arnoldia

The Magazine of the Arnold Arboretum

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Inside back cover: This magnificent specimen (accession 5883-A) of Sargent oak (*Quercus* x *sargentii*) crowns the State Lab Slope area at the Arnold Arboretum. Photo by Nancy Rose.

Tree by Tree, Yard by Yard: Replanting Worcester's Trees

Mollie Freilicher

The trees of Worcester, Massachusetts, have had a hard time recently, as Asian longhorned beetle (ALB) (*Anoplophora glabripennis*) has decimated public and private trees there and in surrounding communities. What may be less well known is that the invasion of ALB is just the most recent blow in what has been a difficult century for trees in the Worcester area. Some of the issues that the city has faced, such as canopy defoliation from gypsy moth (*Lymantria dispar*) and tree death from chestnut blight (*Cryphonectria parasitica*) and Dutch elm disease (*Ophiostoma ulmi*), were not unique to Worcester, affecting many communities across the eastern and central United States. Other threats have been more localized. Worcester, along with much of New England, suffered major tree loss in the 1938

MASSACHUSETTS HISTORICAL SOCIETY COLLECTIONS

Disasters have hit Worcester's trees before, including the devastating 1953 tornado. Photo of tornado damage by Alfred K. Schroeder, June 1953.

MICHAEL BOHNE, BUGWOOD.ORG

PA DEPT. OF CONSERVATION AND NATURAL RESOURCES, BUGWOOD.ORG

An adult male Asian longhorned beetle. ALB larvae tunnel into host trees, damaging essential conductive tissues. After pupating, adult beetles emerge from large, round exit holes, as seen on this maple trunk.

hurricane, and a tornado in 1953 devastated parts of Worcester. More recently, the ice storm of 2008 damaged many trees, some beyond recovery, in the Worcester area. The ongoing onslaught has made it difficult for planting efforts to keep up with tree losses.

Following the 1953 tornado and the already significant losses from Dutch elm disease, Worcester began growing maples and ramping up its planting efforts. Maples, especially Norway maple (*Acer platanoides*), known for its urban adaptability, became a mainstay of the planting program. Over the next six decades, maples came to comprise 80% of street trees, leaving many of the city's public trees vulnerable to a maple-specific insect or disease.

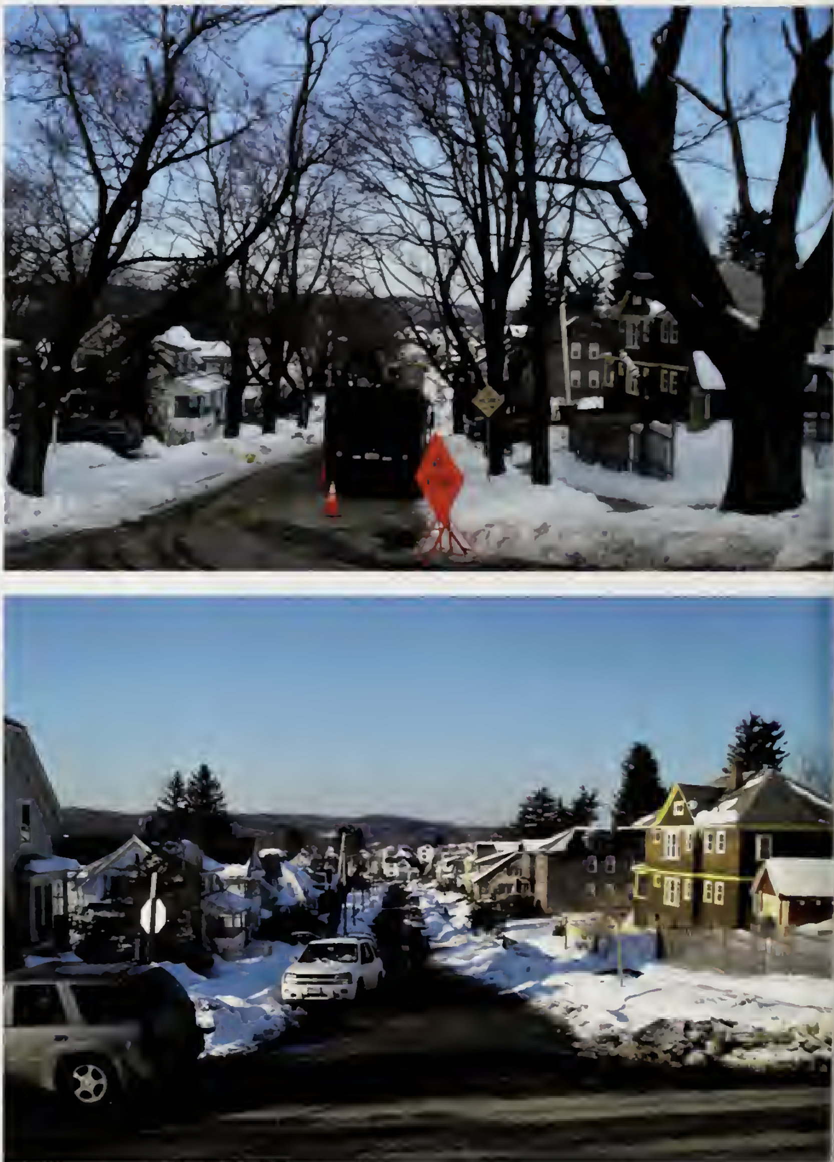
Enter Asian longhorned beetle. This maple-loving insect was found in Worcester in August 2008 and has since been detected in four surrounding towns, spurring the creation of a regulated area in Worcester County that now measures 98 square miles. Like the hurricane and tornado, ALB quickly changed the landscape of Worcester's northern neighborhoods. Residents felt bereft of trees and looked to state and federal authorities to come forward with a solution. Even in areas without ALB, communities across the United States have been losing trees to development, to neglect over time, and to a lack of adequate replacement programs. Add up Worcester's experience with the hurricane, the tornado, the ice storm, and ALB, and the importance of replanting becomes clear. On a psychological level, replanting is also an important part of the healing process following the losses to ALB and the ice storm.

Tree Benefits

While urban residents have enjoyed shade and the aesthetic benefits of trees, in the last several decades researchers have studied the ecological, psychological, and social benefits of trees in urbanized areas. It is now known that trees are important for air quality, watershed health, carbon dioxide reduction, soil quality, noise reduction, property values, and psychological and social well-being. Street trees alone in Worcester provide over $2.3 million in annual benefits such as those described above. That is not even counting the thousands of trees in parks, yards, and woodlots across the city. The replacement value for the 17,000 street trees accounted for in a 2006 street tree inventory was close to $100 million. Urban forests are valuable indeed.

Tree Loss and ALB Protocol

To examine the legacy of the past planting efforts in Worcester, we can look at street trees, often the most visible component of planting programs. The street tree inventory of Worcester identified the distribution of street trees across neighborhoods throughout the city. Neighborhoods with the most street trees also had high numbers of maples: Burncoat, Greendale, Salisbury Forest Grove, and the Salisbury Street area. These areas have close to a thousand or more maple street trees and represent some of the areas with trees most vulnerable to ALB. With ALB in the maple-laden Greendale and Burncoat neighborhoods and with nearby industrial areas and major transit corridors that can serve as entry points and modes for spreading ALB, there was a perfect storm for an infestation of ALB. Since the only way to deal with an infested tree is to cut it down and chip it, there is potential for significant tree loss when ALB is present in high numbers. The density of infested trees in the Greendale and Burncoat areas, and the density of egg sites and exit holes on the infested trees themselves, resulted in the removal of infested trees and surrounding host trees that were also high risk for ALB infestation. The number of infested trees has not reached the soaring levels seen in 2008, but Worcester and the surrounding communities in the regulated area, (Auburn, Holden, West Boylston, Boylston, and Shrewsbury) have all been affected by the beetle and, as of May 2011, over 29,000 trees have been removed.



Granville Avenue in Worcester, Massachusetts, as removal of street trees begins, and the barren view afterwards.

In the heavily infested Greendale and Burncoat neighborhoods, some residents lost most, if not all, trees from their lots. For many longtime residents, the loss of trees was an emotional experience. Some streets that had been lined with maples quickly became barren. Residents felt the character of their neighborhoods had completely changed. Images of empty streets were reminiscent of pictures following the tornado, when some streets were stripped of all trees. With the losses to ALB and the ice storm, the opportunity arose to reshape the urban forest—to improve diversity by planting a variety of non-host trees (trees that cannot support ALB), to move away from monocultures of maples, to strategically place trees along streets, in parks, and on private property to ensure that they have adequate growing space now and in the future, to educate residents about the value of trees and how to care for and maintain them, and to keep track of the new trees over time. The scale of such a replanting effort was larger than in any of the other ALB infested areas in the United States (parts of New York, Illinois, and New Jersey).

Planning the Plantings

The lead federal agency in the Massachusetts ALB Cooperative Eradication Program is the United States Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) and the lead state agency is the Massachusetts Department of Conservation and Recreation (DCR). Replanting has been a component of all ALB programs in the United States and the United States Forest Service (USFS) is the lead agency for working with cooperators toward this end. Some cooperators in the Worcester area include municipalities and non-profit organizations that have stepped up

MOLLIE FREILICHER

Professional staff, volunteers, and property owners have all been involved in tree replanting efforts. Here a DCR team in Boylston plants trees.

MOLLIE FREILICHER

Trees at the holding yard are loaded for delivery to planting sites.

planting efforts. Congressman Jim McGovern and Lt. Governor Tim Murray founded the Worcester Tree Initiative (WTI) in 2009 with the goal of planting 30,000 trees in the Worcester area over a five-year period. The WTI works toward this goal through tree giveaways, tree plantings, and training programs for volunteers. At tree giveaways, attendees learn how to plant and care for a tree properly before taking home a tree of their choice to plant in their yard. The WTI also works with school volunteers and students to plant trees on school properties and also holds "train the trainer" events to train volunteers in tree planting and care so that they can, in turn, train others and be part of WTI's outreach events.

The City of Worcester has also increased its planting efforts. Since 2009, the city Forestry Division has planted hundreds of new trees along streets. In 2010, the city implemented an "adopt a tree" program to encourage residents whose properties do not have trees, or who have trees vulnerable to disease or insect infestation, to accept a tree planted by the city. The Forestry Division has also worked with the WTI to assist with school and park plantings in Worcester. Municipalities and non-profit organizations work together to ensure that efforts are not duplicated and that each entity reaches out to help replant trees in the area.

In the Worcester area, there have been two government-funded replanting programs that the DCR has administered with federal funds. The two programs share the basic goals of replanting trees and improving diversity, however the execution and scope of the programs differ. The first was a $500,000 program funded by the USDA that began in spring 2009 and wrapped up in spring 2010. The goal of the USDA-funded planting was to mitigate the impact to the communities where host trees were removed because of ALB infestations. The USDA-funded planting specifically targeted property owners who lost trees to ALB in the 2-square mile core area where most removals occurred in 2009. For a property owner to be eligible for a tree with the USDA planting, the owner had to have lost a tree over six inches diameter at breast height (dbh) from a maintained area of the property. This put the focus on replacing landscape and specimen trees on properties in areas where natural regeneration could not be expected. Naturalized, unmaintained areas that could regenerate on their own were not included in this planting. Already two years on, property owners are seeing these areas come back to life.

By spring 2009, the funding was in place from the USDA to plant approximately 800 trees in the areas first affected by tree removals. Properties that lost trees to ALB were identified from the USDA database and DCR foresters mailed information to property owners about replanting. Interested property owners responded and staff scheduled visits to select trees and locations. Additionally, staff went door to door to reach property owners who did not respond.

