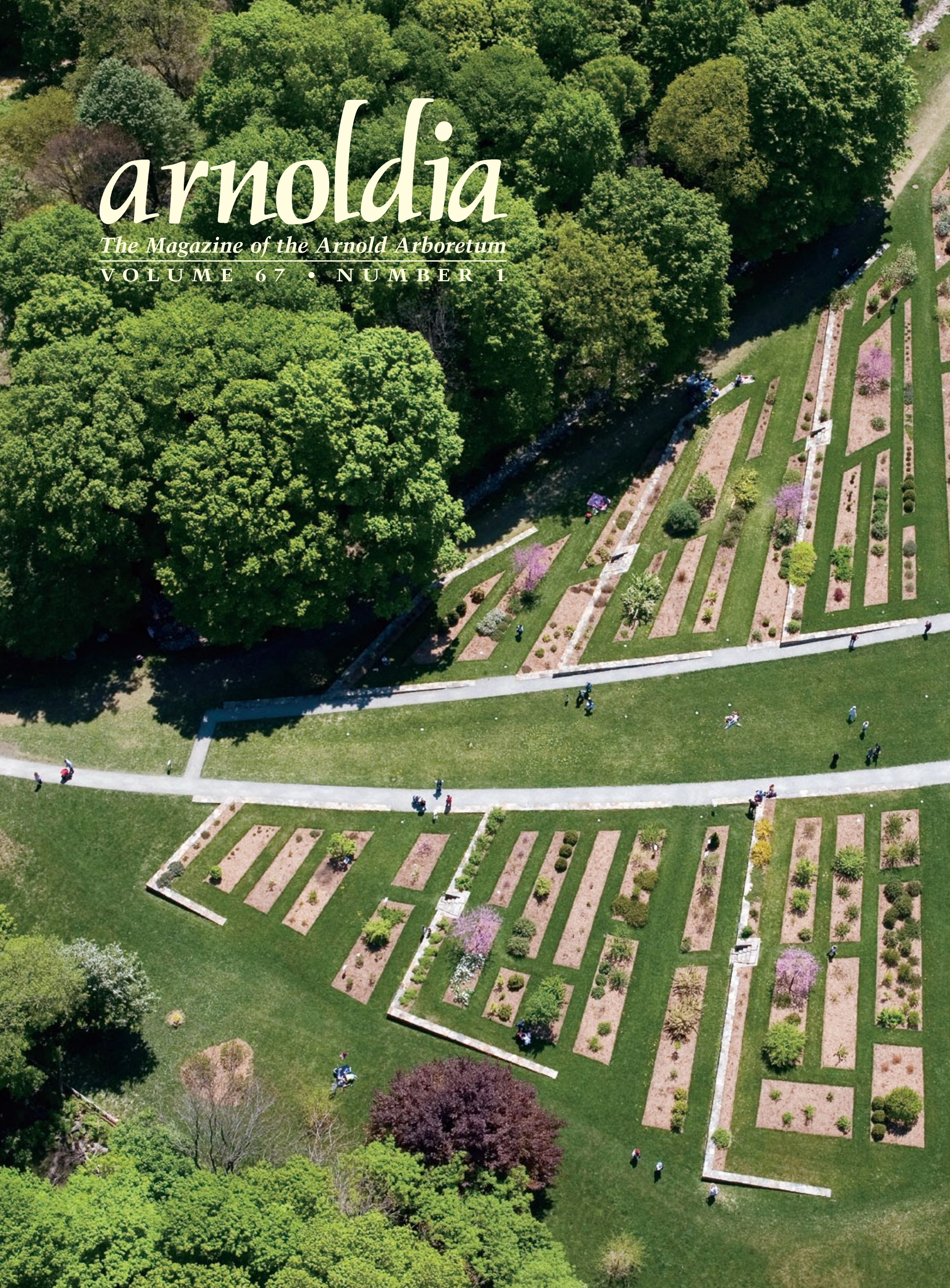
arnoldia

The Magazine of the Arnold Arboretum

VOLUME 67 • NUMBER 1



arnoldia

The Magazine of the Arnold Arboretum

VOLUME 67 • NUMBER 1 • 2009

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.

Arnold Arboretum members receive a subscription to *Arnoldia* as a membership benefit. To become a member or receive more information, please call Wendy Krauss at 617.384.5766 or email wendy_krauss@harvard.edu.

Postmaster: Send address changes to

Arnoldia Circulation Manager
The Arnold Arboretum
125 Arborway
Boston, MA 02130–3500

Nancy Rose, *Editor*
Andy Winther, *Designer*

Editorial Committee
Peter Del Tredici
Michael S. Dosmann
Jianhua Li
Richard Schulhof

Copyright © 2009. The President and Fellows of Harvard College

The ARNOLD ARBORETUM of HARVARD UNIVERSITY

CONTENTS

Front cover: Aerial photography has provided fascinating views of the Arnold Arboretum over many years, as evidenced in Sheila Connor's article. Here, the Leventritt Shrub and Vine Garden is seen from the air in May, 2005. Photo by Jay Connor.

Inside front cover: A close-up showing the lacy inflorescences of this issue's profiled plant, *Hydrangea paniculata* 'Praecox'. Photo by John H. Alexander III.

Inside back cover: Curatorial Fellow Sue A. Pfeiffer describes the history and ornamental features of the Arnold Arboretum introduction *Hydrangea paniculata* 'Praecox', seen in photographs from about 1930 (upper left; Arnold Arboretum Archives), 1988 (upper right; John H. Alexander III), and about 1996 (lower; Peter Del Tredici).

Back cover: Though not well known today, quince was once an important orchard fruit. This 1909 botanical illustration of 'Champion' quince by Amanda A. Newton is one of a series of detailed pomological watercolors commissioned by the USDA in the late nineteenth and early twentieth centuries. The collection is now housed at the National Agricultural Library in Beltsville, Maryland.

Cydonia oblonga: The Unappreciated Quince

Joseph Postman

The quince of Persia attains a weight of 1.5 kilos (more than 3 pounds), ripens on the tree or in the store, and can be eaten like a soft ripe pear, according to a report in *The Horticulturist, and Journal of Rural Art and Rural Taste* of 1849 (Meech 1908).

That description hardly fits the quince known in America today, or rather the quince which is hardly known today. During Colonial times a quince tree was a rarity in the gardens of wealthy Americans, but was found in nearly every middle class homestead (Roach 1985). The fruit—always cooked—was an important source of pectin for food preservation, and a fragrant addition to jams, juices, pies, and candies. However, by the early twentieth century quince production declined as the value of apples and pears increased. Today's consumers prefer the immediate gratification provided by sweet, ready-to-eat fruits. After Charles Knox introduced powdered gelatin in the 1890s the use of quince pectin for making jams and jellies declined. U.P. Hedrick lamented in 1922 that "the quince, the 'Golden Apple' of the ancients, once dedicated to deities and looked upon as the emblem of love and happiness, for centuries the favorite pome, is now neglected and the least esteemed of commonly cultivated tree fruits." (Hedrick 1922)

Luther Burbank took credit for transforming this neglected fruit from a commodity that was "altogether inedible before cooking" into a crop he likened to the best apple. He half-jokingly cited a formula to make quince fruits edible prior to his breeding efforts: "Take one quince, one barrel of sugar, and sufficient water…" (Whitson et al. 1914). Burbank released several improved cultivars in the 1890s that he hoped would raise the status of the fruit. Two Burbank cultivars, 'Van Deman' and 'Pineapple', are important commercially in California today, but overall quince fruit production in the United States is so small that it is not even tracked by the USDA National Agricultural Statistics Service (McCabe 1996; USDA 2009b). While underappreciated here, these Burbank quinces have found their way to other parts of the world where they are among the handful of cultivars considered worthy of production (Campbell 2008).

Burbank's 'Pineapple' quince as seen in a photograph from the 1914 multi-volume publication *Luther Burbank, His Methods and Discoveries and Their Practical Application.*

In 1908, Meech described 12 quince varieties important in the United States at the time, although some

The attractive flowers and foliage of quince.

like 'Orange' (syn. = 'Apple') were as often as not grown from seed rather than propagated as clones. Quince is easily grown from either hardwood or softwood cuttings, and is readily grafted onto another quince rootstock. Although it is an important dwarfing rootstock for pear, quince should not be grafted onto pear roots because this reverse graft is not reliable.

Quince has a very extensive history in the Middle East, and may have even been the fruit of temptation in the story of the Garden of Eden. The ancient Biblical name for quince translates as "Golden Apple" and cultivation of *Cydonia* predates cultivation of *Malus* (apple) in the region once known as Mesopotamia, now Iraq. Juniper and Mabberly (2006) explain how this region is well adapted to cultivation of quince, pomegranate, and other fruits, but Mesopotamia was much too hot and dry for the cultivation of all but the most recently developed low-chilling-requirement apples. Quince was revered in ancient Greece, where a fruit was presented to brides on their wedding day as a symbol of fertility. It was mentioned as an important garden plant in Homer's *Odyssey,* and Pliny the Elder extolled its medicinal properties.

Botany and Intergeneric Liaisons

Cydonia oblonga is a monotypic genus belonging to family Rosaceae, subfamily Spiraeoideae, tribe Pyreae, and subtribe Pyrinae (USDA 2009a). It grows as a multi-stemmed shrub or small tree and has pubescent to tomentose buds, petioles, leaves, and fruit. Leaves are ovate to oblong, about 2 inches (5 centimeters) across and 4 inches (10 centimeters) long. The solitary white flowers are 1½ to 2 inches (4 to 5 centimeters) across, have 5 petals, 20 or more stamens, 5 styles, an inferior ovary with many ovules, and are borne on current season growth. Bloom time overlaps with that of apples, usually beginning mid April in the central latitudes of the northern hemisphere. The fruit is a fragrant, many-seeded pome about 3 inches (8 centimeters) in diameter. Shape ranges from round to pear-like, flesh is yellow, and the Baileys refer to it as "hard and rather unpalatable"

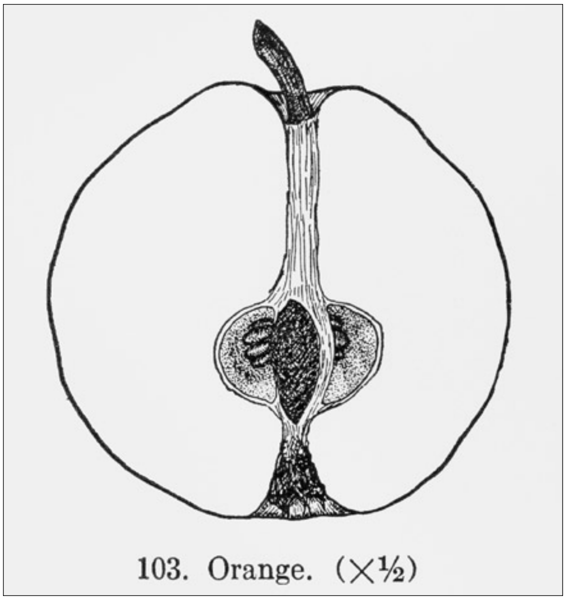


Illustration of 'Orange' quince from U.P. Hedrick's 1922 *Cyclopedia of Hardy Fruits*.

