fargesii* in Zhou Qu county, near the Sha Tan Forest Station. The parent plants were growing in a mesic mixed deciduous forest and were located a few meters above a stream. Many *C. fargesii* were seen throughout a small area; all of these trees had been heavily coppiced but had resprouted vigorously. As in 1996, we were impressed by the beautiful exfoliating bark.

Corylus fargesii is now well established at all of the NACPEC member gardens and in several other North American public gardens. Trees from the 1996 collection are doing especially well at the Morris Arboretum, where we have 10 plants from this accession, all of which show remarkably similar growth habit and size. These trees have grown quickly, reaching 25 to 30 feet (8 to 9 meters) after 13 years, with strong central leaders and very uniform broadly ovate habits. The trees exhibit some variation in the level of exfoliation and color of the bark, which ranges from a deep copper to a pale cream color. Farges filbert has clean summer foliage with no insect or disease problems, and turns a good yellow in autumn. Our plants are growing in several locations, with slight differences in soil pH and all with evenly moist, well-drained soils.

Farges filbert has been propagated successfully from seeds and by grafting, but with only marginal success from stem cuttings. The diversity of conditions under which it is growing successfully indicates broad adaptability from the central Midwest to New England and south to the mid-Atlantic states. The species appears to be fully cold hardy in USDA Zones 5 through 7 (average annual minimum temperatures -20 to 0°F [-29 to -18°C]). This tree's highly ornamental exfoliating bark and rapid growth rate indicate great potential as an ornamental tree for a range of situations, and it promises to be an excellent addition to landscapes in the future.

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Chinese Ashes
Fraxinus spp.

Kris R. Bachtell and Olivia Siegel

Since its discovery in Detroit, Michigan, in 2002, the emerald ash borer (EAB), *Agrilus planipennis,* is estimated to have killed over 40 million ash trees in southeastern Canada and in 14 states throughout the central and eastern United States. Native to Asia, EAB probably arrived in North America by ship in solid wood materials used for packing freight. This insect's impact has cost municipalities, property owners, nursery operators, and the forest products industry tens of millions of dollars. It appears that no North American ash species is resistant to this pest, so all are threatened—there are an estimated 8 billion ash trees currently growing in the United States.

On the few ash species that have been studied in China, EAB is usually a secondary or periodic pest, infesting only stressed trees and not necessarily resulting in tree mortality. Most outbreaks in China have been associated with urban and restoration plantings involving North American species, particularly green ash (*Fraxinus pennsylvanica*) and velvet ash (*F. velutina*), both of which have been extensively planted in many northern Chinese cities.

It is extremely important to gain access to *Fraxinus* species from China to test the full range of EAB response and to assess the adaptation of Asian ash species to American conditions and their appropriateness for urban landscapes. There are 22 Fraxinus species listed in the *Flora of China.* Some of these species are tropical, and therefore not suitable for regions of the United States currently under siege by EAB, but they are of potential utility for expanding the range of ash adaptation or for responding to EAB if the pest proves to be adapted to tropical or subtropical areas in the New World.

During previous NACPEC expeditions, collecting *Fraxinus* species had not been a primary focus. Typically, there were too many other more exciting species to collect and there was no reason to focus on ash. With the invasion of EAB this changed. A 2006 NACPEC-sponsored grant request was funded by the USDA and supported contract collecting of native *Fraxinus* seeds in China by Kang Wang of the Beijing Botanic Garden from 2007 through 2010. Addi-

KRIS BACHTELL

Collecting seeds of Manchurian ash (*Fraxinus mandshurica*) in China.

KRIS BACHTELL

***Fraxinus insularis* foliage and seeds.**

tionally, the 2008 NACPEC expedition to Shaanxi Province focused on collecting *Fraxinus* in the botanically rich Qinling mountain region. We collected several thousand seeds of five *Fraxinus* species there. Several of these species are poorly represented in the United States; for example, Pax's ash (*F. paxiana*) and island ash (*F. insularis*) are being grown at only two or three botanical institutions. We made several collections of these species, along with Chinese ash (*F. chinensis*), Manchurian ash (*F. mandshurica*), and Chinese flowering ash (*F. stylosa*). Of these, Manchurian ash is probably the best known, since it is a large-growing tree with an established landscape value (the cultivated selection 'Mancana' is common in the nursery industry). Other species, such as island ash and Chinese flowering ash, are medium-sized trees that may have urban use potential if they prove adaptable. Pax's ash is a shrubby species that possesses extremely large flower clusters, but its landscape potential is unknown.