As the USDA planting program was wrapping up, the next program was just getting started. The American Recovery and Reinvestment Act of 2009 (ARRA) provided $4.487 million in funding for the second planting program that got underway in spring 2010. The ARRA planting will continue into 2012. It targets all property owners in the regulated area regardless of whether they lost a tree to ALB. The only limit to the number of trees a property can have is the number of trees the property could support. In addition to increasing diversity and the number of trees on private property, the ARRA planting aims to restore public shade trees, to plant 15,000 trees on private property, to restore forest canopy and watershed functions affected by reduced canopy, and to create jobs. As of May 16, 2011, over 4,700 trees have been planted through the ARRA program. In addition to working with residents to site trees, DCR foresters also conduct inspections of trees planted in previous seasons to ensure that trees

NANCY ROSE

Though popular ornamental trees, mountain ashes (*Sorbus* spp.) were not offered in replanting programs because of their suscebtibility to ALB. *S. aucuparia* 'Michred' shown here.

Host Genera for Asian Longhorned Beetle

Acer	Maple
Aesculus	Horse chestnut
Albizia	Mimosa
Betula	Birch
Celtis	Hackberry
Fraxinus	Ash
Platanus	Sycamore
Populus	Poplar
Salix	Willow
Sorbus	Mountain ash
Ulmus	Elm
Cercidiphyllum	Katsura tree
Koelreuteria	Goldenrain tree

are establishing adequately. These inspections are also part of a larger data collection effort on the plantings, which will provide valuable information for other communities dealing with ALB and subsequent tree planting efforts.

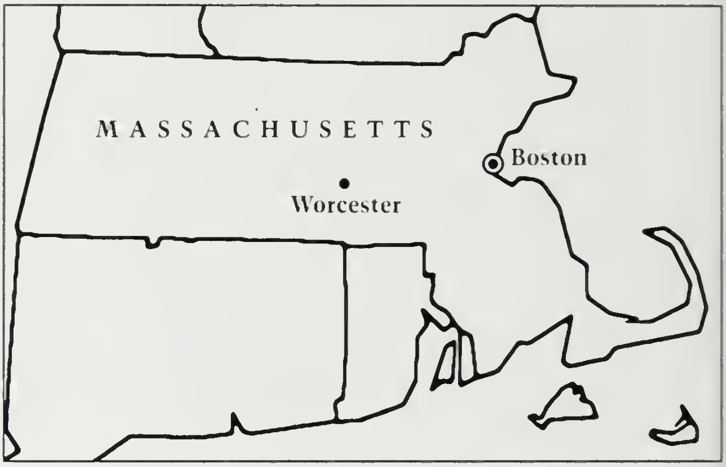
Selecting Species

An early task of the replanting programs was to determine a species list to offer. First and foremost, trees for replanting could not be host trees for ALB. The tree species also had to tolerate urban conditions and be relatively free of insect and disease problems. It was also important to have trees that ranged in size and character at maturity from small ornamental trees to large shade trees and included both deciduous and evergreen species. The species also had to be readily available in large quantities from the nursery, a factor that ruled out some otherwise practical candidates such as Kentucky coffeetree (*Gymnocladus dioicus*) and Serbian spruce (*Picea omorika*). Foresters selected a mix of native and non-native species (see Table 1).

Property owners wanted trees for a variety of reasons, including shade, ornamentation, and privacy, and a diverse list helped meet those needs. With demand high for some species on the list, occasionally some residents had to accept substitutes, especially in the case of cherries (*Prunus* spp.) and crabapples (*Malus* spp.). Demand was so high for some selections that nursery supply could not keep up and these species, including Japanese tree lilac (*Syringa reticulata*) and ginkgo (*Ginkgo biloba*), had to be removed from the planting list. The initial list included 18 species and this list has evolved to include 22 species for the upcoming planting seasons.

ALB Regulated Area

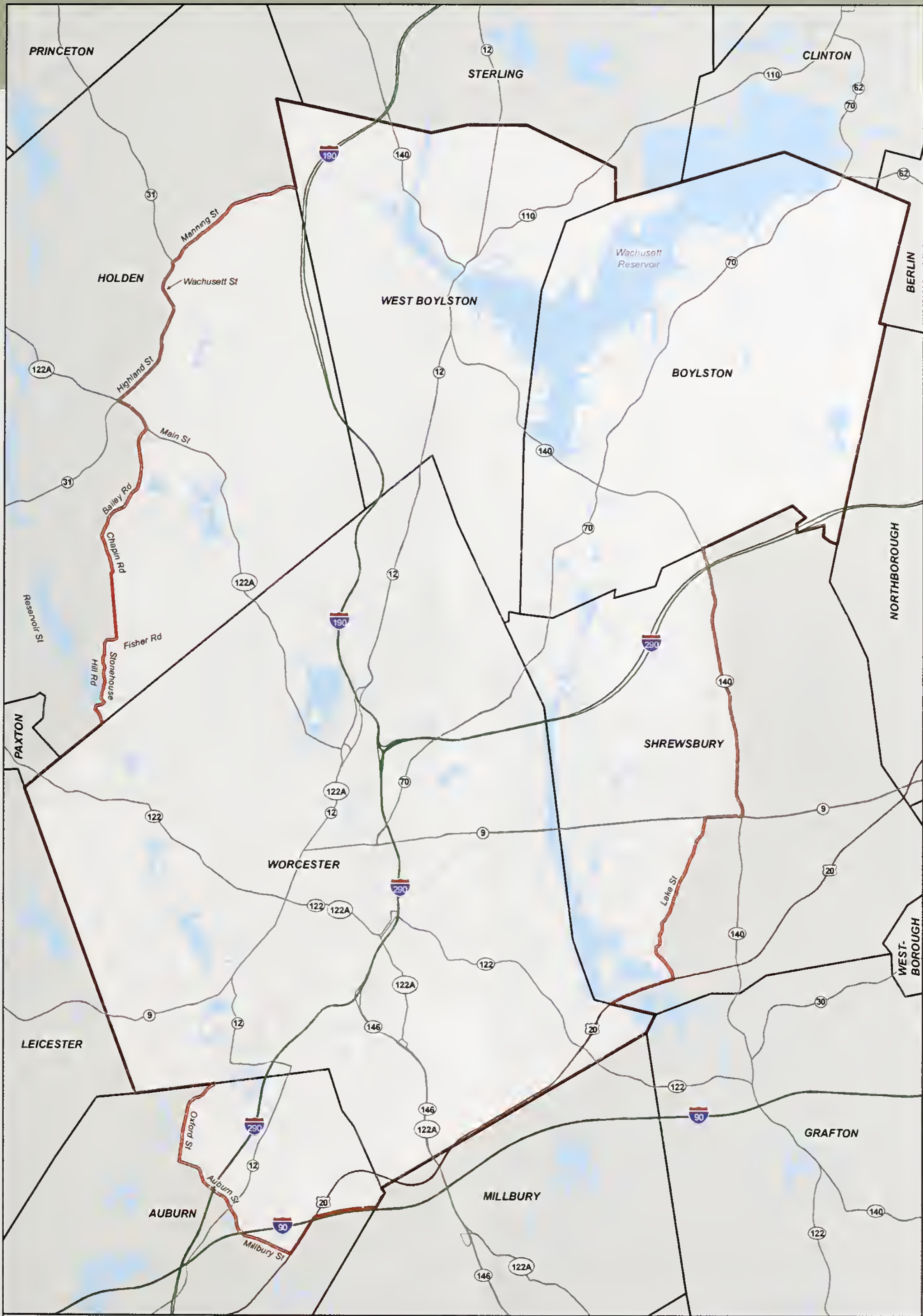
The map on the facing page shows the 98-square-mile regulated area for Asian longhorned beetle infestation in Worcester County. Firewood, green lumber, branches, roots, logs, debris, and nursery stock of host genera is restricted from leaving the regulated area. The boundary is determined by creating a 1.5-mile buffer around infested trees, so as infested trees are found near the edges, the regulated area expands.



Current Infestation Information

The Asian Longhorned Beetle Cooperative Eradication Program is a partnership between the United States Department of Agriculture's Animal and Plant Health Inspection Service and U.S. Forest Service, the Massachusetts Department of Conservation and Recreation, the Massachusetts Department of Agricultural Resources, and the towns and cities of the regulated areas. Chart is current as of May 24, 2011. For up-to-date information on the program go to: http://www.massnrc.org/pests/alb/

	Worcester County	Boston/ Brookline
Current Staff	147	9
Quarantine (Square Miles)	98	10
Infested Trees Removed	19,368	6
High Risk Trees Removed	10,250	0
Trees Planted	5,898	12



Regulated Area to Suppress and Control the Asian Longhorned Beetle
May 9, 2011

- Regulated Area
- Lakes and Ponds
- Town Boundary
- Interstate
- U.S. Highway
- State Route
- Non-numbered route

dcr Massachusetts

Geographic data supplied by the Office of Geographic and Environmental Information (MassGIS) and DCR GIS.

Outreach and Property Owner Visits

The outreach from the ALB Cooperative Eradication Program for both planting programs was similar. From the outset, it was important for staff from DCR and APHIS to visit property owners to discuss options for replanting. Many property owners were inexperienced with trees, so a personal visit was important not only to assess properties for tree species suitability but also to educate residents about trees and tree care. With personal visits, we could ensure that the right tree was selected for the right place and, just as importantly, that a tree selected was one that the property owner liked and would maintain. After all, these trees have to survive if they are going to provide enjoyment and benefits into the future. In addition to granting permission for tree planting, property owners signed an agreement stating that they would maintain trees for two years including watering, mulching, and removing stakes if they were used. Residents also were eager to share their experiences with the tree removals and often used the site visits as part of their healing process in their discussions with staff.

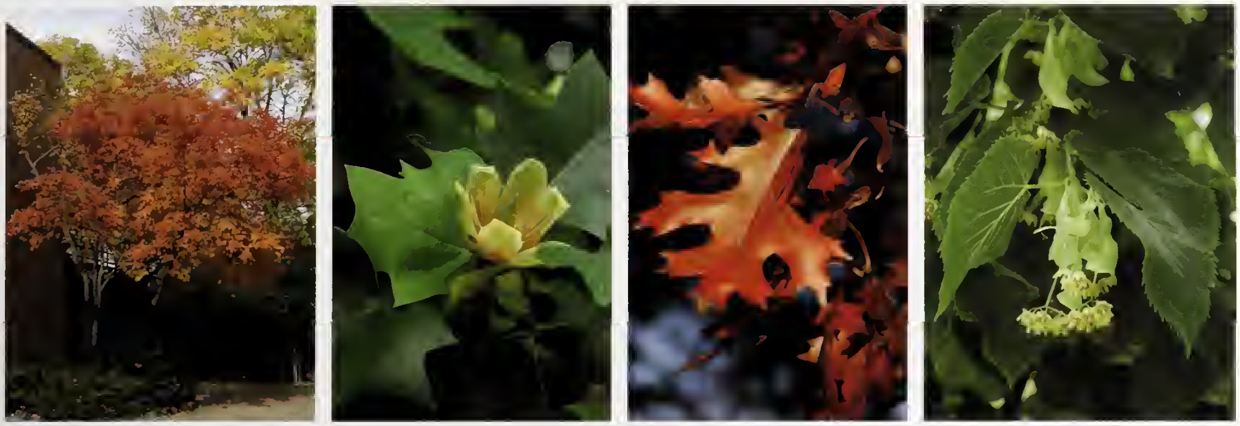
NANCY ROSE

Its narrow, upright form makes Serbian spruce (*Picea omorika*) a good choice for urban sites, but it was not readily available from nurseries so could not be offered in the replanting programs.

Flowering cherries (*Prunus* spp.) were popular choices for homeowners participating in replanting programs.