JOSEPH POSTMAN

A *Pyronia* fruit—from a cross of *Pyrus pyrifolia* (Japanese pear) and *Cydonia oblonga*—growing in the USDA genebank orchard.

(Bailey and Bailey 1976; Rehder 1986). Fruit size and leaf size of cultivated varieties can be many times larger than the wild type described above. All varieties are self-pollinating.

Intergeneric crossing is fairly rare in plants, but has occurred naturally on occasion in the Rosaceae. While not as promiscuous as its cousins *Sorbus* and *Mespilus*, *Cydonia* has had a number of encounters with related genera that resulted in intergeneric offspring. In 1913 a Mr. Veitch in London sent scions of a quince-pear hybrid to Louis Trabut, the Algerian botanist. Trabut proposed the name *Pyronia veitchii* for this curious seedless-fruited hybrid (Trabut 1916). *Pyronia* is little known today, except by fruit tree pathologists who use the virus-sensitive clone as a graft-inoculated indicator to detect virus diseases in pome fruits. Another more recent hybrid generated in Japan between *Cydonia* and the Japanese pear, *Pyrus pyrifolia*, was probably the product of embryo rescue, a controlled tissue culture technique. In Italy and the Czech Republic, a purported hybrid between quince and apple (*Cydomalus*) has been touted as a possible rootstock for both apples and pears (Wertheim 2002).

Center of Origin

Cydonia is native to western Asia, and the center of origin is considered to be the Trans-Caucasus region including Armenia, Azerbaijan, Iran, southwestern Russia, and Turkmenistan (USDA 2009a). During ancient times, quince spread from its wild center of origin to the countries bordering the Himalaya Mountains to the east, and throughout Europe to the west. It has many uses and traditions associated with it throughout this broad range. Several recent USDA funded plant collecting expeditions to Armenia, Georgia, and Azerbaijan returned with quince seeds and cuttings from these countries. The availability of *Cydonia* germplasm in the United States increased significantly from 2002 to 2006 as a result of these collections (McGinnis 2007).

Cultivation for Fruit and Rootstock Production

Worldwide, there are about 106,000 acres (43,000 hectares) of quince in production with a total crop of 335,000 metric tons. Turkey is the largest producer with about 25% of world production. China, Iran, Argentina, and Morocco each produce less than 10%. The United States is a very minor player in quince fruit production with only about 250 acres (about 100 hectares) planted, mainly in California's San Joaquin Valley. Burbank's 'Pineapple' is the most widely grown cultivar in that state and is said to be more flavorful than 'Smyrna' (McCabe 1996).

Quince fruit has a number of culinary uses. *Dulce de membrillo*, or quince paste, is popular in several European countries, particularly Spain. It is also much appreciated in parts of

JOSEPH POSTMAN

Dr. Vagharshak Hayrapetyan, head of the Scientific Center for Viticulture, Fruit Growing, and Winemaking in Yerevan, Armenia, poses with the winter quince variety 'Chartar Gyugh' in September, 2006. Scions of this heirloom quince cultivar were recently brought to the United States.

Latin America. This sweet, fragrant, jellylike confection is cut into slices and often served with a heady cheese. Quince is also served poached in either water or wine, and when so prepared develops a rich aroma and deep caramel-red color. In Armenia, quince is used in many savory as well as sweet dishes, and is often cooked with lamb (Ghazarian 2009). Quince fruit is also used by some home brewers to make very fine hard ciders.

While quince is still grown for its fruit in some parts of the world, in England, France, and the United States it is primarily grown for use as a dwarfing pear rootstock. In the region around Angers, France, quince has been used as a pear rootstock since before 1500. The French were growing quince plants from cuttings and layering in stool beds by the early 1600s and France became an important source of rootstocks around the world. Quince rootstocks grown near Angers were known as 'Angers Quince' and those propagated near Fontenay were known as 'Fontenay Quince' (Roach 1985; Tukey 1964). Confusion arose about the identities of various quince rootstocks, and in the early 1900s researchers at East Malling in England collected rootstocks from a number of nurseries and designated clones with letters of the alphabet. Quince rootstock clones now available in the United States include Quince A and Quince C, which came from East Malling–Long Ashton (EMLA); and Provence Quince (= Quince BA 29-C) from France. A pear tree grafted onto Quince A will be about half the size of a tree grafted onto pear seedling rootstock. The tree will also be more precocious and fruit size will be larger. Quince C produces a tree slightly smaller and more precocious still. Provence Quince rootstock produces a pear tree slightly larger than Quince A or C. Some pear varieties are not graft compatible with quince and require a compatible interstem pear variety such as 'Comice', 'Old Home', or 'Beurre Hardy' as a bridge.

Landscape Use

Few small trees rival the quince in becoming interestingly gnarled and twisted with age. Nonetheless, renowned Arnold Arboretum horticulturist Donald Wyman (Wyman 1965)

STEPHEN AUSMUS, USDA ARS

These bowls of quince show the diversity of shapes found in quince fruit.

JOSEPH POSTMAN

This young quince tree, growing in the genebank orchard at USDA-ARS, Corvallis, Oregon, has been pruned to open up the crown and remove basal suckers.

did not consider *Cydonia* worthy of his list of recommended landscape trees. He relegated it to his secondary list because of inferior flower interest, poor growth habit, and pest problems. However, *Cydonia* is an essential component of many historic gardens, and Frederick Law Olmsted included the common quince as a valuable plant in some of his landscapes (Deitz 1995).

As a young tree, *Cydonia* may sucker profusely, and it takes some pruning effort during the first few years to establish an open-crowned specimen tree rather than a small thicket. Quince is such an interesting plant that it's worth the pruning effort, and germplasm recently imported from other parts of the world may provide some relief from pest and climate challenges that limited its use in the past.

Potential for Genetic Improvement

Quince is adapted to hot, dry climates and to acid soils. Under favorable conditions, ripe fruit can become quite fragrant, juicy, and flavorful. When grown in high pH soils, however, trees can become stunted and suffer iron chlorosis. In northern latitudes or colder climates the fruit of many cultivars does not fully ripen prior to the onset of winter, and in places where it rains during the ripening season, fruit cracking can be a big problem. Although most commercial quince production today is located in very warm areas, one of the largest quince orchards in 1895 was a 60 acre (24 hectare) planting in upstate New York near Waterport (Brown's Berry Patch 2007).

Whether grown for fruit production or for use as a pear rootstock, quince is impacted by several disease problems. Fire blight caused by the bacterium *Erwinia amylovora* limits the cultivation of quince either for its fruit or as a pear rootstock, especially in regions with warm, humid summers. The genus *Cydonia* is one of the most susceptible to fire blight in Rosaceae, the plant family which includes many susceptible hosts (Postman 2008). Leaf and fruit spot caused by *Fabraea maculata* (anamorph = *Entomosporium mespili*) can result in tree defoliation and production of disfigured, unmarketable fruit if not controlled. Powdery mildew and rust diseases also impact quince production.

Genetic improvements needed for expanding the use of quince as a dwarfing pear rootstock include increased resistance to fire blight for warm and humid summer climates, and increased winter cold-hardiness for northern climates. Adaptation to alkaline soils will allow quince production to expand to more diverse

JOSEPH POSTMAN

The Turkish cultivar 'Harron' has the largest fruit size of the hundred or so quince clones growing at the USDA genebank, but the fruit may crack badly when exposed to rain just before it is ripe.

JOSEPH POSTMAN

A young boy in Georgia's northeast province of Kakheti displays quince fruit from a tree in the village of Shilda. Scions of the Shilda quince were collected by ARS genebank curators Joseph Postman and Ed Stover during a 2006 expedition to the Caucasus region. A tree is growing in quarantine at Beltsville, Maryland, and will be sent to the USDA-ARS genebank in Oregon upon release

soil conditions both as a rootstock for pear or for production of quince fruit. Very slight progress in soil adaptation was achieved by selecting somoclonal variants of rootstock clone Quince A following multiple generations of in vitro culture on high pH media (Bunnag et al. 1996). Quince for fruit production will benefit from earlier ripening, and elimination of summer "rat-tail" blooms, which predispose a tree to attack by fire blight. Fruits that are picked too green will never ripen properly (McCabe 1996). Resistance to the fungal rusts and mildews will allow quince to be produced with fewer pesticide applications.

Available Germplasm

A quince germplasm collection was established in Izmir, Turkey, beginning in 1964 that includes many regionally developed fruit cultivars and landraces (Sykes 1972). In Karaj, Iran, a collection of more than 50 *Cydonia* accessions are maintained, including both cultivated and wild types (Amiri 2008). Smaller quince collections are growing in Italy, Greece, Spain, and other European countries (Bellini and Giordani 1999). There are also significant collections in Ukraine and southwest Russia. A large fruit tree collection in Kara Kala, Turkmenistan, was once a part of the Vavilov Institutes during Soviet times. Many fruit tree accessions, including quince, were rescued from that station in the late 1990s and brought to other genebanks for safekeeping.

More than a dozen quince accessions from Kara Kala, representing both wild types and fruiting cultivars, are growing at the USDA genebank in Oregon. The Oregon facility is one of several ex situ genebanks housing temperate fruit and nut collections for the USDA National Plant Germplasm System (NPGS) (Postman et al. 2006). The NPGS *Cydonia* collection includes more than 100 clones with origins from 15 countries maintained as self-rooted trees in a field collection (Postman 2008). About half of this collection represents cultivars for fruit production, and the other half are pear rootstock selections, wild types, and seedlings. Observations made at the genebank have revealed a wide diversity of genotypes, some with resistance to *Fabraea* leaf and fruit spot, and a range of ripening seasons that may make it possible to produce quince fruit in short-season production areas. Quince selections made in Bulgaria following a fire blight epidemic in that country have shown good field resistance to the disease, and some of this Bulgarian germplasm was recently introduced into the United States by the NPGS genebank.

For nearly a century, the quince has been almost ignored for fruit production in North America, while many improvements have been made in the Middle East and central Asia. Germplasm is now available in the United States for expanding the use of *Cydonia* both as a rootstock for pear and as a fruit producing tree in its own right. As Luther Burbank concluded a hundred years ago, "The quince of today is, indeed, a half wild product that has waited long for its opportunity. It remains for the fruit growers of tomorrow … to see that the possibilities of this unique fruit are realized" (Wickson et al. 1914).