Twenty-six *Fraxinus* seed collections have been made in China, resulting in 11 different taxa currently represented by over 600 plants. Ash seed is relatively easy to harvest, clean, and germinate, so the degree of success growing these plants has been good. Surplus seeds will be preserved in the USDA's germplasm repository in Ames, Iowa, and made available for scientific research throughout the world. Currently, plants from the 2008 Shaanxi expedition are being used by leading researchers in efforts to identify relative susceptibility and resistance of different ash species to EAB. The seed collections will also aid research in identifying appropriate genetic material to create new North American-Asian ash hybrids that combine resistance genes from the Asian species with useful characteristics from the North American species. Researchers Koch et al. recently cited the importance of the NACPEC *Fraxinus* collections to their genetics and breeding efforts, noting that the previous lack of Asian ash accessions in the United States had greatly restricted the potential for hybridization. Future collecting expeditions are planned and many additional research questions related to EAB still need to be answered.

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Manchurian Catalpa
Catalpa bungei

Richard T. Olsen and Joseph H. Kirkbride, Jr.

Familiarity breeds contempt—for catalpa. The genus has nine accepted species, two in eastern North America, four in the West Indies, and three more in eastern Asia. The North American species (*Catalpa bignonioides* and *C. speciosa*) are the best known in the West, often overlooked as waifs in urban landscapes or as country trees, too large or messy for modern landscapes, yet tolerated when in flower in late May to June. Perhaps this sentiment permeated the group conscience on NACPEC's 1994 Wudang Shan expedition, when, on the first day of collecting, they were underwhelmed by Kevin Conrad's sighting of a lone pollarded catalpa in a field of soybeans and corn. Conrad, representing the United States National Arboretum (USNA), was on his first expedition to China, the wide-eyed and energetic newbie in a field of veteran collectors. Reluctantly, the group stopped to collect seed and vouchers of what was identified as the Manchurian catalpa, *Catalpa bungei.* As it turned out, it was the only catalpa seen on the trip and proved to be one of the most important collections of the expedition.

In 1831, Alexander Andrejewitsch von Bunge collected herbarium specimens of a catalpa near Beijing, which C. A. Meyer later identified and described as a new species, and named in honor of Bunge. *Catalpa bungei* and *C. ovata* are the two most commonly cultivated species of catalpa in China, both in agroforestry for their high quality wood and in religious circles as one of the "jeweled trees" of Chinese Buddhism. There is much research published in Chinese journals on propagation, breeding behavior, and sylviculture of *C. bungei,* but this emphasis on its importance has not filtered to the West, where appreciation for the species is lacking. Early introductions of catalpa into Europe were erroneously ascribed to this new species, even as they came into flower with upright, many-flowered panicles of small yellow or yellowish-green flowers that clearly identified them as *C. ovata.* The inflorescences of *C. bungei* are corymbose, with fewer but larger flowers conspicuously spotted with pink, effectively coloring the flowers rose. The first introduction of true *C. bungei* is attributed to the Arnold Arboretum in 1904, when wild-collected seeds were acquired (via American diplomat E. T. Williams) from the vicinity of Beijing. These seeds—and subsequent plants—were distributed to European botanical institutes, but the species remains almost nonexistent in cultivation, a victim of confusion generated by earlier misidentifications. The Arnold Arboretum still has a living plant of this accession (AA#12927), which has stood sentinel above the lilac collection for over a century.

The great plant collectors E. H. Wilson and F. N. Meyer did not overlook catalpa on their forays across China in the early twentieth century. Wilson, collecting for the Arnold Arboretum, never knowingly collected *C. bungei,* but based on herbarium specimens from his trips, his collections of *C. fargesii* (syn. *C. duclouxii*) are a mixed bag of phenotypes, some of which agree with *C. bungei.* But Meyer, collecting for the USDA, collected what he labeled *C. bungei* on five separate occasions, calling the species "one of the finest flowering trees in the world". The taxonomy of these species is not well resolved, but based on recent phylogenetic analyses, this group forms a clade separate from the North American and West Indian species. The USNA conducts on-going taxonomy and breeding work in the genus *Catalpa,* and *C. bungei* has taken center stage, thanks to its beautiful flowers, disease resistant foliage, and general adaptability. In our search for germplasm to introduce into our breeding program, we have scoured both domestic and foreign nurseries for material of *C. bungei* and related species.

We have yet to find a nursery offering the real *C. bungei*. Our search of botanical gardens and arboreta yielded only three accessions in North America that are true-to-type, two of wild origin: the original *C. bungei* 12927 at the Arnold, and *C. bungei* WD009 from the Wudang Shan trip in 1994. Unknowingly, NACPEC had made the first collection of *C. bungei* in 90 years, providing germplasm for urban tree breeding and increasing our knowledge of an underutilized and underappreciated genus.

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An herbarium specimen from the lone *Catalpa bungei* collected in Wudang Shan during the 1994 NACPEC expedition to Hubei, showing its foliage and long seed pods (bent to fit on sheet). *Facing inside back cover:* Manchurian catalpa (*Catalpa bungei*) bears lovely rose-tinted flowers. Photo by Richard Olsen.