Learning from Other Replanting Programs

In June 2009, Eric Seaborn, the Program Coordinator for DCR Urban and Community Forestry and Alan Snow, the DCR Community Action Forester, traveled to New York for a workshop on how New York and New Jersey ALB programs conducted their plantings. While Seaborn and others had already devised the basic strategy for the replanting and developed the methodology for both plantings, the workshop granted the opportunity to hear about successes from the New York and New Jersey replanting efforts and to view materials officials there used in outreach. The Worcester



NANCY ROSE (ALL PHOTOS)

Trees selected for the replanting effort include (left to right) seviceberry (*Amelanchier* spp.), tuliptree (*Liriodendron tulipifera*), red oak (*Quercus rubra*), and linden (*Tilia* spp.).

Table 1. Replanting List for Massachusetts Regulated Area.

This represents current and past species that have been offered in the replanting program.

LARGE SHADE TREES	
Carpinus caroliniana	American hornbeam
Cladrastis kentukea (syn. *lutea*)	Yellowwood
Fagus sylvatica	European beech
*Ginkgo biloba**	Ginkgo
Gleditsia triacanthos	Honeylocust
Larix spp.	Larch
Liquidambar styraciflua	Sweetgum
Liriodendron tulipifera	Tuliptree
Metasequoia glyptostroboides	Dawn redwood
Nyssa sylvatica	Blackgum
Ostrya virginiana	American hophornbeam
Quercus alba	White oak
Quercus bicolor	Swamp white oak
Quercus coccinea	Scarlet oak
Quercus palustris	Pin oak
Quercus rubra	Red oak
Tilia spp.	Linden/basswood
ORNAMENTAL TREES	
Amelanchier spp.	Serviceberry
Chionanthus virginicus	Fringetree
Cornus spp.	Dogwood
Malus spp.	Crabapple
Prunus spp.	Cherry
*Syringa reticulata**	Japanese tree lilac
EVERGREEN TREES	
Abies concolor	White fir
Picea pungens	Colorado spruce
Pinus strobus	Eastern white pine
*Thuja occidentalis**	American arborvitae

*No longer offered

area replanting built on those efforts, especially with regard to tree care information that was distributed to residents.

Database and Information Tracking

On top of the planting, diversity, and watershed goals for the USDA and ARRA plantings, DCR is gathering information on the trees planted for a central database. The database includes data from the USDA and ARRA plantings as well as other organizations planting in the regulated area including the WTI and the City of Worcester. With so much planting in the Worcester area, there is a great opportunity to study the fates of newly planted trees in New England communities. Additionally, there will be chances to investigate many aspects of tree planting, establishment, and survival on a large scale.

To keep track of trees, DCR foresters use tablet computers enabled with GPS and sketch-mapping software . The Forest Service provided equipment and technical assistance to adapt software used for forest health monitoring in Massachusetts so that it could be used for the replanting. This software has eased data collection and facilitated the presentation of the planting data. When foresters are on site visits with property owners, the software enables the foresters to see the property on an orthophoto (a type of aerial image used in Geographic Information Systems [GIS]), and drop a point on the map where a tree is to be placed. Once the forester draws the point on the map, a window opens where the forester can enter information on the tree, the property, and the contact information for the property owner. The software then creates a file that is usable in any GIS software. This file contains both the data the foresters have input as well as the spatial data. Foresters use this file to generate the tree order for the nursery. Foresters also use this software to conduct a post-planting inspection. It is this information, the data from the final inspection, that goes into the central database and that will provide a baseline of data on the newly planted trees. Foresters are also beginning to use the USDA Forest Service's i-Tree

MOLLIE FREILICHER

Trees are readied for planting at Quinsigamond Community College during 2009, the first year of the USDA replanting program.

Data on these recently planted street trees on Fairhaven Road in Worcester will be gathered for a central database that will help evaluate tree establishment and survival.

software to explore the structure of and the environmental services provided by the newly planted trees.

What's Next?

As of May 24, 2011, the replanting program has planted nearly 6,000 trees and has found homes for over 9,000 trees for the spring and fall 2011 plantings. It will be some years before the streets of Worcester are lined with large trees again, but the diversity of trees that are being planted today will help buffer the city against future pests. Strategic placement of trees now can also help eliminate later conflicts with infrastructure such as power lines. With the many partners involved, and support at the state and federal level, Worcester and the rest of the regulated area is poised for an exciting recovery.

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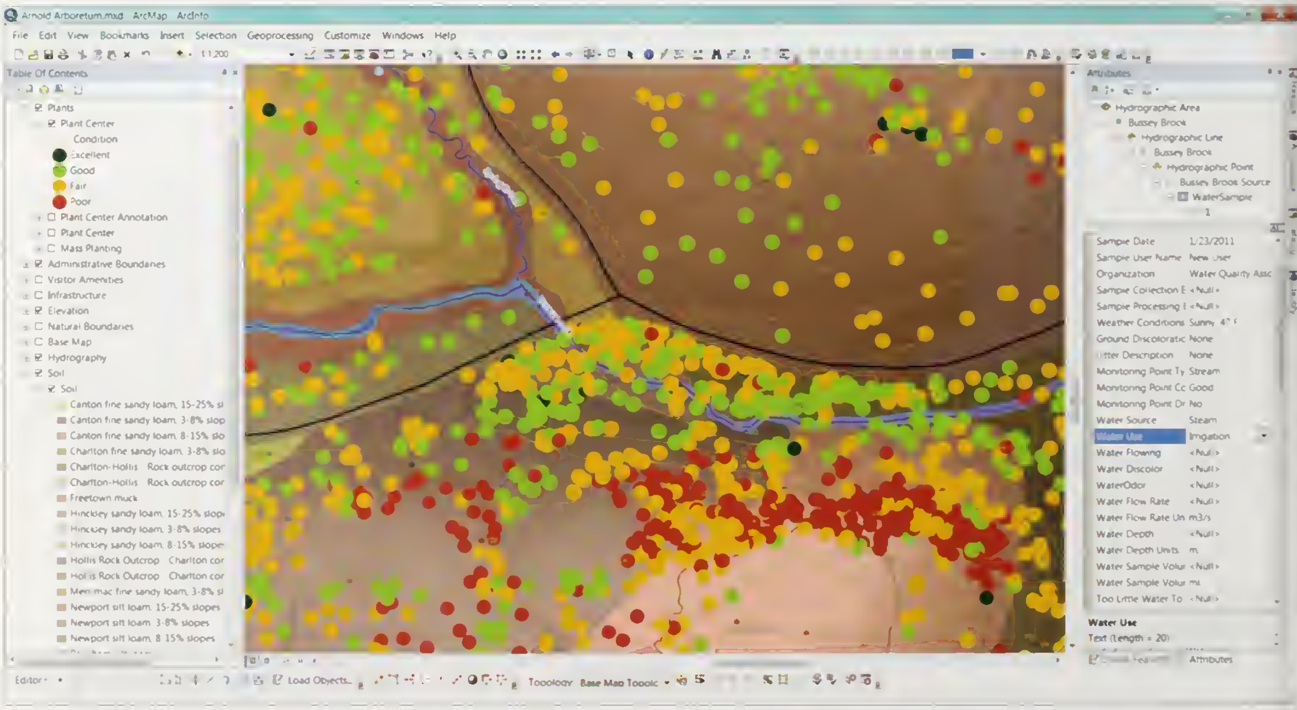
Geographic Information Systems for the Plant Sciences

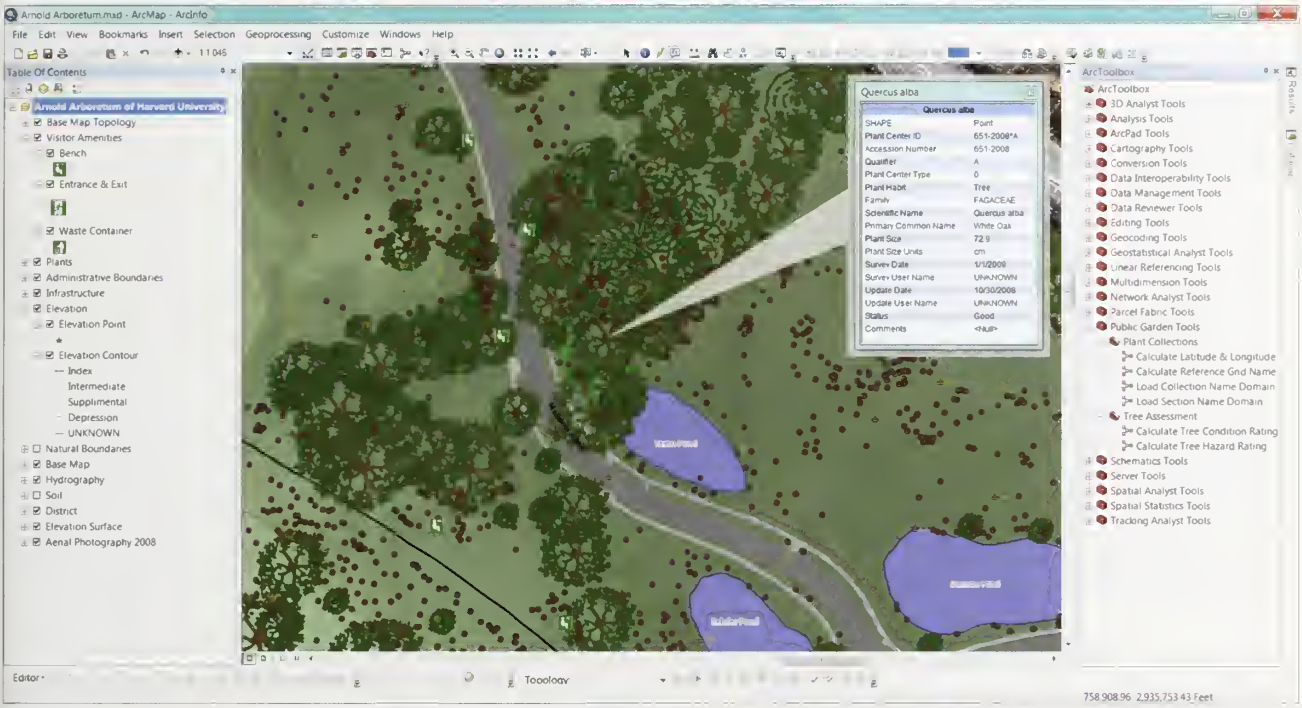
Brian J. Morgan

The disciplines of the plant sciences and geography have been intertwined as far back as circa 300 BCE when the Greek scholar Theophrastus, frequently referred to as the "Father of Botany," described the habitat and geographical distribution of plants in his first work on the subject titled *Enquiry into Plants (Historia Plantarum)*. It wasn't until the sixteenth century and the establishment of the world's first botanical garden in Padua, Italy, that the leading icon of modern geography, the map, found its permanent place in the plant sciences by documenting the locations of woody plants in the garden for identification purposes. Today, location—the unifying theme of geography—has taken on an even more important role in the plant sciences where it is considered an essential attribute to record, and variable to consider, for the study of plants in fields ranging from agriculture to ecology.

In the digital age that we live in, the cataloging of plants and the analysis of the influence that location plays on the growth and distribution of them is increasingly performed using geographic information systems (GIS). GIS is commonly defined as a system of personnel, computer hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS merges the visual aspects of a map with the analytical power of a database, and allows plant scientists to view, question, understand, interpret, and visualize data in many ways that reveal relationships, patterns, and



Analysis of plant condition at the Arnold Arboretum reveals a cluster of plants in poor condition (indicated by red dots), in this case mostly eastern hemlocks (*Tsuga canadensis*) damaged by hemlock wooly adelgids.



GIS is used to explore plant collections in public gardens. By linking maps with the collections database, details about accessions such as this white oak (*Quercus alba*) are readily available.

trends in the form of maps, globes, reports, and charts. In our rapidly changing world, GIS gives scientists the power to quickly understand and formulate solutions to the problems presented by our most complex issues such as population growth, resource consumption, and climate change.