The Chinese Quince: *Pseudocydonia sinensis*

MICHAEL DOSMANN

This Chinese relative of *Cydonia* presently belongs to the genus *Pseudocydonia,* but has previously been assigned to both *Chaenomeles* (*Chaenomeles sinensis*) and *Cydonia* (*Cydonia sinensis*). Chinese quince has attractive single pink flowers that appear earlier than those of *Cydonia* but not as early as most *Chaenomeles.* The fruit is a large, oval, aromatic yellow pome that ripens in the fall. The shiny, leathery leaves develop nice red-orange fall color. But its most interesting characteristic is the exfoliating bark that reveals brown, green, orange, and gray patches. Chinese quince's attractive bark rivals that of many stewartias. The trunk often becomes fluted with age, adding even more textural appeal.

Luther Burbank devoted some attention to the Asian quinces and was probably responsible for a large-fruited clone of *Pseudocydonia.* Michael Dirr (1997) notes that Chinese quince is reliably hardy in USDA Zones 6 to 7 (average annual minimum temperatures -10 to 10°F [-23 to -12°C]), and possibly hardy in Zone 5 (-20 to -10°F [-29 to -23°C]). Fire blight is said to seriously impact its cultivation. However, the presence of very nice specimens of Chinese quince at the National Arboretum in Washington, D.C., and in gardens in the Carolinas—locations where *Cydonia* is readily killed by fire blight—indicate that it can be grown even in regions where the disease is present.

COURTESY OF KENPEI

Chinese quince's pink flowers, attractive patchwork bark, and fluted trunk are highly ornamental.

References

Amiri, M.E. 2008. The status of genetic resources of deciduous, tropical, and subtropical fruit species in Iran. *Acta Horticulturae* 769:159–167.

Bailey, L.H. and E.Z. Bailey. 1976. *Hortus Third.*

Campbell, J. 2001. Quince Growing. New South Wales AgFact H4.1.3.

Bellini, E. and E. Giordani 1999. Online European Minor Fruit Tree Species Database – EMFTS Database. http://www.unifi.it/project/ueresgen29/netdbase/db1.htm (7 March, 2009).

Brown's Berry Patch. 2007. http://www.brownsberrypatch.com/history_farm.html (2 April, 2009).

Bunnag, S., R. Dolcet-Sanjuan, D.W.S. Mok, and M.C. Mok. 1996. Responses of two somaclonal variants of quince to iron deficiency in the greenhouse and field. *Journal of the American Society of Horticultural Science* 121:1054–1058.

Deitz, P. 1995. Fairsted: at home with Frederick Law Olmsted. *Magazine Antiques,* August 1995.

Dirr, M.A. 1997. *Dirr's Hardy Trees and Shrubs, An Illustrated Encyclopedia.* Timber Press, Portland, Oregon.

Ghazarian, B. 2009. *Simply Quince.* Mayreni Publishing, Monterey, CA. 216 pp.

Hatch, P.J. 1998. *The fruits and fruit trees of Monticello.* University Press of Virginia. pp. 127–128.

Hedrick, U.P. 1922. *Cyclopedia of Hardy Fruits.*

Juniper, B.E. and D.J. Mabberly. 2006. *The story of the apple.* Timber Press, Portland, OR. 219 pp.

McCabe, C. 1996. Enjoying the forbidden fruit. *Saveur* 14:105–110.

McGinnis, L. 2007. Quest for Quince: Expanding the NCGR Collection. *Agricultural Research,* January 2007:20–21.

Meech, W.W. 1908. *Quince Culture; an illustrated handbook for the propagation and cultivation of the quince, with descriptions of its varieties, insect enemies, diseases and their remedies.* Orange Judd Co., New York. 180 pp.

Postman, J. 2008. The USDA Quince and Pear Genebank in Oregon, a World Source of Fire Blight Resistance. *Acta Horticulturae* 793:357–362.

Postman, J., K. Hummer, E. Stover, R. Krueger, P. Forsline, L.J. Grauke, F. Zee, T. Ayala-Silva, B. Irish. 2006. Fruit and Nut Genebanks in the US National Plant Germplasm System. *HortScience* 41(5):11881194.

Rehder, A. 1986. *Manual of Cultivated Trees and Shrubs Hardy in North America,* 2nd edition. Dioscorides Press, Portland, OR.

Rieger, M. 2006. Mark's Fruit Crops. http://www.uga.edu/fruit (4 February, 2009). USDA. 2009a. ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. URL: http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?12779 (20 January 2009)

Roach, F.A. 1985. Quinces. In: *Cultivated Fruits of Britain: Their Origin and History.* Blackwell, London pp. 220–225.

Sykes, J.T. 1972. A description of some quince cultivars from western Turkey. *Economic Botany* 26:21–31.

Trabut, L. 1916. *Pyronia:* A hybrid between the pear and quince. *Journal of Heredity* 7:416–419.

Tukey, H.B. 1964. Dwarfing rootstocks for the pear. Ch. 11 In: *Dwarfed Fruit Trees,* The MacMillan Co., New York. pp. 182–199.

USDA. 2009a. Germplasm Resources Information Network - (GRIN) Online Database. National Germplasm Resources Laboratory, Beltsville, Maryland. http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?12779 (05 February 2009)

USDA. 2009b. National Agricultural Statistics Service, U.S. fruit production data. http://www.nass.usda.gov/QuickStats/indexbysubject.jsp (4 February, 2009)

Wertheim, S.J. 2002. Rootstocks for European pear: a Review. *Acta Horticulturae* 596:299–309.

Whitson, J., R. John, and H.S. Williams (eds.) 1914. The Transformation of the Quince. Chapter 7, Volume 4 In: *Luther Burbank, His Methods and Discoveries and Their Practical Application.* Luther Burbank Press, New York and London pp. 211–240.

Wyman, D. 1965. *Trees for American Gardens.* Macmillan Publishing Co., New York.

Joseph Postman is a plant pathologist and curator of living pear, quince, and hazelnut collections at the USDA Agricultural Research Service, National Clonal Germplasm Repository in Corvallis, Oregon.

Information about quince genetic resources in the USDA National Plant Germplasm System, as well as a field day on October 10, 2009 featuring the Corvallis genebank's quince orchard, is available at http://www.ars.usda.gov/pwa/corvallis/ncgr. A one day symposium on underutilized pome fruits will be held in August, 2010 during the 28th International Horticulture Conference in Lisboa, Portugal. For more information visit the 'Symposia' link at http://www.ihc2010.org/

Bird's-eye Views: Aerial Photographs of the Arnold Arboretum

Sheila Connor

COURTESY OF THE BOSTON PUBLIC LIBRARY

James W. Black's 1860 image of Boston, the earliest aerial photo still in existence.

Our desire to fly must have been driven, in part, by wanting to have a bird's-eye view of the land. Today, we can launch ourselves skyward simply by clicking on Google Earth, where a virtual world created by combining aerial photography, satellite imagery, and GIS (geographic information systems) unfolds on our computer screen.

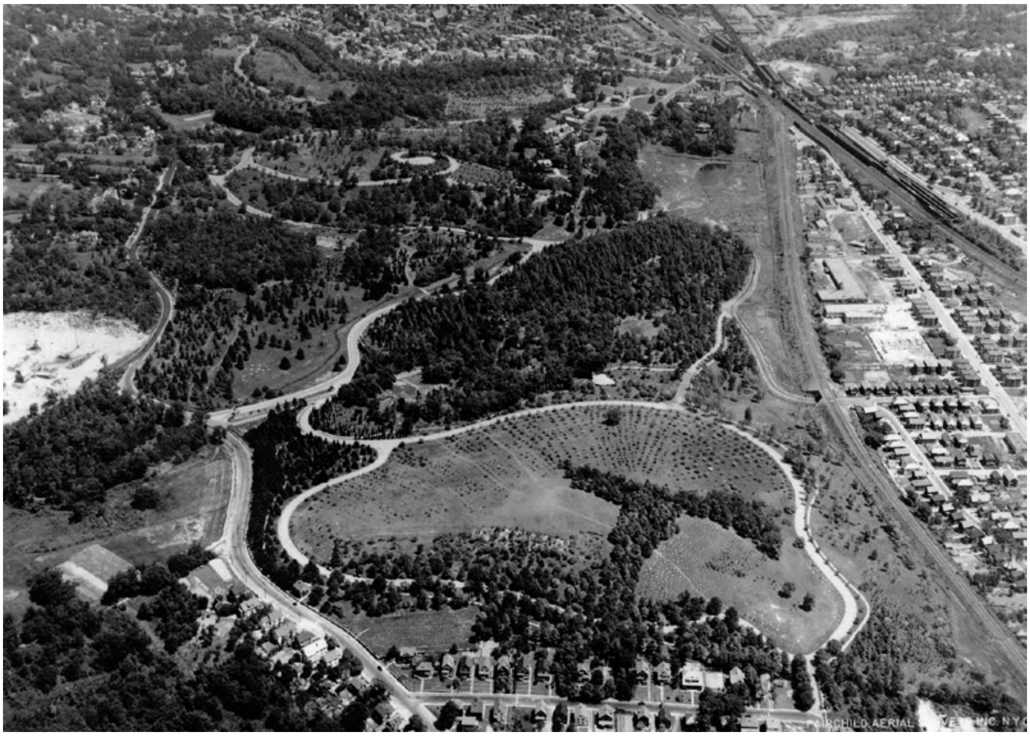
Attainment of that instant bird's-eye view was many years in the making, though. The first aerial photographs were taken from a hot air balloon in 1858 by the French portraitist "Nadar" (Gaspard-Félix Tournachon), who did so while tethered 240 feet (73 meters) above the village of Petit-Bicêtre near Paris. Two years later—also in a tethered hot air ballon—James Wallace Black ascended 1,200 feet (366 meters) over the densely developed port city of Boston, Massachusetts. His image, "Boston, as the eagle and wild goose see it," is the earliest known aerial photograph still in existence. Kites, rockets, and carrier pigeons (outfitted with tiny breast-mounted cameras) were the next airborne means used.

Just a few years after the Wright brothers famous first flight, images were shot from an airplane piloted by Wilbur Wright, the first taken from an airplane. The military, both here and abroad, quickly grasped the value of these unexpectedly revealing views and established aerial reconnaissance units. Following World War I, newly created commercial companies expanded upon the progress made in aerial techniques.

New Equipment, New Techniques

Sherman Mills Fairchild started several of these new peacetime ventures. Fairchild had originally secured a contract with the army to develop a camera for aerial photography. With the shutter placed inside the lens, his high-speed camera was capable of producing images with little or no distortion, which made accurate mapping possible. Although the army did not take delivery of his cameras until after the war, Fairchild continued to improve upon his design and, in 1920, started the Fairchild Aerial Camera Corporation.