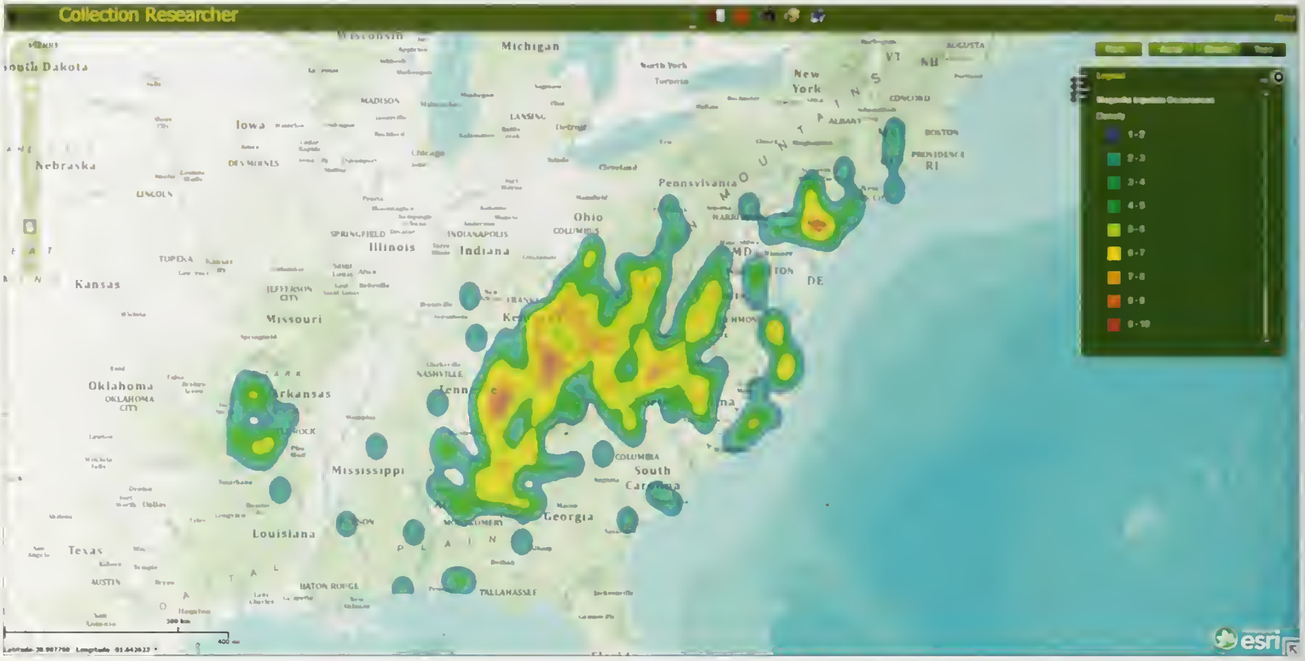
COMPONENTS OF A GIS

Personnel and Equipment

The foundation of a powerful GIS is built with the personnel required to develop and manage the system. GIS managers and analysts usually have a strong background in the principles of cartography and database management systems, and a number of graduate and certification programs have appeared in the last decade to support this education. Fortunately, recent advances in simple desktop GIS software like Esri ArcGIS Explorer for the visualization and analysis of any geographic data, and in web-based solutions like Google Maps, have made the use of GIS technology accessible to all.

With expert personnel in place, the next item needed for a geographic information system is the computer software used to capture, manage, analyze, and display spatial data. Desktop GIS software packages like Esri ArcGIS Desktop or Quantum GIS are most commonly used to perform the majority of GIS functions, but server-based systems like Map Server and Esri ArcGIS Server are increasingly being employed to share data, maps, and even analysis capabilities with users through their web browsers without the need for training or special software. These server systems even allow for the collection and use of GIS data and maps on mobile devices like smartphones and tablets that contain location sensors such as a global positioning system (GPS) receiver.

The computer hardware used for a desktop GIS is largely dependent on the requirements of the software selected, the amount and intricacy of the data to be analyzed, and the complexity of the analyses to be performed. While a standard desktop or laptop computer can be used for most systems, workstation-class desktop computers with fast processors, ample memory and storage, and high-performance graphics are most common. Server-based systems that allow multiple users to work with GIS data stored in a



A prototype web application allows users to visualize occurrences of plants in their native environments with data from the Global Biodiversity Information Facility (GBIF). This map shows the native occurrence of umbrella magnolia (*Magnolia tripetala*), a species noted for its large leaves that can reach nearly two feet long.

database management system like Postgre SQL or Microsoft SQL Server typically require the addition of a server-class computer capable of hosting the database and serving data over the local network and internet.

Spatial Data

Perhaps the most important component of a GIS is the data it contains. A large percentage of research and organizational data that is collected has a spatial component and is thus suitable for use with a GIS. This means that this data can be referenced to a location and visualized in the form of a map or globe and then analyzed to reveal relationships, patterns, and trends.

Geographic data is most easily discussed in terms of the themes that it represents, such as topography, vegetation, soils, precipitation, etc. This thematic data can be compared by overlaying layers in GIS software. This quickly allows spatial relationships between the layers to be discovered, such as the correlations between precipitation, elevation, and vegetation types.

Each thematic layer can be made up of one or more feature classes that are stored as separate files or tables in a spatial database. Feature classes are traditionally differentiated by the type of geometry used to represent real world features. For example, spot elevation measurements would be represented by points, contours of equal elevation would be represented by lines, flat water bodies like lakes would be represented by polygons, and a continuous elevation surface created from these features would be represented by a raster, or digital image, where each pixel represents the elevation value at that location.

In addition to its type of geometry, a feature class can be defined by the attributes associated with it. For example, the location of a particular plant that is represented as a point might have the name of the plant, the relative condition of the plant, and the value of the diameter at breast height (DBH) measurement stored in the file or table along with the geometry of the point itself. This combination of a map with a database allows for easy visualization of the data in GIS software, where the points representing plants can be labeled with their names, assigned different colors depending on their condition, and scaled according to their DBH measurements.

If a GIS is going to be implemented across a particular institution for long-term use, such

Collecting GPS data at the UC Davis Arboretum.

as a conservation organization for biodiversity assessment, or a botanical garden for plant collection curation, it is common to design or employ an existing data model. A data model can be thought of as a database design or template that carefully considers how real-world features are represented as geometry in feature classes, the attributes appropriate for each feature, and any known relationships that exist between individual features or entire feature classes. In the plant sciences, user community designed data models for Esri ArcGIS exist for biodiversity assessment, forestry, and public gardens. These models can be downloaded for free and allow scientists to get started with their GIS projects quickly, without the need to design their own models. Data models like the one developed by the Alliance for Public Gardens GIS (ArcGIS Public Garden Data Model) additionally provide standardization across multiple organizations, thus simplifying the exchange of critical biodiversity data.

Whether using an existing data model or designing a new GIS from the beginning, one of the first things to consider is the availability of the data required for the project. A common starting point is to collect as much existing data as is readily available through internet data repositories like the United States Geological Survey Earth Explorer or local government spatial data clearinghouses. One of the primary sources of this data is from a technique called remote sensing which is formally defined as the collection of information about an object without making contact with it. [Ed. note: See next article for more on the use of remote sensing.] As it relates to spatial data, remote sensing usually refers to data captured from aircraft or spacecraft, and typically comes in the form of aerial photography, multi-spectral images that measure non-visible forms of electromagnetic radiation, or even LIDAR height data that is

Open Source vs. Commercial Software

There is much debate within the GIS developer and user community regarding the choice of commercial software versus open source software. Commercial products like those offered by Esri and MapInfo are quite expensive to purchase and typically require annual maintenance fees for support and upgrades, but offer well-designed user interfaces and sophisticated analysis tools. Conversely, open source solutions such as those that are part of the Open Source Geospatial Foundation (OSGeo) are free to use, but are more difficult to operate and get support for. Developers and scientists within academia generally tend to favor the use of open source software for GIS applications and research, while private companies and governments usually use commercial products. Ultimately, the choice is a tradeoff between cost and ease of use, but the same functionality is available from either option.

collected with a laser. Remotely sensed imagery frequently serves as a base map or background that other data—location of roads, vegetation types, etc.—can be extracted from using the techniques of supervised classification or heads-up digitizing. When this data is not sufficient for identifying features such as the location and species of plants, it is customary to collect additional data in the field by using GPS or traditional surveying techniques.

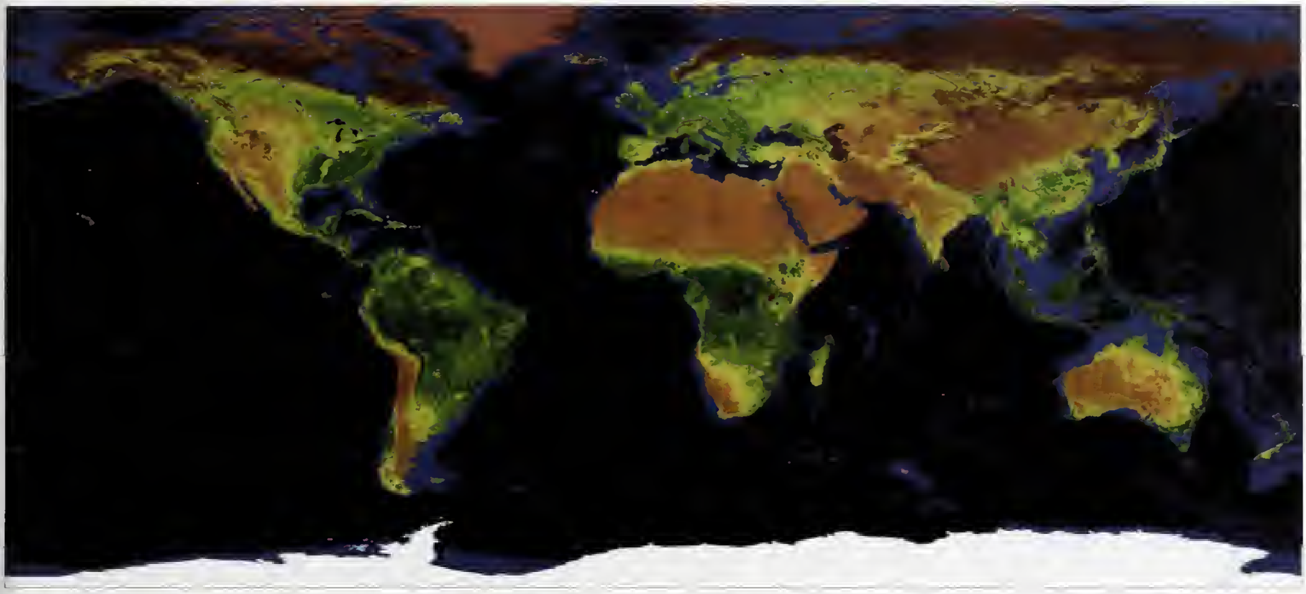
Spatial Analysis and Information Products

Once the necessary geographic and attribute data are collected for a project, the next step is to harness the true power of GIS to analyze this information in an effort to understand, question, interpret, and visualize it to reveal relationships, patterns, and trends. One common type of analysis is to investigate quantities. Plant scientists may be interested in analyzing the quantity of a particular species or group of species in a given area. Most desktop GIS software packages provide a suite of tools for working with this type of information in the form of densities, clusters, and distributions. Another common analysis is to look at what is nearby. If a cluster analysis shows a group of sensitive trees in decline, then buffering, flow analysis, and spatial statistics can be used to attempt to identify a cause by looking at topography, geology, soils, hydrology, and other related data. Many of these analysis capabilities are built into most desktop GIS software packages in the form of geoprocessing tools. These tools can be used individually or grouped together into an analysis workflow called a model. This kind of model typically has a set of adjustable parameters that influence the processing of the input data to produce a meaningful result.

Once the phase of spatial analysis is completed and a relationship, pattern, or trend has been revealed or confirmed, the final step is to summarize the results of the analysis as an information product that can be used to make decisions and take informed action. Most desktop GIS software packages have the capacity to produce a variety of information products in the form of tables, charts, reports, maps, or a combination thereof. The plant scientists investigating the previously mentioned cluster of declining trees may have determined that increased earthquake activity on a nearby fault resulted in the release of sulfuric acid into a nearby stream, thus causing their decline. To make a case for proposed mitigation, the scientists might present their findings in the form of a map showing the locations of the geologic, hydrologic, and plant features of concern along with a chart showing the increased sulfuric acid concentrations over time, and perhaps a second map detailing their proposed plan. If the results of this study need to be conveyed to a wider audience such as stakeholders or the general public, a server-based solution might be employed to create another type of information product, a web browser application that allows users to explore and interact with the scientists' data themselves. This is just one hypothetical example of how GIS can be used in the plant

COURTESY REBECCA SUCHER, MISSOURI BOTANICAL GARDEN

Mapping a plant collection at the Missouri Botanical Garden in St. Louis, Missouri.



Global greenness (vegetation) can be evaluated with the Normalized Difference Vegetation Index (NDVI) from remote sensing data gathered by satellites.

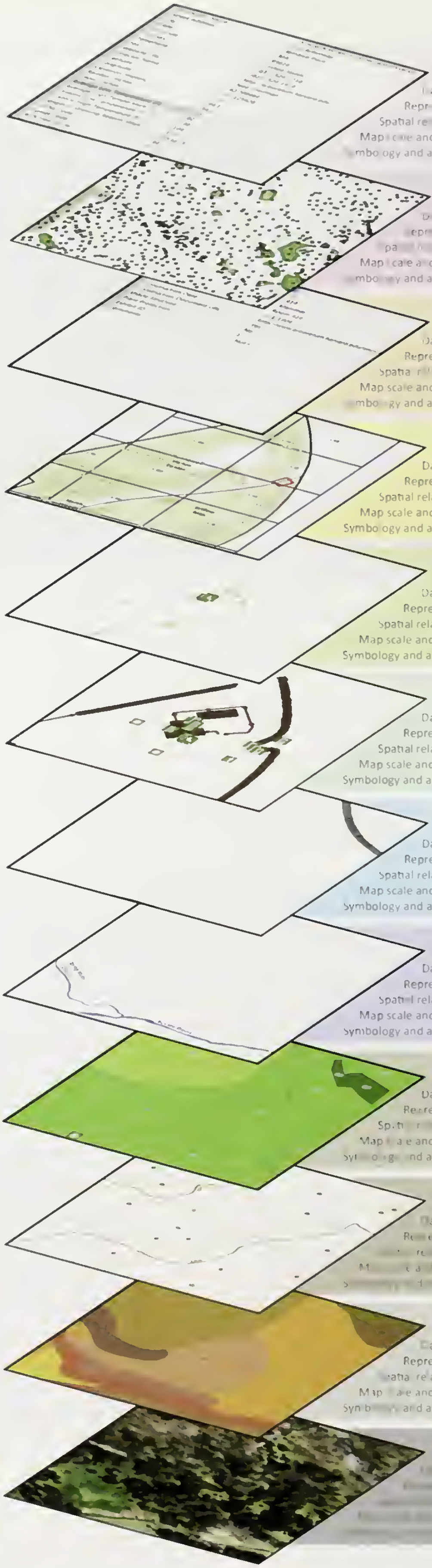
sciences. The next section describes how it is being employed in real-world projects for both research and management.

APPLICATIONS OF GIS

Our ever increasing need for land and resources combined with the threat of climate change has pushed the assessment of biodiversity to the top of the list of plant science research priorities. The scientific literature is rich with articles on the subject, ranging from studies of parks and reserves to the entire planet. GIS is often cited as the primary tool used to perform many of these studies, which frequently employ species occurrence data from informatics sites like the Global Biodiversity Information Facility (GBIF) and remotely sensed data from satellites like Landsat 7 TM to determine the relative species richness of a particular area. In one study of African vascular plant diversity, the investigators performed a multivariate analysis to determine the relationship between the number of species in well-known areas and the associated environmental conditions like topography, temperature, precipitation, and evapotranspiration. This relationship was then used to interpolate the species richness in lesser-known areas to produce a vascular plant diversity map for the entire continent (Mutke et al. 2001).

Once the biodiversity of an area has been assessed, the spatial data generated from the assessment can be used to help prioritize which parcels of land should be designated as conservation areas. Since the study of land and the process of delineating boundaries are inherently spatial in nature, GIS is cited as the overwhelming choice of tool for the task. In addition to biodiversity data similar to that produced in the previous study, conservation planning activities usually include topography, precipitation, soil, geology, and land use data. In a forest conservation study in Malaysia the investigators used a decision making approach that assigns weighted values to possible alternatives in an effort to prioritize areas for conservation. This study considered species and ecosystem diversity, the soil and water conservation functions of plants, and potential threats to the forest, and through a process called map algebra, hot spots for conservation were determined and used to delineate potential new protection areas (Phua and Minowa 2005).

GIS can also be an invaluable tool when planning a collecting expedition. Traditional approaches to expedition planning have favored areas that were considered interesting or easily accessible, and tended to focus on species that were easily studied. GIS allows for the unbiased



Layer	**Reference**
Map use	Metadata
Data source	Expert knowledge
Representation	Table
Spatial relationships	Property may have Institutions
Map scale and accuracy	Not applicable
Symbology and annotation	None

Layer	**Plants**
Map use	Living plant collection management and analysis
Data source	Aerial photography and local surveys
Representation	Polygon and point
Spatial relationships	Mass Planting must contain Plant Center
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by growth habit and labled with name and accession

Layer	**Animals**
Map use	Living animal collection management
Data source	Expert knowledge
Representation	Table
Spatial relationships	Barrier, Exhibit, and Structure may have Enclosures
Map scale and accuracy	Not applicable
Symbology and annotation	None

Layer	**Boundaries**
Map use	Administrative and natural boundaries
Data source	Aerial photography and local surveys
Representation	Polygon
Spatial relationships	Polygons must not overlap and must not have gaps
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by feature class and labeled with name

Layer	**Cultural**
Map use	Historic features and landmarks
Data source	Aerial photography and local surveys
Representation	Polygon, line, and point
Spatial relationships	Lines must not overlap
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by feature type and labeled with name

Layer	**Facilities**
Map use	Facility inventory and asset management
Data source	Aerial photography or local surveys
Representation	Polygon, line, and point
Spatial relationships	Polygons must not overlap and lines must not intersect
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by feature type and labeled with name

Layer	**Transportation**
Map use	Infrastructure inventory and routing
Data source	Aerial photography or local surveys
Representation	Polygon, line, and point
Spatial relationships	Polygons must not overlap and lines must not intersect
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by feature type and labeled with name

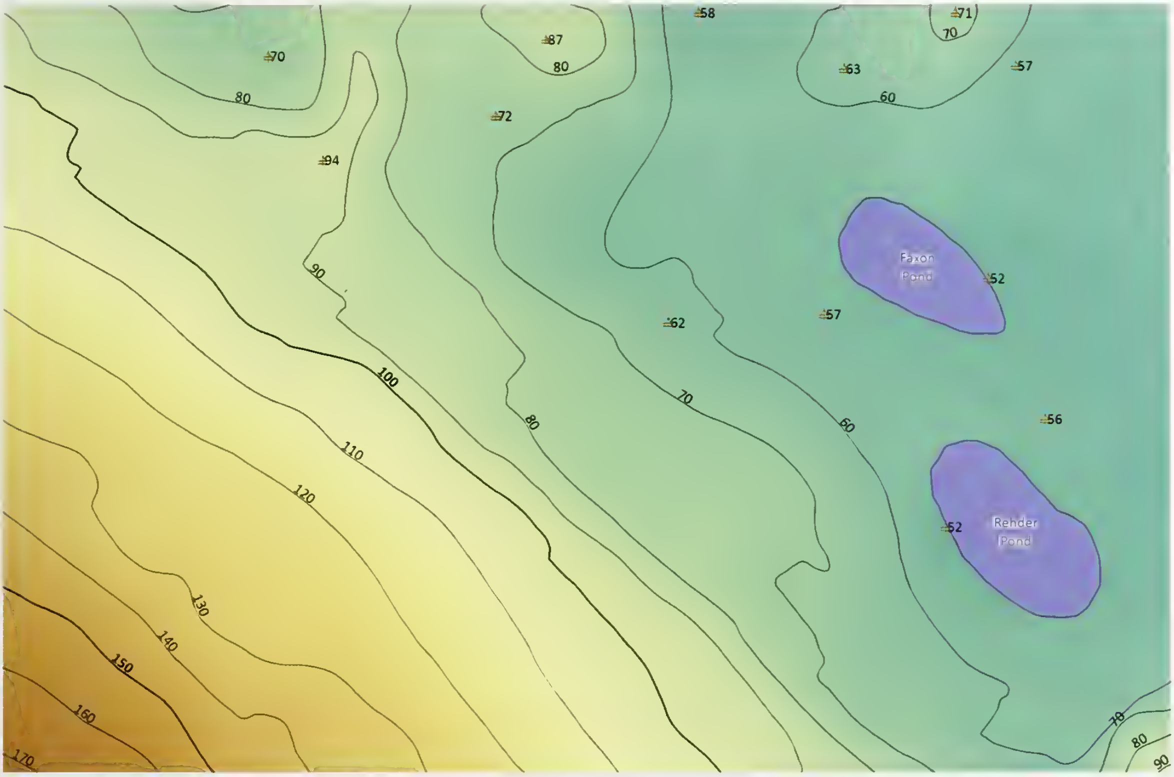
Layer	**Hydrography**
Map use	Cartography and hydrologic analysis
Data source	Aerial photography, topographic analysis, or local surveys
Representation	Polygon, line, and point
Spatial relationships	Polygons must not overlap and lines must not intersect
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by feature type and labeled with name

Layer	**Climate**
Map use	Microclimate analysis including temperature and humidity
Data source	Local weather sensors
Representation	Polygon, point, and table
Spatial relationships	None
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by microclimate type

Layer	**Topography**
Map use	Topographic analysis including slope, aspect, hillshade, viewshed, etc.
Data source	Local municipalities and site surveys
Representation	Line and point
Spatial relationships	Lines must not intersect
Map scale and accuracy	Suitable for products of 1:24,000 and larger
Symbology and annotation	Categorized by contour type and labeled with elevation

Layer	**Soils & Geology**
Map use	Soil and geologic surface overlays
Data source	SSURGO, local soil surveys, USGS, etc.
Representation	Polygon and point
Spatial relationships	Polygons must not overlap or have gaps
Map scale and accuracy	Suitable for 1:24,000 and smaller
Symbology and annotation	Categorized by soil or geologic unit

Layer	**Imagery**
Map use	Map background and reference
Data source	Aerial photography
Representation	Raster
Spatial relationships	Pixels cover the image area
Map scale and accuracy	Pixel size is 3" to 1'; useful for products of 1:300 and smaller
Symbology and annotation	Color or grayscale