He also began designing aircraft to suit his photographic needs and founded his second company, Fairchild Aerial Surveys, Inc. The company is well known for the remarkable aerials it produced of every major city in the United States between 1920 and 1960, and the Arboretum was one of its earliest clients. Using one of the company's specially designed cameras, a pilot flew over the Arboretum in 1927 in a Fairchild FC-1 and took "the first airplane view to show all of America's greatest hardy garden," as reported in the *Boston Herald* newspaper. This "bird's-eye view" was



ALL PHOTOS FROM THE ARCHIVES OF THE ARNOLD ARBORETUM UNLESS OTHERWISE INDICATED

This 1927 Fairchild aerial photograph of the Arboretum, looking toward Boston, shows Peters Hill in the foreground and the familiar curlicue of roadway atop Bussey Hill.

JAY CONNOR

This 2005 image was made with the same perspective as the 1927 photo. Peters Hill is in the foreground, but mature trees now obscure the top of Bussey Hill. Downtown Boston is seen in the distance.

A large paved circle for bus turnarounds is seen atop Peters Hill in this 1967 photograph. Prior to 1964 there was no paved roadway to the top of the hill. In the late 1990s the paving was removed as part of a landscape restoration project that returned the hilltop to a design consistent with Frederick Law Olmsted's naturalistic style.

JAY CONNOR

Additional unplanned footpaths created over the years are visible in this 2007 image of Peters Hill. In place of the pavement at the summit there are now a scattering of granite blocks used for informal seating. The granite blocks, recycled from a demolished Olmsted-era bridge that once stood near the Forest Hills Station, were originally placed in a circle on Peters Hill in the 1980s to deter a then popular youth activity—setting stolen cars on fire and pushing them down the hill.

reproduced in the the newspaper's autogravure section on November 20, 1927.

Since that initial flight, photographers have used planes, helicopters, a dirigible, and, most recently, a drone as means to attain views of the Arboretum. The resulting collection of negatives, microfiche, prints (both black and white and color), and digital images provides a unique perspective and an amazing record of how change occurs in the Arboretum's seemingly permanent landscape. Entire plant collections disappear only to reappear years later completely redesigned and reconfigured. Others simply disappear. A few migrate, acquire a new name, then eventually vanish. Roads appear, are paved, then unpaved, and fade away. Sidewalks and paths (whether planned or established by desire) do the same, and while our aerial archaeology has not revealed any crop circles, one can easily see the remains of the characteristic circles that signify abandoned planting holes, sites where specimens once grew.

Making Maps

The first vertically shot aerial survey of the living collections took place in 1936. (In vertical aerial photography the camera is in a level position and pointing directly downward, the best format for precise mapping.) This survey consisted of a series of four images taken by Bradford Washburn, then a 26-year-old instructor at Harvard's Institute for Geographical Exploration. His long

When seen from above in this 1955 Bradford Washburn aerial (top), the broad, grassy plain just below the summit of Bussey Hill sports shadows of planting holes from the *Prunus* collection that once occupied the site, seen in the May 1929 photo (bottom) taken by the renowned New England landscape photographer Herbert Wendell Gleason.

affiliation with the Arboretum, coupled with his expertise in aerial photography and cartography, greatly influenced the number of aerial photographs taken of our landscape.

Mr. Washburn often acted as a project manager, directing and organizing both vertical and oblique (camera is angled) shots made of the arboretum. Under his direction an image of the

One of Washburn's 1936 vertically shot aerials of the Arboretum. Marked on the map are:

1. Present site of the Dana Greenhouse, constructed in 1962, and the Leventritt Pavilion and Shrub and Vine Garden (an aerial view of this garden is on the front cover).
2. The site of the original Shrub and Vine Collection, now occupied by the Bradley Rosaceous Collection.
3. Site of the Bussey Institution, the location of the Arboretum's greenhouses prior to 1962, and now the site of the Massachusetts State Laboratory.
4. Bussey Brook Meadow, also known as the South Street Tract and Stony Brook Marsh, prior to the pond being filled in and the creation of the Blackwell Footpath
5. Peters Hill had only the outer ring road at the time.
6. Weld Hill, once known as the Weld Walter Street Tract, prior to the construction of the Hebrew SeniorLife Center on the site of the former Joyce Kilmer Park
7. Highly visible remnant of Centre Street left from the Centre Street realignment and widening in 1931. Today, a grassy swath still indicates the route of the old roadbed.

entire Arboretum was taken in 1952. Then in 1955, his first year as chairman of the Arboretum's Visiting Committee, he raised the sum of $310.00 from the committee for a flyover by Eastern Aerial Surveys, Inc., with the recommendation that a second survey take place the following spring. Twelve images resulted from the October 6 survey. Unfortunately there is no record of a spring session. Northeast Aerial Photos produced the first series of color images of the Arboretum in 1967. A year later, color images of the Hunnewell Building and the newly built garage facility were taken, and in 1974 a survey of the entire Arboretum produced a suite of seventeen images.

Bradford Washburn's long-held goal of creating a mapping system of the Arboretum's living collection based on aerial photography finally came to fruition when Dr. Peter Shaw Ashton, then director of the Arboretum, approached him in 1978 to orchestrate the coordination of a photogrammetric survey of the Arboretum by Swissair Photos + Surveys, Ltd. (now named Swissphoto AG).

The Hunnewell Building and then newly built garage behind it are shown in this 1968 photograph.

JAY CONNOR

A similar view as seen in May, 2005.

"On a cloudless day in April, 1979, the survey crew took a series of aerial photographs, which were then transformed into orthographically corrected images displaying an exceptionally accurate picture of the Arnold Arboretum at a scale of 100 feet to the inch. A ground-survey team was hired to complete the contours in certain areas of the Arboretum that are covered by an evergreen canopy. Swissair provided the Arboretum with a base map of the grounds that illustrates true north, contour lines at intervals of ten feet, physical features (roads, paths, walls, and buildings), and reference points."

From the article "Cartographic Records of the Living Collections" Ethan W. Johnson, *Arnoldia.* 49 (1) 1989.

BRADFORD WASHBURN was an extraordinary man. Born in Boston in 1910, as a teenager he developed a love for mountain climbing, summiting peaks around the world in the days well before high tech climbing gear was available. As an undergraduate at Harvard he honed his passions—climbing, photography, and scienctific exploration—and in 1934 pursued graduates studies in cartography, surveying, and aerial photography at Harvard's Institute for Geographical Exploration. At 29 he became the director of the New England Museum of Natural History, now the Boston Museum of Science, a position he held for 40 years. As a pioneer in aerial photography, Washburn's stunning mountain images made him one of the most important landscape photographers of the twentieth century. Recently, one of Washburn's cameras (a 1929 Zeiss 4 x 5) was taken on the space shuttle's Hubble telescope repair mission by astronaut and mountain climber John Grunsfeld. It seems fitting that Washburn's camera was used to make the ultimate in aerial photos—images from space.

PHOTOGRAPH ©2009 MUSEUM OF FINE ARTS, BOSTON. GIFT OF BRADFORD AND BARBARA WASHBURN. 1999.446

***Bradford Washburn and the Fairchild 71 Monoplane, Valdez, Alaska,* a 1937 gelatin silver print photograph by Bob Reeve.**

Susan Kelley, then curatorial associate in mapping, and I met with Mr. Washburn in 2000 to learn more about his early Arboretum work. He believed that his photographs of the collections would eventually provide a valuable record. Upon seeing our current maps of the living collections, which were based on the 1979 photogrammetric survey and formatted in AutoCAD, which interacts with the computerized plant records database, BG-Base, Mr. Washburn pronounced them "gorgeous!"

More Bird's-eye Views

Sasaki Associates Ltd. produced aerials in 1990 and 1991 as part of the Arboretum's Master Plan process, and in 2002 the Arboretum participated for the first time in a survey of the Harvard campus, which was coordinated by Harvard's Planning and Real Estate Department. The living collections were again included in the Harvard survey in 2006. Recently, when aerial imagery has been needed, photographs have also been acquired from surveys done by the United States Geological Surveys (USGS). Our most recent full scale vertical aerial view of the entire Arboretum was taken in spring 2008, as part of the USGS Boston 133 Cities Urban Area mapping program.

Interspersed between these major surveys were other more site specific or overview flights. In 1950, Arboretum horticulturist Donald Wyman took a series of photographs at a

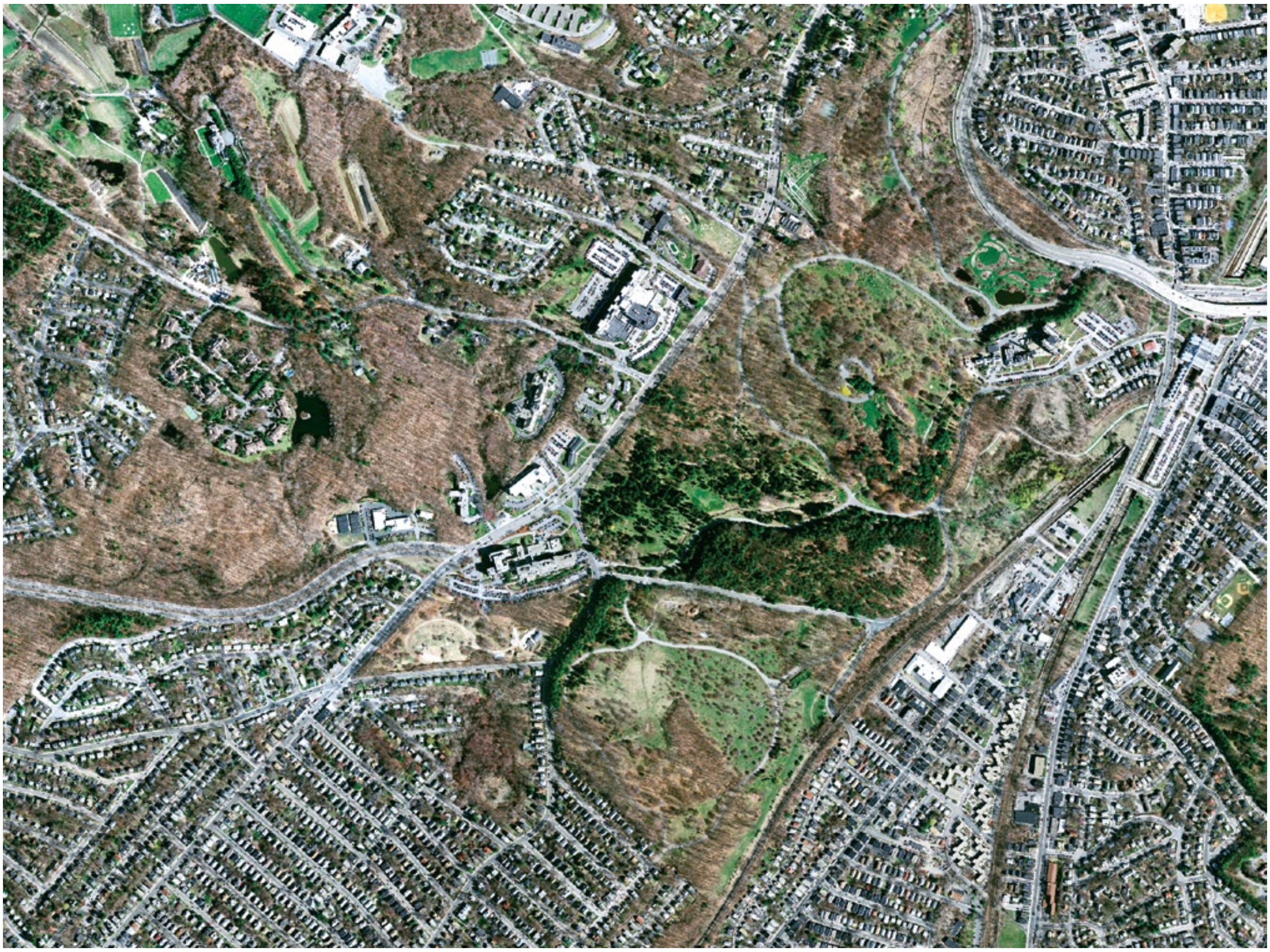


Image of the Arnold Arboretum in 2008 from the United States Geological Surveys.