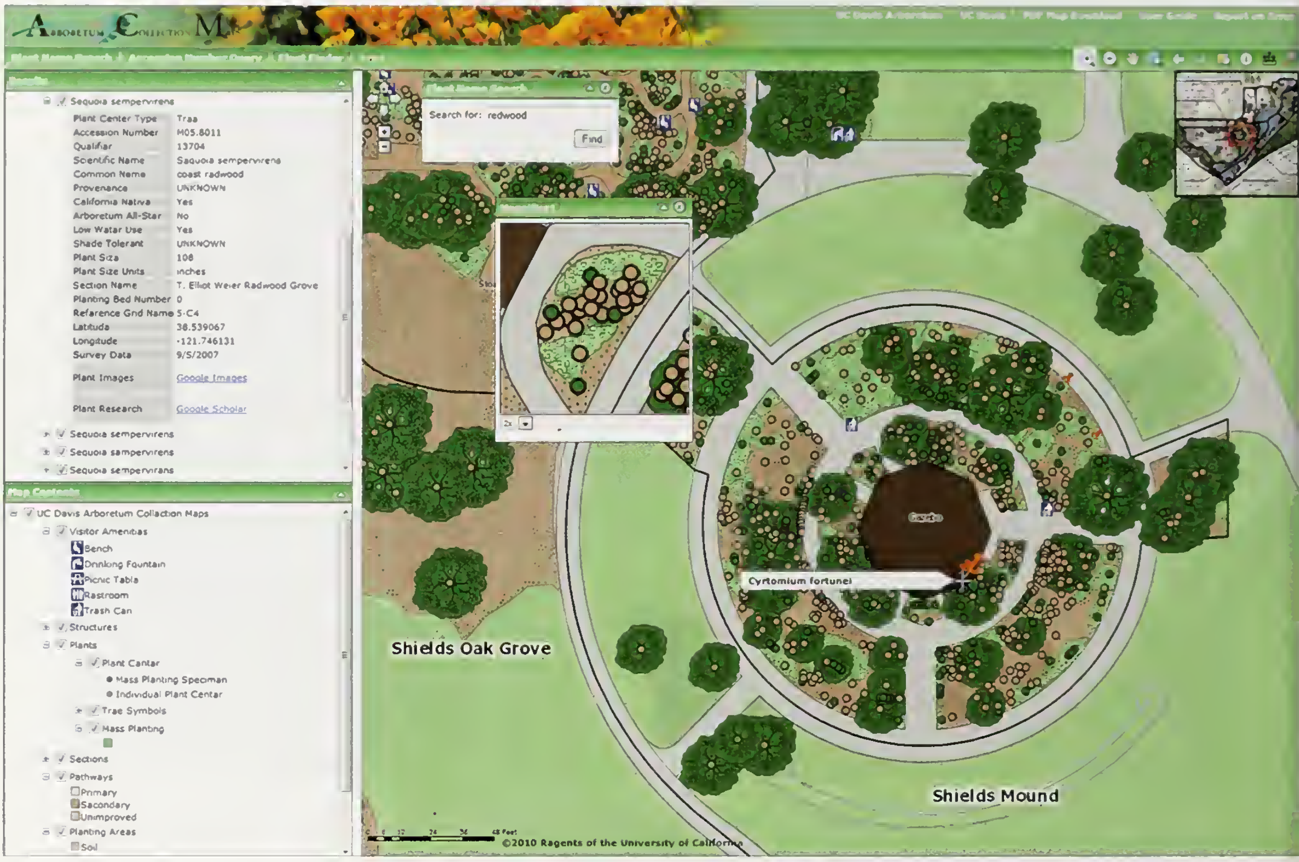


GIS data can be represented as points, lines, polygons, and rasters. Here spot elevations are shown as points, contours are shown as lines, ponds are shown as polygons, and an elevation surface is shown as a raster in part of the Arnold Arboretum.

sampling of an area that not only maximizes heterogeneity, but can also assure that the largest gaps in the record of biodiversity are filled with the least amount of effort and resources. GIS-based expedition planning typically utilizes existing biodiversity data along with topography, geology, vegetation, temperature, and precipitation data to determine areas that have the greatest potential to provide the maximum amount of new information and specimens. In a survey gap analysis study in Guyana the investigators used museum and herbaria specimen data to locate geographical gaps in the existing data in an effort to determine candidate survey sites for each taxonomic group of interest. These candidate sites were then compared with weighted abiotic variables to determine a final set of collecting sites that had the greatest chance of producing new information and specimens for each taxonomic group (Funk et al. 2005).

Once plant specimens have been collected and cultivated in a botanical garden or arboretum, GIS is commonly used to curate the collection and to help make management decisions throughout the entire lifetime of the plant. GIS is commonly used for creating collection maps and planting plans, identifying problems and threats, planning mitigation, and performing research. In addition to data about the living collection, a typical garden GIS employs data on topography, soils, hydrology, land use, facilities, transportation and more. In a tree conservation study at the UC Davis (University of California, Davis) Arboretum the investigators used data on the location, species, size, and condition of each specimen in conjunction with data on site characteristics and conflicting urban infrastructure to determine a condition rating and a hazard rating for each tree in the collection. These ratings were then used to identify areas of concern and to produce prioritized mitiga-

***Facing page:* Thematic layers in the ArcGIS Public Garden Data Model allow comparisons and correlations of databases from soils and topography to plants and animals.**



UC Davis Arboretum Collection Mapper allows users with no GIS experience to explore plant collections.

tion plans that considered the safety of visitors and impact on the rest of the living collection (Ingolia 2010).

THE FUTURE OF GIS

Studies such as these would be difficult, if not impossible, to complete without the use of a GIS. Not only are the results of these studies valuable to the scientific community, but the data generated during the process can be shared and employed by researchers in future efforts. As our world continues to evolve at a quickening pace, and threats to plants in their native environments rise, our ability to quickly understand and formulate solutions to these complex issues is essential to plant conservation. Geographic information systems provide us with a platform to accomplish this and much more, and as our society becomes increasingly location aware, this technology is likely to become one that we question how we ever lived without it. Do you know where your plants are?

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Remote Sensing as a Botanic Garden Tool

Ericka Witcher and Patrick Griffith

Remote sensing is a tool already in use for plant exploration, ecology, forestry, habitat restoration, and other related fields. It also has great potential in botanic gardens for botany, horticultural science, and management purposes. At Montgomery Botanical Center, located in Coral Gables, Florida, we were able to improve our assessment of the property with the addition of new software that provided the capability for deeper evaluation of the collections and natural resources using remote sensing imagery and data. By adding LIDAR (Light Detection And Ranging) imagery to maps and employing techniques normally used at larger regional scales, new information was discovered about the garden and its collections.

A 2008 aerial photo of Montgomery Botanical Center property in south Florida.

Garden maps serve multiple purposes. Their primary use is as a location catalog—what a garden has and where it is. People who use the garden, whether staff or visitors, will want to know where certain features are at some point. The information displayed in this kind of map can reflect the vastly different purposes of, say, a researcher examining different subspecies of *Coccothrinax miraguama* (miraguama palm), an irrigation technician repairing a break, or a visitor looking for the restroom, but all three of their garden maps would need to show what things are and where they are located. On the other hand, maps can also be used for more dynamic purposes in the garden. New areas of horticultural and scientific interest can be illuminated through the addition of a spatial or geographic component—where things are in relation to something else. Spatial relationships in a botanical garden, for example, can examine how close vulnerable plants are to open spaces or high-use visitor areas, how tree canopies change over time, or the density of plantings. Expanding beyond the property, considerations regarding latitude and regional topography can be taken into account. Integrating a garden map into a Geographic Information System (GIS) is a way to keep and readily analyze a lot of data about a lot of different things in a garden.

A Garden for Conservation and Research

Montgomery Botanical Center (MBC) is a non-profit research institution. With 120 acres in a sub-tropical latitude, we are able to specialize in palm and cycad taxa that would have difficulty growing elsewhere in the United States (Calonje et al. 2009, Noblick et al. 2008). MBC's living plant collections are well-documented and population-based in order to reflect the genetic diversity found in the wild, and they have great research and plant conservation value. People of all backgrounds—from students to hobbyists to commercial growers—can observe and examine unusual, rare, or endangered specimens they might not have the opportunity to see in the habitats of origin, or in side-by-side comparative collections that would not occur in the wild (Husby et al. 2010). Because of the exotic

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Shade and soil needs are affected by what is overhead and underfoot: for example, the dappled shade and natural mulch provided by this *Ficus racemosa* counteracts the stress of alkaline soil on the *Chamaedorea stolonifera* now thriving at its base. Similar conditions must be found for future plantings.

Definitions

Remote sensing data: ***Quantifiable information collected from a distance about something, such as measured elevations or the hue of vegetation, usually referring to aerial or satellite signal collectors.***

Remote sensing imagery: ***The composite pictures created from the collected data.***


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Vegetative and geologic characteristics, like canopy and elevation changes seen here along the Palm Walk, are quantifiable with LIDAR-integrated maps.

origins or sensitive nature of many plants in our collections, we must work to create and maintain an environment that provides for their individual needs for life and growth. To that end, we are continually looking for new ways to assess the garden property and analyze both its biological and geological resources.

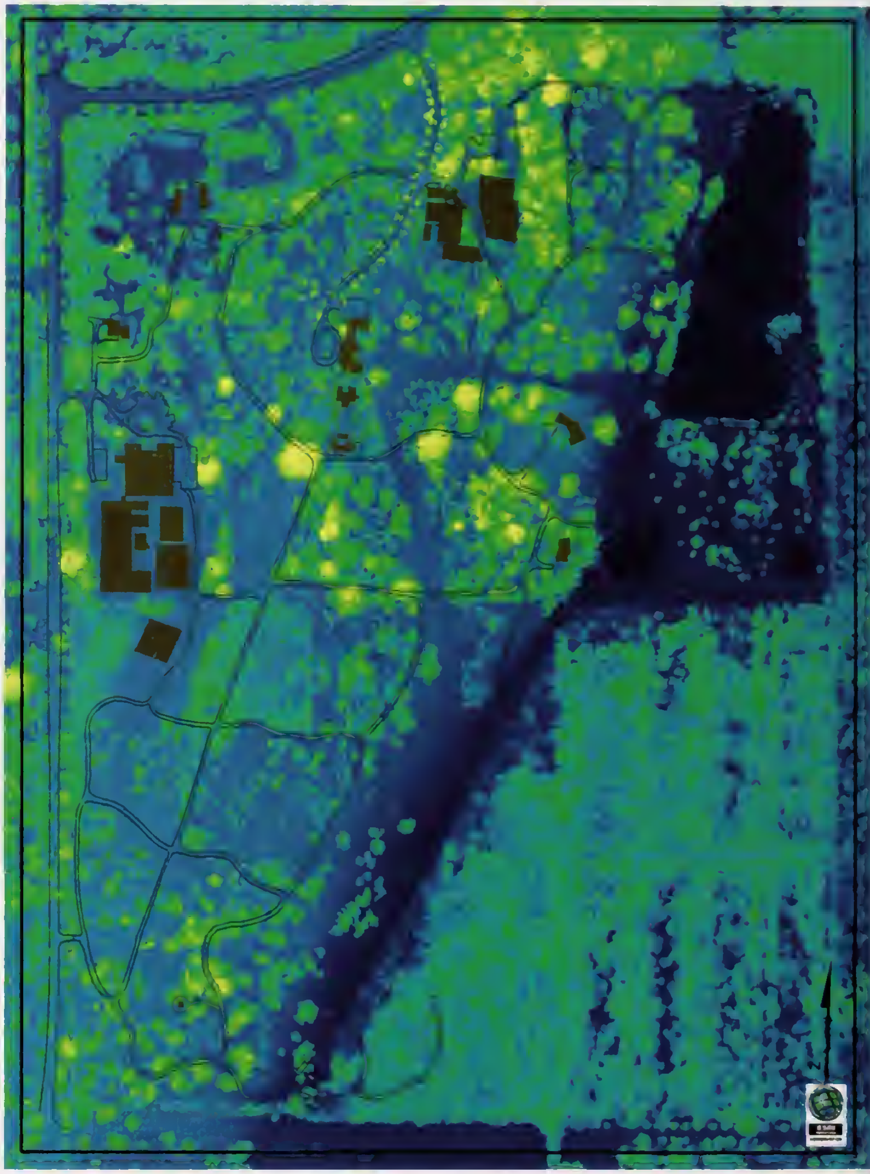
Legacy Imagery

For several years we had utilized aerial photographs to examine tree canopy and other features at MBC that were difficult to thoroughly evaluate from ground level. Orthophotographs (planimetrically-corrected aerial photographs) and uncorrected aerial photos are frequently used in many different industries, including botanic gardens, for many disparate purposes, and are readily available through a variety of sources (e.g., the USGS website http://www.usgs.gov/pubprod/, or state or county websites). These photos provided a good general sense of how areas were developing, but we experienced a fair amount of difficulty integrating them with our AutoCAD (a computer-aided-design software program)-based maps, so their utility was somewhat limited. We wanted a way to view the photos and the maps at the same time as well as use other types of imagery, then be able to perform spatial analysis.