Weld Hill in 1955, with Kilmer Park adjacent (top of photo).

Weld Hill in 2006, part of the Harvard survey.

height of 3,000 feet from a plane flown by his 17-year-old son.Wyman's photographs were taken from a vantage point reminiscent of the 1927 Fairchild survey images. Eight years later, Heman Howard, in charge of the mapping and labeling department, also duplicated this view with a series of oblique shots from both 1,400 and 2,300 feet. The Massachusetts Department of Public Works photographed the lilac collection and replicated the bird's-eye view in 1969 and, in 1995, Sergio Marino of GPI Models took a series of images from a helicopter to facilitate his construction of an 8 feet by 16 feet scale model of the Arboretum. The model became

FULLERVIEW PHOTOGRAPHY

An oblique view of Weld Hill, taken from a drone on May 20, 2009, shows the Arboretum's new research facility under construction.

the centerpiece for the exhibit *Science in the Pleasure Ground* in the Arboretum's Hunnewell Visitor Center, where it continues to be a popular feature. My brother, Jay Connor, has taken almost 200 oblique images of the collections. He began photographing the Arboretum in 2004, usually from a helicopter, but once from the iconic Hood Blimp, officially an American A-60+ Lightship. This familiar cigar-shaped balloon is capable of hovering motionless for hours at a time. As Boston Red Sox fans can attest, it is truly an airship designed for aerial observations.

The Arboretum's most recent aerial photography project involves the new research facility on Weld Hill. Over the past two years, Dave Fuller of Fullerview Photography has sent up a drone to capture images of the construction of the building. Over the coming months, arboretum staff will be adding aerial imagery to our GIS (geographic information system) using ESRI software. This will provide a new generation of bird's-eye views of the arboretum's landscape and its change over time. Incorporating these images into our GIS system will assist in reconciling diverse georeferenced features and provide unprecedented detail about our living collections for researchers and visitors.

Sheila Connor is the Horticultural Research Archivist at the Arnold Arboretum.

Seeking Cold-Hardy Camellias

Anthony S. Aiello

For those of us in more northern climates, trips to southern or West Coast gardens in early spring often result in admiration (and a little envy) for the range and beauty of camellias (*Camellia* spp.) that can be grown in Zones 7 or warmer. As with many plants, we always want those that are either too tender or too boreal for our zone; those plants well suited for a particular climate are all too quickly considered prosaic and it is the struggling arcane plants that most of us cherish as gardeners. It was the tantalizing possibility of finding more cold-hardy camellias that 25 years ago led to a plant hunting expedition and the resulting multi-year evaluations of a group of *Camellia japonica.*

Domestic and international plant exploration, and subsequent evaluation of plant acquisitions have been important missions of the Morris Arboretum in recent decades. Since the late 1970s, staff of the Morris Arboretum have participated in 20 plant collecting trips, including trips to South Korea, China, the Caucasus Mountains, and regions within the United States. On these expeditions, seed is collected and returned to the Morris Arboretum for propagation. (Occasionally live plants are collected, but because of difficulties with transportation and import regulation, seeds are the primary form collected.) One of the main goals of our plant exploration and evaluation program is broadening the genetic pool of known species to extend cold hardiness and increase vigor.

Between 1979 and 1991, Morris Arboretum staff participated in five collecting expeditions to South Korea. These trips were planned to sequentially cover different geographic regions of South Korea. The 1984 Expedition to Korea's northwestern coast and islands (Korea Northwest Expedition – KNW) visited areas along the northwestern coast and inland to the Kwangnung Arboretum (now Korea National Arboretum) of South Korea (Meyer 1985). It is from this 1984 expedition that the Morris holds a number of accessions of *Camellia japonica* collected on Taechong and Sochong Islands, off the west coast of South Korea. The island collections represent some of the most northern collections ever made of common camellia. As an extension of the Asian land mass, Korea is exposed to a continental climate that includes strong, cold, and persistent winter winds. Even along the coast, the Korean climate is much harsher than that in Japan. As a result, despite their location in the Yellow Sea, these islands are exposed to more extreme temperatures than one would expect from their maritime location.

MORRIS ARBORETUM OF THE UNIVERSITY OF PENNSYLVANIA

Map of areas visited on the 1984 Korea Northwest collecting expedition.

The Trip to the Islands

The idea of visiting and collecting from these island populations of *Camellia japonica* was instigated by Barry Yinger (Asiatica Nursery,


PAUL W. MEYER

The Taean Peninsula on the northwest coast of South Korea. This area and islands off of the northwest coast were the focus of the 1984 Korea – Northwest collecting expedition.

Lewisberry, Pennsylvania), who had read of this northern cold-hardy population in the early 1980s (Yinger 1989a; Yinger 1989b). Through great persistence, Yinger first encountered these plants on Taechong and Sochong Islands in the winter of 1981. Yinger relates how his concern that the camellias were destroyed during the almost total deforestation of Korea during World War II turned to delight once he reached the islands. Yinger wrote about his first encounter with these camellias on Sochong Island:

> "… off we went, up the hillsides overlooking the Yellow Sea, buffeted by the cold wind from the northeast. The hillside was bleak and brown with few trees of any kind. The only greenery was an occasional grove of pines, the lower limbs of which had been chopped off for firewood. Up a little further and there—at last—a grove of camellias glittering green against the brown dried grasses, catching the winter sunshine and throwing it back to us." (Yinger 1989a)

By counting the growth rings of stumps of camellias that were cut for firewood, Yinger estimated the age of these trees, some of which were 15 to 18 feet (4.6 to 5.5 meters) tall, as close to 150 years old. These astonishing trees had silently witnessed the political vagaries that had affected the Korean peninsula and its people over that long period.

In October 1984, Yinger, then at the U.S. National Arboretum, returned to Taechong, Sochong, and Paekryong Islands with Sylvester March, Paul Meyer, and Peter Bristol (of the National, Morris and Holden Arboreta, respectively) along with their Korean colleagues Chang Yong June and Chang Yong Hun. Although these islands are controlled by South Korea they are located just south of the 38th parallel and north of the mainland border between North and South Korea. The islands are within view of North Korea, so they are of military and political significance; the explorers were required to

PAUL W. MEYER

Mature plants of *Camellia japonica* growing on a steep hillside on Sochong Island. Peter Bristol and Sylvester March are pictured at lower left.

have a naval escort to reach and travel on the islands and were forbidden from photographing the boat on which they travelled. As Meyer (1985) wrote:

> "... it must have been a peculiar sight as the Korean navy boat pulled out of Inchon Harbor. Among the Korean sailors were four American plant explorers eager to collect on a group of islands in the Yellow Sea. Piled high on the deck were herbarium presses, seed bags, and general expedition supplies. The pole pruners leaning against the gun turrets created a strange juxtaposition. If the North Koreans observed this they must have wondered what this unusual mission was all about."

Although the collecting supplies were exposed to the sea air, the Americans were sequestered below decks in crowded cabins for the duration of the long trip. Once on the islands, the collectors were escorted by the sailor companions, who eventually chipped in and helped with seed collecting and cleaning (trip details from Yinger 1989a and 1898b; Meyer 1985; and Meyer, personal communication).

The Americans travelled among the three islands for approximately one week, making a large number of collections from a great diversity of plants. Among these were nine seed collections of *Camellia japonica* including some

PAUL W. MEYER

Collecting seeds from mature, open-grown *Camellia japonica* plants on Sochong Island. An unidentified Korean sailor is standing beneath the trees at left.

that were growing in pastures and others that had been transplanted into local farmers' gardens. Six of these came from Taechong Island and the other three from Sochong Island. The islands' inhabitants recognized the beauty of these plants and often transplanted them into their small home gardens. Meyer (1985) found a grove on Sochong Island to be the most impressive; here, the camellias grew into large trees that grew luxuriantly on a site exposed to sea winds and salt spray. The areas where they grew were heavily cut and grazed by goats. Only tall plants with their lower foliage eaten remained, and the grazing prevented any natural regeneration of seedlings. (Here at the Morris we have a similar problem, except it is the white-tailed deer that browse on our low hanging camellia foliage.)

The human and livestock pressure on the islands was significant and the field notes describe collecting from resprouting plants in locations that were either cut-over forests, heavily grazed, or along roadsides. As unromantic as these types of plants and locations may sounds, they can make for excellent field

PAUL W. MEYER

Fruit of *Camellia japonica* collected on the 1984 Korea – Northwest expedition. The camellia fruit is a woody capsule containing several seeds.

ARNOLD ARBORETUM

The handsome foliage of Japanese spicebush (*Lindera obtusiloba*) in golden fall color.

collecting. Compared to a mature forest, with little sunlight reaching the understory and fruits far out of reach, roadsides or regrown areas provide plants with sufficient sunlight to produce fruit while lending easy access to the plant collector.

In addition to the camellias, numerous other plants were collected on the islands, and many of these have grown exceptionally well for us. Most notable among these collections are *Callicarpa japonica, Lindera obtusiloba, Sorbus alnifolia, Styrax japonica, Pinus thunbergii,* and *Viburnum bitchuense.* Meyer (1985) was particularly impressed by seaside populations of *Styrax japonica,* which were noteworthy because of leathery and glossy leaves that were unaffected by salt spray or summer sun. Plants grown from this seed collection grace our parking lot where their May flowers provide a fragrant welcome to our visitors. Over the years we have lost many compound-leaved *Sorbus* species, but perhaps the best mountain ash for our area is *Sorbus alnifolia.* With its simple leaves, abundant white flowers, striking coral-red fruits, and russet fall color, the Korean mountain ash is one of my favorite plants throughout the year. Another standout from this group is *Lindera obtusiloba;* anyone who knows the sublime golden yellow fall color of Japanese spicebush agrees that it is one of the most outstanding shrubs for autumn foliage.

Wanted: A Hardy Camellia

What was the impetus that led to such effort to reach a far-flung corner of the world? As mentioned previously, camellias are exquisite garden flowers, but the vast majority of camellia cultivars are not hardy in regions colder than USDA hardiness Zone 7. From the late 1970s into the early 1980s a series of extremely cold winters devastated camellia collections at the U.S. National Arboretum and elsewhere (Ackerman 2007; Ackerman and Egolf 1992). At the National Arboretum alone, the harsh winters reduced the collection of 956 30- to 40-year-old plants to less than a dozen struggling survivors (Ackerman 2000; Ackerman and Egolf 1992). These severe winters—and the damage to large numbers of cultivars—inspired Dr. William Ackerman, a plant breeder and camellia aficionado at the National Arboretum, and Dr. Clifford Parks, a professor from the University of North Carolina in Chapel Hill, to undertake breeding programs to develop camellias cold-hardy in Zones 6 and 7. In light of the severe winters at the time of the Korean expeditions, there was considerable excitement about the potential for cold-hardy provenances of *Camellia japonica* coming from South Korea (Yinger 1989a). It was hoped that these northern collections of *Camellia japonica* would expand the hardiness of common camellia, generally considered to be reliably hardy in Zone 7 (Flint 1997) but historically not reliably cold hardy in the Philadelphia area (Zone 6b).

The nine accessions of *Camellia japonica* were collected on the Korean islands in October 1984, and some of these seeds were sown at the Morris Arboretum beginning in November of that year. Eight of the nine accessions germinated successfully, with varying numbers of seedlings among accessions. Given the northern locations of the parent populations, we began a long-term field and garden trial of several accessions. Since the late 1980s plants grown from these collections have been evaluated for cold hardiness and several ornamental characteristics such as general vigor, leaf quality and retention, flower abundance and color, and plant habit. The camellias in this study all exhibit attractive evergreen foliage and single red flowers, which is typical of the straight species. These plants are large shrubs, reaching up to 12 feet (3.6 meters) tall or higher in 25 years. Although their single red flowers are not like the very showy forms grown farther south, their greatest value is in their hardiness and potential for breeding.

RICK J. LEWANDOWSKI

RICK J. LEWANDOWSKI

Field trials of *Camellia japonica* at the Morris Arboretum's Bloomfield Farm, February and April, 1994.

The Tryouts Begin

In 1986 plants were designated for one of two parallel evaluation studies: either a replicated field trial, or garden settings throughout the Arboretum. Of the eight successfully germinated accessions, six were eventually planted in the Arboretum's trials or throughout the Arboretum.

In April 1987, 730 seedlings were planted in a replicated field trial at the Arboretum's Bloomfield Farm research area and were evaluated for cold hardiness. From 1989 to 1993 all of these plants were evaluated for general foliage quality, vigor, and hardiness (survival) on a scale of 1 to 5 (with 1 being dead and 5 being excellent). As would be expected with seedling grown plants, there was great variation in the survival and quality of plants in this study (Aiello *et al.* 2008).

By June 1990, 589 plants survived, and 283 were deemed acceptable because they had a rating of 3, with only slightly damaged foliage. Three years later, in August 1993, the cutoff for retaining plants was elevated to a 4 ranking, that is, plants that showed only occasional foliar damage. At this level of scrutiny only 40 of 170 remaining plants made the grade. The winters of 1993–94 and 1994–95 resulted in further loss of plants, and by April 1995 the remaining plants were moved to our greenhouses. Then, between the fall of 1995 and spring of 1999, 25 of these highest rated plants from the original 730 in the Bloomfield trial were planted into the Arboretum's public garden for further assessment (Aiello *et al.* 2008).

In a parallel study, between 1987 and 1991 an additional 33 of the originally germinated seedlings that were not part of the formal field trial were planted in protected garden settings throughout the Arboretum. These plants did not receive the formal ratings applied to their siblings in the research plots. Nevertheless, the winters took their toll and by October 1999, 22 of these plants remained in the garden.

Bringing it All Together

***Camellia japonica* plants growing at Gates Hall at the Morris Arboretum.**

In October 1999, shortly after I arrived at the Morris Arboretum, a total of 50 camellias were alive in garden settings throughout the Arboretum. Faced with what was already a 15-year old trial, I wanted to bring some resolution to this evaluation effort and to determine which of the remaining plants truly stood out among the others. The 50 plants included the 25 plants from the field trials, 22 remaining plants from those originally planted in garden settings, and three additional plants which had been cutting-grown in our greenhouse from original seedlings. These 50 plants were growing in protected areas throughout the Arboretum, where the camellias could grow under the canopy of conifers or against buildings, where they were shielded from strong winter winds and afternoon sun. For example, one group was massed to the north of a very large *Chamaecyparis pisifera* that screens our parking lot from Meadowbrook Avenue, a quiet residential street that borders our property. Another group was planted along the northeast face of Gates Hall, the Arboretum's administration building.

Starting in the fall of 1999 and continuing through the spring of 2004, the 50 plants throughout the Arboretum were visually evaluated. In the spring and fall of each year the plants were rated for a variety of ornamental traits including general vigor, hardiness, leaf retention, and foliar and floral characteristics. Plants with foliage that was deep green, glossy, disease-free, and with no winter injury received the highest ratings. Although there was not a great deal of variation in floral traits, plants with greater numbers of flower, flowers that were more open, and flowers with richer bright scarlet color were considered the most desirable. There was also significant variation in plant habit and we gave higher ratings to denser and more regularly shaped plants (Aiello *et al.* 2008).

After these visual evaluations were completed in late 2004, 43 plants remained alive and each year's ratings for these plants were combined. These 43 plants were grouped into three categories according to overall performance and appearance after 5 years of evaluation. These categories were somewhat subjective but allowed us to consolidate several seasons of information into a shorthand that would clarify the better performing plants.

Of the 43 plants, the top 15 ("A" rating) exhibited consistent, positive performance in three key areas of the evaluation criteria. In particular, these plants flowered every year, maintained a desirable habit, and retained attractive glossy green foliage throughout the seasons. The foliage quality is especially important in March, when the effects of winter start to show on poorer performing plants. Because *Camellia japonica* flowers on old wood before new growth emerges, we were especially interested in those plants that retained high quality foliage as the flowers emerged from March into April. The middle 16 plants ("B" rating) generally performed well in one or two areas of the evaluation, but their performance was either not consistent, or was poor in the other categories. For instance, "B" plants may have had good foliage quality but their flowering was poor or inconsistent, or they might have had beautiful flowers but scraggly open habits that detracted from the overall quality of the plant. The lowest rated 12 plants ("C" rating) generally performed poorly in several categories. In some instances, they may have exhibited one positive characteristic, but this was overridden by the overall appearance of plant.

The Current Situation and Next Steps

After more than 20 years of evaluation, the numbers of Korean *Camellia japonica* at the Arboretum has gone from approximately 750 plants to just over 40 individuals. The remaining plants represent six of the original nine collections from Korea (KNW 312, 342, 344, 348, 350, and 352) and are a valuable genetic resource for introduction and breeding. Although their ornamental value may not compare to cultivars hardy in the southern and western United States, our plants exhibit attractive single red flowers and glossy evergreen foliage. They represent a significant advance in the hardiness of common camellia, with suitability for Philadelphia and the mid-Atlantic region, and possibly the lower Ohio Valley and coastal New England. These cold-hardy selections will appeal to Zone 6 gardeners who have coveted these plants after visiting the "Camellia Belt" found in southeastern and West Coast states.

Along with evaluating the remaining plants in our collection, over the past several years we have been propagating and distributing cutting-grown individuals from our highest rated plants. Camellias have been provided to other public gardens throughout the northeastern United States, including Chanticleer, and the Scott, Tyler, Willowwood, Polly Hill, and Arnold Arboreta. Our hope is that distributing this material will help conserve the germplasm and provide evaluation over a broader range of climates.

ANTHONY S. AIELLO

Camellias with glossy green foliage that remained attractive through the winter received higher ratings in the evaluation.

ANTHONY S. AIELLO

Single, red flowers were standard for the Korean seedlings, though some plants had more vibrant color or greater numbers of flowers.

Currently we are planning to name and introduce several individual plants from our *Camellia japonica* trials (see sidebar). Two of these plants are those that show the highest ratings for combination of plant habit, foliar quality, and flower density. One plant shows a striking upright habit and a fourth is consistently precocious, regularly blooming in late autumn compared to the normal early spring blooming time of the species.

Presently there are three commercially available introductions from the 1984 Korean *Camellia japonica* collections. These are: 'Korean Fire' (KNW 352) a 2003 Pennsylvania Horticultural Society Gold Medal winner that was introduced by Barry Yinger through Hines Nursery (Bensen 2000); and 'Longwood Valentine' and 'Longwood Centennial' (KNW 350) introduced by Longwood Gardens (Tomasz Aniśko, personal communication).

Going forward, our goal is to distribute our selections and compare them to other known cold-hardy forms of *Camellia japonica.* We are also working with plant breeders to share material in the hope that the hardiness inherent in our plants can be utilized to develop cold-hardy varieties with greater variation in flower color and form. Much of the work in developing cold hardy camellias has been conducted by Dr. Ackerman and Dr. Parks (Aniśko 2000). Additionally, Longwood Gardens continues a long research program in breeding and selecting camellias (Aniśko 2000).

The evaluation of woody landscape plants is a long-term commitment, one that often spans the tenures of staff at institutions that

New Camellia Introductions

There are four plants that we are planning to name and introduce. The varietal names and descriptions of these are as follows. All heights are approximate.

'Balustrade' (86-043*J / KNW 342). One of two plants at the Studio Building, a small office building near our administrative offices. This plant has a very narrow, upright habit and strongly upright branch angles. This plant has been growing in its current location since the spring of 1988 and is 11 feet (3.4 meters) tall and 3 feet (.9 meter) wide. The single flowers are a good scarlet red, typical of the species. It received an overall "A" ranking and flowered every year, with excellent lustrous foliage.

'Meadowbrook' (86-050*U / KNW 352). One of a grove of plants growing on the north side of a large *Chamaecyparis pisifera* along Meadowbrook Avenue, near the Arboretum's parking lots. This plant has outstanding blue-green foliage. It has been growing in its current location since December 1995 and is 12 feet (3.6 meters) tall and 6 feet (1.8 meters) wide. Its flower color is a rosy red and lighter in color than others that we have evaluated. It received an overall "A" ranking, flowered every year, and had especially high marks for foliage quality; its attractive lustrous foliage stands out for its high quality in all seasons. It is fully branched to the ground with an ovate habit.

'Bloomfield' (86-050*W / KNW 352). Another in a grove of plants growing on the north side of a large *Chamaecyparis pisifera* along Meadowbrook Avenue, near the Arboretum's parking lots. This plant combines the best flowering of all of our plants with excellent foliage quality and vigorous growth. This plant has been growing in its current location since December 1995 and is 16 feet (4.9 meters) tall and 9 feet (2.7 meters) wide. The single flowers are scarlet red, typical of the species. It received an overall "A" ranking, flowered every year, and had especially high marks for foliage quality and habit. This was ranked the number one overall plant of the entire evaluation. It is fully branched to the ground with an excellent ovate habit.