New Systems Add Capability

A software grant for botanical gardens and zoological parks provided an all-in-one solution. Two MBC staff members had prior experience with the software, and with the help of an additional intern, by late 2009 we had completely converted the old maps and their CAD layers to a GIS (geographic information system). The local coordinate system was replaced with geographic latitude and longitude so the converted CAD layers would relate to Earth's surface. MBC was then able to add one more tool to their garden shed: remote sensing data and imagery.

The ability to use remote sensing data in conjunction with map files opened up entirely new ways of visualizing the garden property. Tree canopies were accurately identified by species by overlaying the mapped plant points onto the orthophotos. Map files of road edges and lake boundaries from 10 years before were adjusted to align with their current locations. Instead of looking at information imposed on a representation of the property, the information was examined in view of the property as a whole in the real world.



First-Return LIDAR image of MBC property showing topmost surfaces, where bright yellow is the highest elevation and deep blue is the lowest.

BY ERICKA WITCHER FOR MONTGOMERY BOTANICAL CENTER

MBC also lacked an accurate elevation map. The landscape in South Florida is flat enough that a gain of even one foot (0.3 meters) is a substantial difference in regard to the water table and underlying soil, which are of great importance to plants (Kitaya et al. 2002), but such a subtle variation is often difficult to detect while performing fieldwork. To remedy this, in 2010 we made our own contour map with the GIS software, using a bare-earth LIDAR image of the property. LIDAR imaging uses measurement of the time it takes a laser pulse to be transmitted from and reflected back to an overhead receiver (like an airplane or satellite) to generate a visual dataset. In other words, while aerial photos create a two-dimensional horizontal image, LIDAR adds a third dimension: elevation. LIDAR also is increasingly freely available from local, state, and federal government agency websites (e.g., the USGS website http://lidar.cr.usgs.gov/). A bare-earth LIDAR image displays ground-level data as opposed to treetops and rooflines. With this height information added to the maps, we could concretely see geological aspects that we could only intuit before. Important inland low-lying areas as well as property high points were clearly identifiable, and the labeled contour map provided practical delineations for field work.

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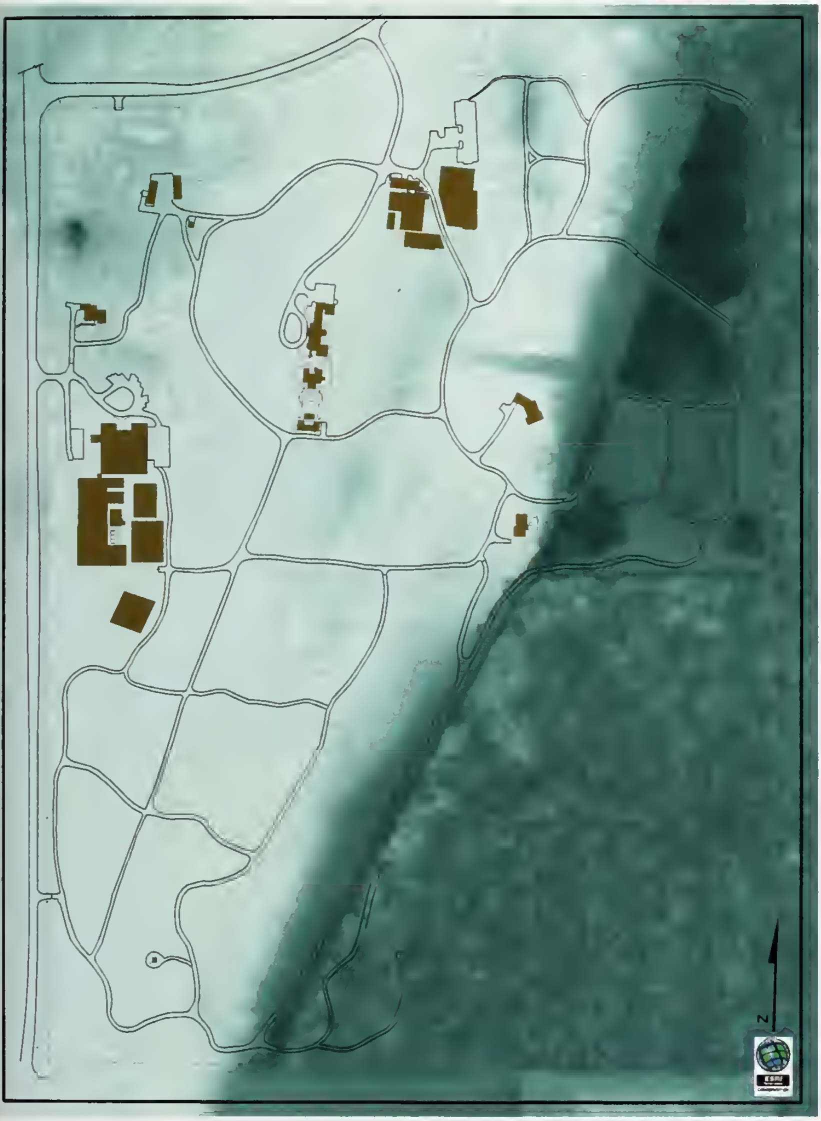

Bare-Earth LIDAR image of MBC property showing ground level surface geology; lower (darker) areas west of the escarpment are important for planting, as they are more likely to contain sand and silt, in contrast to the surrounding alkaline limestone bedrock, or the clay marl to the east.

A first-return LIDAR image also offered a lot of utility for other vegetation-assessment projects. First-return images illuminate all the topmost surfaces of the study area; in this case, canopy height and coverage. In one project, an undeveloped section of the property filled with both an invasive exotic plant, *Schinus terebinthifolius* (Brazilian peppertree), and protected mangrove trees needed a thorough evaluation so we could determine the most efficient course of action for managing the land. Canopy height and density were examined in the LIDAR images and transects were distributed and performed accordingly. The invasive plant was not found to be as pervasive as feared, and as a result, eradication efforts were scaled down proportionally (Edelman and Griffith 2010). Using LIDAR imagery to better visualize the dense plant growth beforehand gave us a more complete picture prior to entering the area, saving time and effort.

For another project we adapted a conventional forestry analysis using first-return LIDAR images to appraise height and breadth information (Sumerling 2010) to establish potential candidates for national or state champion tree status. (Champion trees are the largest known individuals of a species based on measurements of height, trunk circumference, and canopy spread.) This was done by simply overlaying the plant layer over the image and visually identifying the tallest canopies. The plant curators also applied their in-field knowledge of the various species' usual growth habits to propose more individuals for assessment, the height and spread of which were also checked in the LIDAR map. At writing, 27 trees had been awarded state champion status by the Florida Division of Forestry, and 2 trees received national champion status from the conservation organization American Forests.

Future Development

With the successful completion of these projects, we have become more familiar with the uses of both aerial photography and LIDAR for horticultural purposes, and subsequently the

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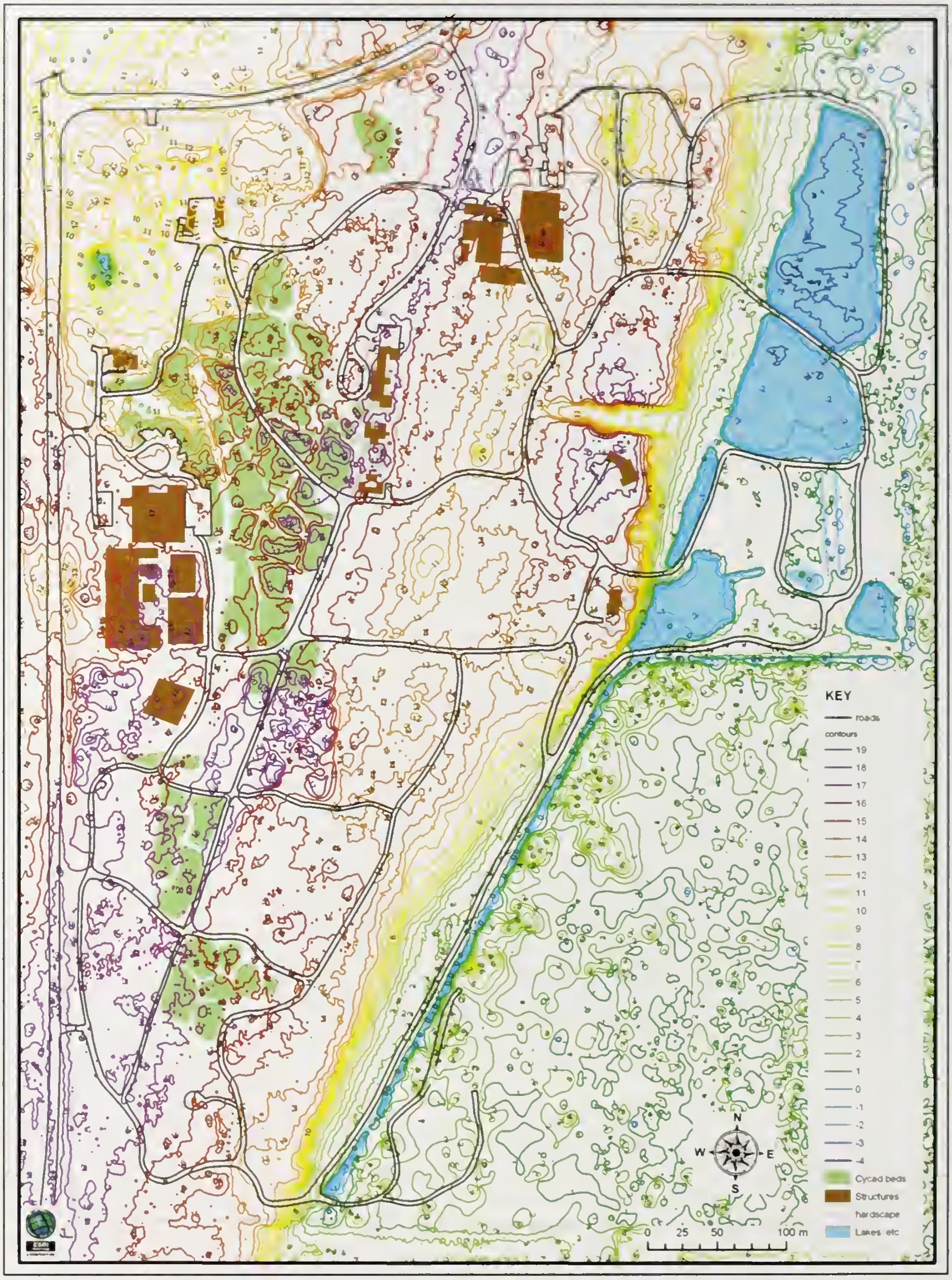
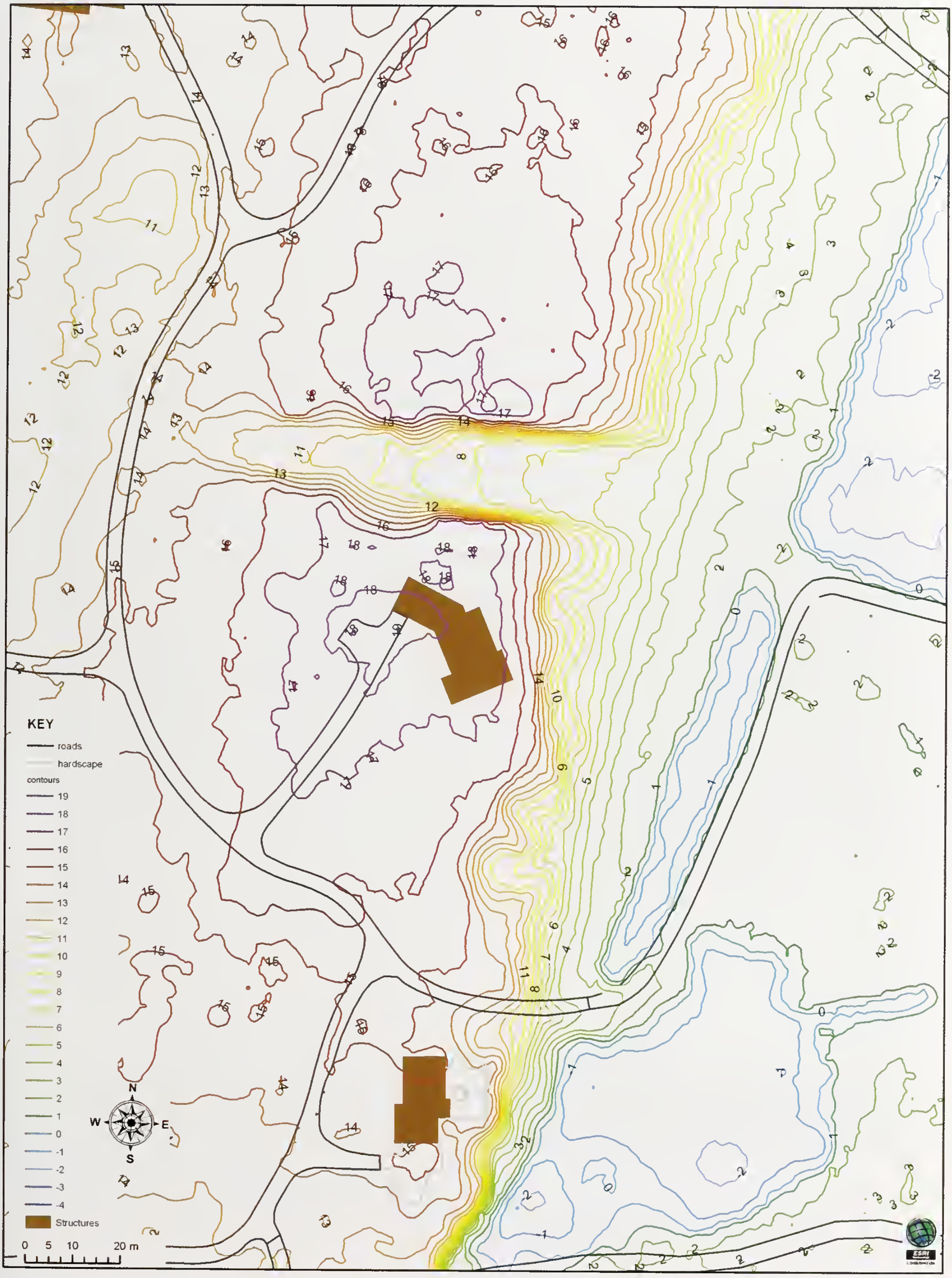