'Morris Mercury' (86-050*Z9 / KNW 352). One of a group of plants growing on the north side of Gates Hall, the Arboretum's administrative offices. This is a precocious, fall blooming plant. This plant has been growing in its current location since October 1999 and is 11 feet (3.4 meters) tall and 7 feet (2.1 meters) wide. It has a more open habit than the others, with an upright arching branch habit. This plant blooms regularly in November of each year, with sporadic blooms the following spring. Despite flowering every year, it received an overall "B" rating due to its open habit and foliar damage after cold winters of 2000 and 2001.

ANTHONY S. AIELLO

Camellia japonica **plants growing along Meadowbrook Avenue at the Morris Arboretum. 'Bloomfield' (Morris Arboretum 86-050*W) is pictured at the center of this photograph.**

PAUL W. MEYER

A *Camellia japonica* grown as an espalier in a protected spot at the Morris Arboretum.

collect, propagate, and evaluate these plants. At the Morris Arboretum we have found that plants collected in the 1980s in South Korea have exceptional cold hardiness and adaptability. For example, stems from *Cornus kousa* that were also collected on the 1984 KNW expedition showed significantly more freezing tolerance in tests than plants of either Japanese or Chinese origin (Aiello 2005). Likewise, after more than 20 years of evaluation, the Korean *Camellia japonica* plants represent some of the most cold-hardy collections ever made of common camellia. These collections may extend the hardiness of *Camellia japonica* into more northern areas and bring the spring pleasure of camellias to eager gardening audiences.

Acknowledgements

The author would like to thank Elinor I. Goff, Michelle Conners, Shelley Dillard, and Sara Ranck for their contributions to this project and to this article.

Literature Cited

Ackerman, W.L. 2000. Northern Exposure. *American Nurseryman* 192 (11): 38–43.

Ackerman, W.L. 2007. *Beyond the Camellia Belt.* Ball Publishing, Batavia, Illinois.

Ackerman, W.L. and D.R. Egolf. 1992. 'Winter's Charm', 'Winter's Hope', and 'Winter's Star' Camellias. *HortScience* 27: 855–856.

Aiello, A.S. 2005. Evaluating *Cornus kousa* cold hardiness. *American Nurseryman* 201 (5): 32–39.

Aiello, A.S., S. Dillard, E.I. Goff, and M. Conners. 2008. Evaluation of cold hardiness and ornamental characteristics of Korean provenances of *Camellia japonica.* Royal Horticultural Society: The Rhododendron, Camellia & Magnolia Group Yearbook: 26–31.

Aniśko, T. 2000. Collection Service. *American Nurseryman* 192 (11): 44–50.

Bensen, S.D., ed. 2000. New Plants for 2001: Shrubs. *American Nurseryman* 192 (12): 34.

Flint, H.L. 1997. *Landscape Plants for Eastern North America.* 2nd Edition. John Wiley and Sons, New York.

Meyer, P.W. 1985. Botanical riches from afar. *Morris Arboretum Newsletter* 14 (1): 4–5.

Yinger, B. 1989a. Plant Trek: In pursuit of a hardy camellia. *Flower and Garden* 33 (2): 104–106.

Yinger, B. 1989b. Plant Trek: On site with hardy camellias, Sochong Island, Korea. *Flower and Garden* 33 (3): 62–66.

Anthony S. Aiello is the Gayle E. Maloney Director of Horticulture and Curator at the Morris Arboretum of the University of Pennsylvania in Philadelphia, Pennsylvania.

Searching for Exotic Beetles

Nichole K. Campbell

When non-native species of plants, animals, and disease organisms are introduced to other regions they have the potential to become serious pest problems in their new location. Concern over the introduction of potentially damaging species has led the Plant Protection and Quarantine (PPQ) program—part of the USDA Animal and Plant Health Inspection Service—to increase its domestic surveillance for non-native species in the United States over the past several years.

Most exotic (non-native) species enter the United States through international movement of people, commodities, and conveyances. Most are accidental introductions, though some intentional introductions (primarily plants) have turned out to be invasive pests. Not all introduced species become agricultural or forest pests; typically, one in seven exotic species is considered invasive. There is often a lapse between the time the pest is introduced and the time that the pest is discovered or reported in the United States; unfortunately this often allows new pest populations to build.

Beetle Patrol

In 2009, PPQ is conducting exotic beetle trapping around the Boston port area as part of the USDA's national wood borer and bark beetle survey. The Boston port area may be a high-risk

PETER DEL TREDICI

A cargo ship heads toward the port of Boston, passing between Spectacle Island and Deer Island in Boston Harbor.

area for the introduction of new exotic forest pests because of the high volume of cargo imports that enter the United States through it.

Commodities entering the port are often shipped in solid wood packing material, a potential harbor for insect pests of trees. Prior to 2005, there were no regulations requiring the treatment of solid wood packing material for the prevention of pest introductions. Today, all foreign solid wood packing material must be fumigated or heat treated to prevent new forest pests from entering the United States through that very high-risk pathway.

The goals of the USDA's national wood borer and bark beetle survey are to obtain information about:

- The presence, distribution, or absence of target species.
- The advent of new species.
- Patterns of distribution throughout the United States and possible pathways for introduction.
- The phenology of target exotic species in the United States and their selection of hosts.
- The characteristics of high-risk habitats or sites.
- The survey methods themselves.

When selecting survey sites, we primarily target cargo transport companies, businesses that receive imports, and areas around the port of entry where there are host trees that could support the establishment of exotic beetles.

PPQ has chosen twenty locations within 15 miles of the port of Boston for the wood borer and bark beetle survey. One of the sites chosen this year is the Arnold Arboretum because of its close proximity to the Boston port and the presence of a wide variety of tree species in its collections.

Setting the Trap

The survey involves trapping and identifying beetles in order to determine if exotic species are present in the area. We placed three Lindgren 12-funnel traps at each of the twenty selected locations for a total of sixty traps in the Boston area. Each trap is baited with one, or a combina-

NICHOLE K. CAMPBELL

One of the Lindgren funnel traps at the Arnold Arboretum.

tion, of the following lures: ultra high release ethanol, ultra high release alpha-pinene, or the 3-ips lure. The volatiles in the lures simulate stressed or dying hardwood and softwood trees, the types of host trees that many of the exotic beetles are attracted to.

The traps are hung in trees, on poles, or on fences near target hosts. Traps are placed a minimum of 25 meters (82 feet) apart to prevent volatiles from mixing in the air and deterring beetles. Each trap has a collection cup at the bottom that is filled with non-toxic antifreeze to preserve the collected beetles. The trapping period will last from mid March through the end of August to cover a range of emergence periods of the target beetles. Bark and ambrosia beetles typically emerge in early to late spring, while larger wood-boring beetles typically emerge later in summer through fall. The traps are serviced on a bi-weekly schedule to collect any trap contents and replace lures as needed.

All of the trapped beetles will be sent to the Carnegie Museum of Natural History, Section of Invertebrate Zoology, in Pittsburgh, Pennsylvania. They will be screened by qualified experts to determine if they are the target exotic beetles or other non-native beetles.

Determining the potential invasiveness of these exotic beetles is difficult since there is very little research information available for most of them. Often, they are not studied in their native countries if they do not cause economic damage there. We can't predict exactly how an introduced beetle species will affect forests in the United States, but experts do try to make educated guesses.

If any exotic beetles are found they will be confirmed by PPQ experts, and state and local authorities will be notified. The USDA's New Pest Advisory Group (part of PPQ), in conjunction with state and local officials, would then evaluate the new pest risk and determine the appropriate action to take to protect our national forests and agricultural industries.

A Gallery of Beetles

Here are some of the exotic beetles targeted in the survey:

Hylurgus ligniperda (Red-haired Pine Bark Beetle)

NATIVE: Europe, Mediterranean areas, Africa, and parts of Asia

ENTERED U.S.: Introduced near Rochester, New York, in 1994. Found in a Lindgren funnel trap. Has been found in four counties.

HOST: *Pinus* spp. (pines) preferred. Also, *Abies* spp. (firs); *Larix* spp. (larches); *Picea* spp. (spruces); *Pseudotsuga* spp. (Douglas-firs)

DAMAGE: Affects bark, stem, root, trunk, and seedlings. Feed and develop in tunnels beneath the bark. They are know vectors of the root disease fungi *Leptographium* spp. and *Ceratocystis* spp.

WILLIAM M. CIESLA, FOREST HEALTH MANAGEMENT INTERNATIONAL, BUGWOOD.ORG

Red-haired (or golden-haired) pine bark beetles under the bark of a Monterey pine (*Pinus radiata*).

Ips sexdentatus (Six-toothed Bark Beetle)

MILAN ZUBRIK, FOREST RESEARCH INSTITUTE – SLOVAKIA, BUGWOOD.ORG

Six-toothed bark beetles in galleries.

NATIVE: Mainland Asia and Europe

ENTERED U.S.: Has been intercepted at ports of entry. Has not been found domestically beyond ports.

HOST: *Pinus* spp. (pines) preferred. Also, *Abies* spp. (firs); *Larix* spp. (larches); *Picea* spp. (spruces); *Pseudotsuga* spp. (Douglas-firs)

DAMAGE: Affects inner bark, leaf, stem, and whole plant. Mates, develops, and feeds in tunnels beneath the bark. Mainly attacks stressed or dying trees. It can kill trees of commercial importance. It also introduces blue stain fungi (*Ophiostoma* spp.) into host trees which hasten the death of tree, discolor wood, and can result in loss of lumber grade and value.

Two Highly Destructive Exotic Beetles

Unfortunately, many exotic wood-boring beetles are not attracted to traps baited with volatiles and can only be surveyed for visually. This requires trained spotters using binoculars from ground level, or professional tree climbers knowledgeable in insect signs and symptoms. The **Asian longhorned beetle (ALB) (*Anoplophora glabripennis*)** is a highly destructive invasive beetle that can only be surveyed for in this manner. There is ongoing research to identify more effective survey methods for this devastating pest.

KENNETH R. LAW, USDA APHIS PPQ, BUGWOOD.ORG

Larvae of the Asian longhorned beetle tunnel into the heartwood of live healthy trees, eventually killing their hosts. Favored species are maples, birches, Ohio buckeye, elms, horse chestnut, and willows. ALB, and efforts to eradicate it, have resulted in the loss of thousands of street trees in several states. ALB was detected in Worcester, Massachusetts, in August, 2008, and its potential spread is of great concern in New England. Volunteers will be educated to survey for ALB throughout Massachusetts this year. Visual surveys and education outreach for ALB will be conducted in all New England states during 2009. For more information about ALB, please visit: http://www.aphis.usda.gov/oa/alb/alb.html or http://massnrc.org/pests/alb/

Emerald ash borer (EAB) (*Agrilus planipennis*) is another highly destructive beetle that has spread in regions of the United States and Canada. EAB attacks ash trees (*Fraxinus* spp.) and has been moved from its introduction point in Michigan to other states primarily through movement of nursery stock and firewood. We have not detected EAB in Massachusetts yet, but a survey for it is planned for this year. The Massachusetts Department of Conservation and Recreation, Division of Forestry, will place purple panel sticky traps baited with lures at twenty high-risk locations such as campgrounds, nurseries, and wood processors. Currently, there are no plans to trap inside the Arnold Arboretum for EAB because it is not a high-risk location for the introduction of this pest. For more information about EAB, please visit: www.emeraldashborer.info

DAVID CAPPAERT, MICHIGAN STATE UNIVERSITY, BUGWOOD.ORG

Ips typographus (European Spruce Bark Beetle)

NATIVE: Europe and Asia

ENTERED U.S.: Has been intercepted in traps in Indiana (1995) and Maryland (2002). It is not known to be established in the U.S.

HOST: *Picea* spp. (spruces) preferred. Also, *Abies* spp. (firs); *Larix* spp. (larches); *Pinus* spp. (pines); *Pseudotsuga* spp. (Douglas-firs)

DAMAGE: Affects bark, crown, foliage, leaf, stem, and whole plant. Considered one of the most serious pests of spruce in Europe. It vectors a blue stain fungus (*Ceratocystis polonica*) which can also kill the host. It causes major economic losses when it is in outbreak numbers and can cause severe decline in spruce populations within its native range. Males aggregate and colonize a stressed tree by boring into the bark and preparing nuptial chambers. The females are then attracted to the chambers to mate. The females lay eggs in maternal galleries where the larva will develop. They can have multiple generations in a year depending on temperature.

MILAN ZUBRIK, FOREST RESEARCH INSTITUTE – SLOVAKIA, BUGWOOD.ORG

Dead spruce trees in Slovakia, killed by European spruce bark beetles.

Xyleborus seriatus (No common name; very little is known about this beetle.)

NATIVE: China, Russia, Japan, Korea, Taiwan

ENTERED U.S.: Intercepted in Lindgren trap in Massachusetts in 2005, the first North American record. This beetle was also trapped in Maine in 2008.

HOST: *Acer* spp. (maples), *Aesculus* spp. (buckeyes), *Alnus* spp. (alders), *Betula* spp. (birches), *Cryptomeria* spp., *Fagus* spp. (beeches), *Larix* spp. (larches), *Pinus* spp. (pines), *Prunus* spp. (cherries), *Quercus* spp. (oaks), *Thuja* spp. (arborvitae), *Tsuga* spp. (hemlocks), etc. Large possible host range.

DAMAGE: Very little data. Is known to be associated with *Ambrosiella* fungi. Spores of a symbiotic fungi are carried on their bodies to new galleries. Larvae and adults feed on this fungi growing between the bark and sapwood. Thought to be a secondary pest and will not kill healthy trees. Several *Xyloborus* species are potential survey targets.

Xylotrechus hircus (No common name; very little is known about this beetle.)

NATIVE: Native to Eastern Russia, China, Korea

ENTERED U.S.: Intercepted in Lindgren trap in Oregon in 1999; not known to be established.

HOST: *Betula* spp. (birches)

DAMAGE: No information available. Species damage unknown. Several *Xylotrechus* species are potential survey targets.

Nichole K. Campbell is a pest survey specialist with the USDA, APHIS, Plant Protection and Quarantine program.

Index to *Arnoldia* Volume 66

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

D

E

Q

R

S

T

UVW

XYZ

Index compiled by Rosalie Davis.

Early Bloomer: *Hydrangea paniculata* 'Praecox'

Sue A. Pfeiffer

During the second half of the nineteenth century, the latest trend in the gardening world was the acquisition and display of exotic plants. At the time, Darwin's theory of evolution was changing the scientific community, and Harvard botanist Asa Gray's paper noting the similarities between eastern North American and eastern Asian floras had recently been published.

By the early 1890s, the still young Arnold Arboretum was beginning to take shape. C. S. Sargent, the first director of the Arboretum, had become highly interested in Gray's work comparing our native flora to that of eastern Asia. His desire to plant the Arboretum with every tree capable of surviving the New England climate led him to seek exotic Asian species from similar climates. Although European plant species were easily obtained, acquiring plant material directly from Asia was still difficult during this era. Wanting to view the native flora and personally judge the plants for their landscape value, Sargent set off on a ten week expedition to Japan in the fall of 1892. He collected extensively on the islands of Hondo and Yezo (now known as Honshu and Hokkaido), returning with seeds of 200 species, including *Hydrangea paniculata,* panicle hydrangea.

Hydrangea paniculata is native to Japan and southern Sakhalin Island in Russia as well as eastern and southern China where it is typically found in mixed forests or open hillsides. A large shrub or small tree, panicle hydrangea may reach 20 feet (6 meters) in height, though in New England landscapes a mature height of 10 to 13 feet (3 to 4 meters) is typical. Its large, simple, dark green leaves have toothed margins and a slightly undulating surface. Panicle hydrangea produces conical compound inflorescences 6 to 8 inches (15 to 20 centimeters) in length at the tips of branches. The inflorescences are comprised of two types of florets; a large number of small, cream-colored, fertile florets, plus a scattering of larger, showier, white, sterile florets. The sterile florets often become speckled or flushed with pink as they age. In New England the species flowers from early August into September.

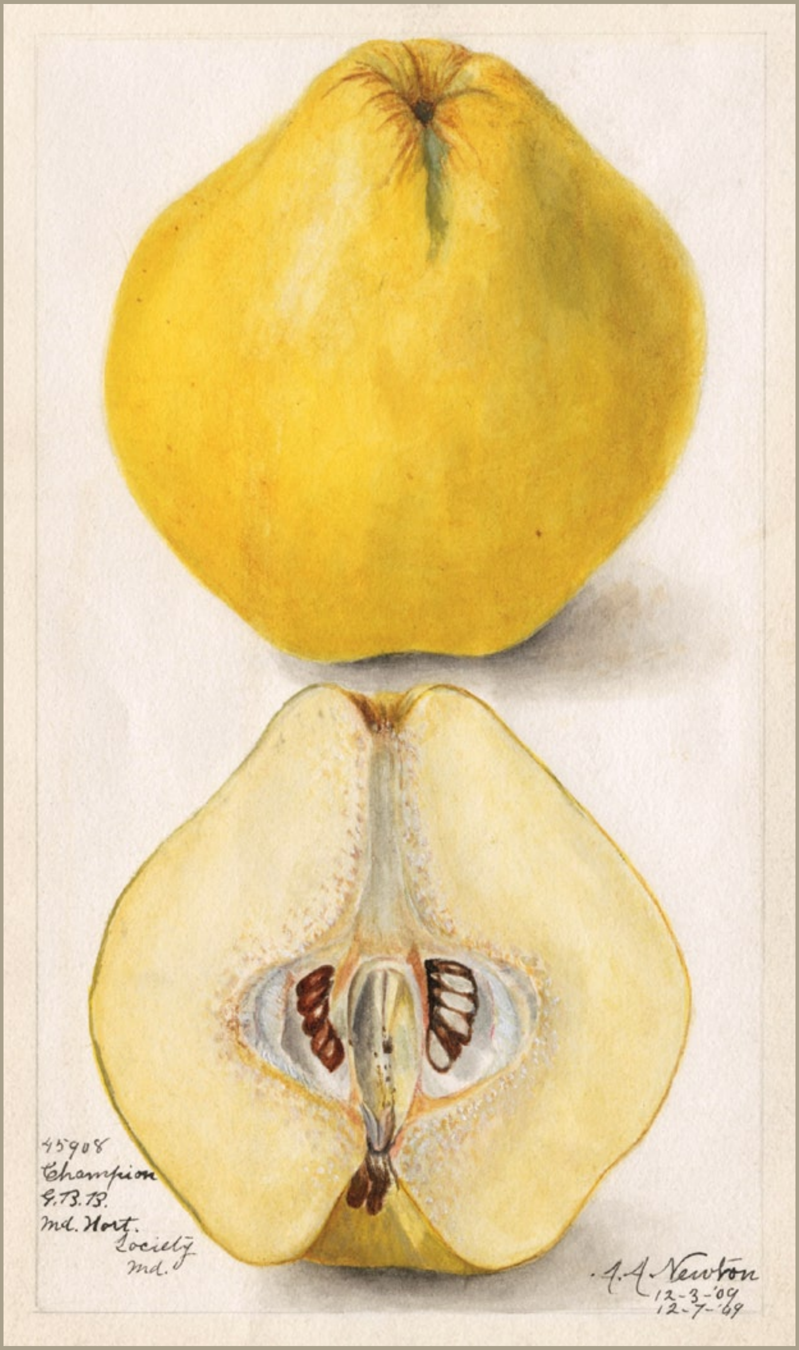
When plants were grown from the *Hydrangea paniculata* seeds collected by Sargent, one was observed to flower far earlier in the summer than the others. Sargent noted this early bloomer in an issue of the Arboretum publication *Garden and Forest* in September 1897, less than five years after the seed was collected. Several years later, the plant was named 'Praecox' (meaning "premature") by Arboretum taxonomist Alfred Rehder. *Hydrangea paniculata* 'Praecox' is a vigorous, fast growing, erect shrub which tends to flower three to six weeks earlier than the species. At the Arboretum it typically starts to bloom in early to mid July. Its beauty in the landscape was described in 1922 by Sargent himself: "When in flower in early July it is one of the handsomest shrubs in the Arboretum," and in 1927 by E. H. Wilson: "Well worth the attention of all interested in hardy plants."

At the Arboretum, the original plant—now 116 years old—can be found in the Bradley Rosaceous Collection. Although not a member of the rose family, the plant (accession 14714-A) has remained in its original location (formerly the Shrub Collection) because of its importance as a type specimen. The plant is now 15.5 feet (4.7 meters) tall and 24.5 feet (7.5 meters) wide. Every July, visitors are drawn to its incredible display of flowers borne on the many arching stems clad in handsome gray-brown exfoliating bark. Another specimen (accession 14714-1-A), propagated from the original plant in 1905, stands nearby and is equally impressive.

Panicle hydrangeas have become very popular in the nursery trade in recent years, and many new cultivars have been introduced. 'Praecox' remains the earliest blooming cultivar and is valuable for extending the panicle hydrangea bloom season. While not as readily available as some cultivars, 'Praecox' is well worth seeking out and acquiring.

Sue Pfeiffer is a Curatorial Fellow at the Arnold Arboretum.




45908
Champion
G.B.B.
Md. Hort.
Society
Md.
A.A. Newton
12-3-'09
12-7-'09