MBC staff created their own topography map with a LIDAR image and GIS software. Note the allée in the escarpment running through the northeast quadrant, seen in detail on facing page. This point on the escarpment was one of the highest points on the property until Robert Montgomery excavated the rock to create the allée in the 1940s, in order for his wife, Nell, to view the lakes from the main house (Anderson and Griffith, in press).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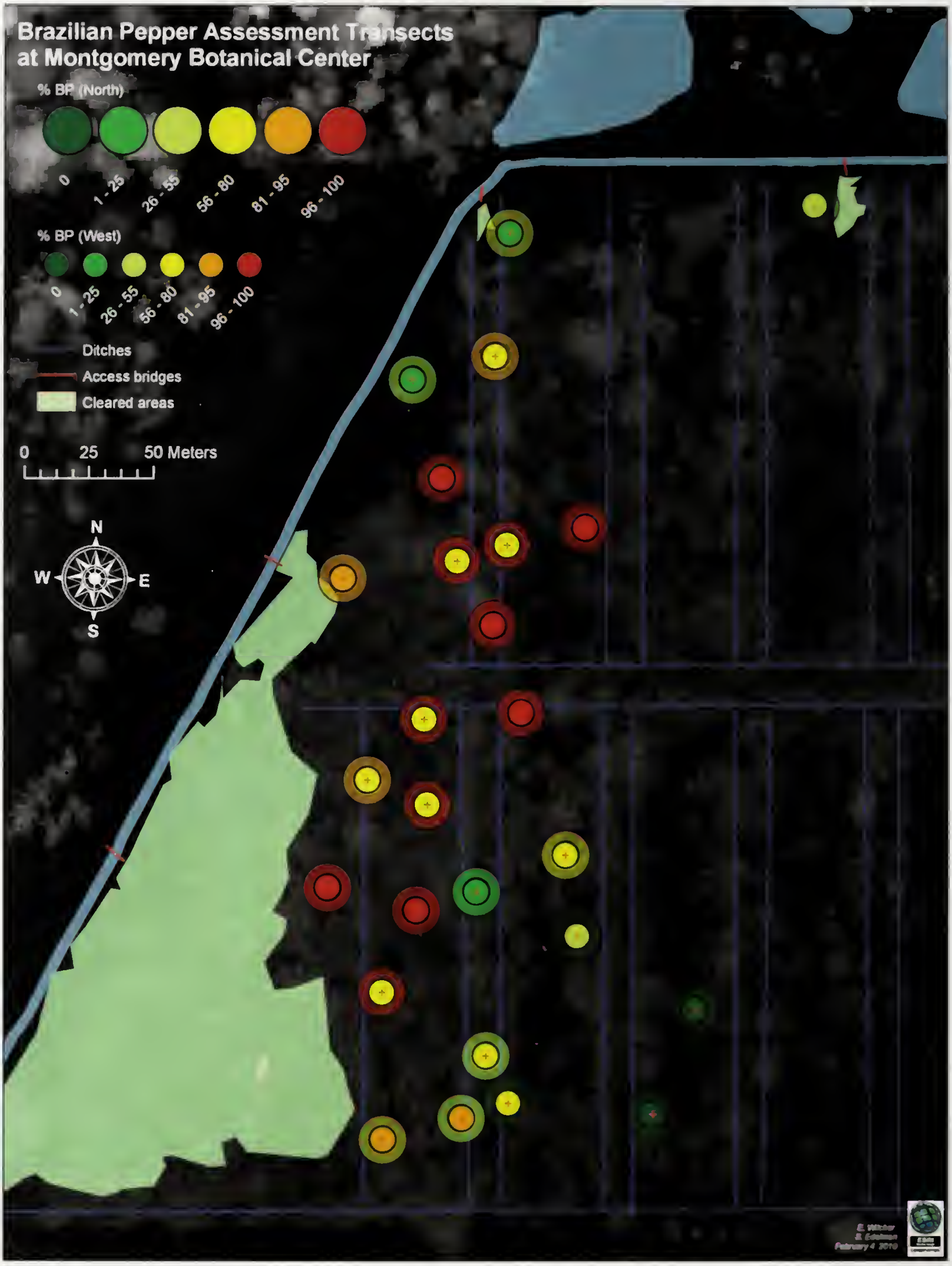

LIDAR helps make informed property management decisions at MBC. Thirty-meter transects were performed to the north and west at each point to assess approximately how much of overhead canopy consisted of invasive Brazilian pepper (BP). Large circles show percentage BP found to the north, and small circles show percentage BP to the west. Due to mangrove protection laws, greater caution must be used during removal wherever a transect was not solid red. A map of the results indicates areas of the most worthwhile effort.

This Florida champion tree, *Pterygota alata* (Buddha coconut), has endured dozens of hurricanes, and at 89 feet tall is one of the tallest trees on our property. We first identified it as a candidate through examination of LIDAR imagery.

LIDAR imagery provides clues to planting conditions at MBC for staff biologist, Chad Husby, looking for future plant sites near the allée.

potential applications for this kind of data. We are also exploring additional applications currently in use by other landscape-level industries that have a good deal of potential for use in botanic gardens (Perroy et al. 2010, Sumerling 2010). For example, we are now working on creating contours from a first-return LIDAR image that will provide new information about the canopy coverage and biomass density in the garden. This type of three-dimensional data can amplify current knowledge about shade structure, wind protection, and plant growth and expansion within the property and create an operational image of the "vegetative topography." Coupled with 15 years of database records tracking the growth and reproductive activity over time of our plants, we anticipate new insights to spur in-depth research. LIDAR also lends itself to three-dimensional modeling and creating fly-throughs, leading to comprehensive visual aids for online garden "explorers" and researchers, as well as garden managers looking to gain new perspectives on their collections and resources.

Meanwhile, maximizing survival rates of invaluable scientific plant collections with analysis of current collections and records, both spatial and temporal, is an ongoing objective. By employing imagery in our GIS and adapting some of the more basic and conventional uses of LIDAR for regional landscapes to the localized, relatively small-scale botanical garden, we have been able to save many hours of laborious fieldwork and gain a nuanced understanding of the property and plants under our care.

Acknowledgements:

We thank Brian Witcher and Judd Patterson of the National Park Service SFCN program for their GIS assistance and consultation, MBC GIS Intern Jonas Cinquini and MBC Intern Sara Edelman for their project assistance, the Stanley Smith Horticultural Trust for all GPS equipment funding, and the ESRI Botanical Garden/ Zoological Park Grant program for providing all GIS software.

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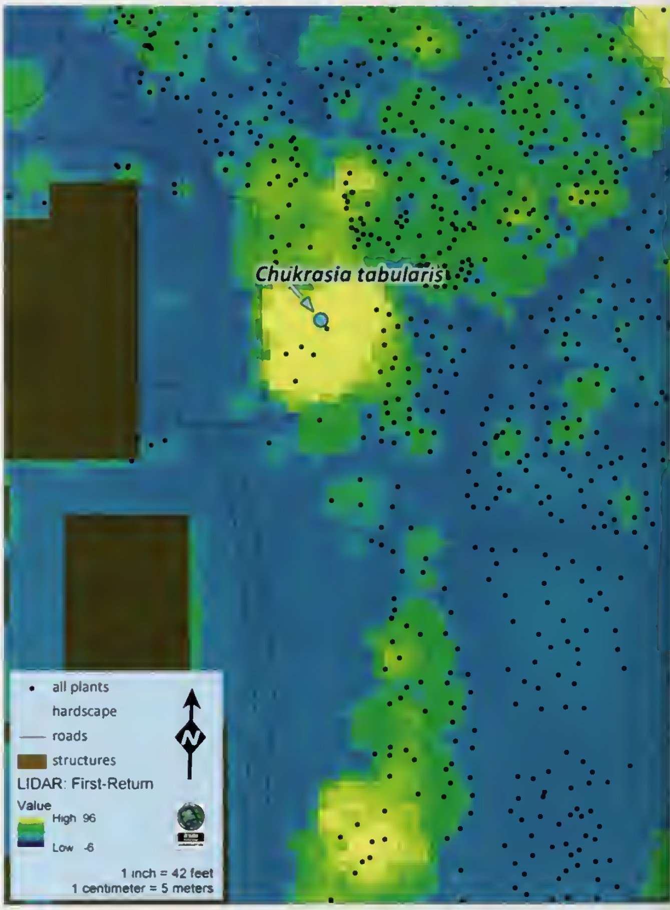

Chukrasia tabularis (Burmese almondwood) is prized for its beautiful hardwood. This specimen at MBC is the Florida state champion tree and was first identified as a candidate through examination of LIDAR imagery (right). LIDAR scale is in feet.

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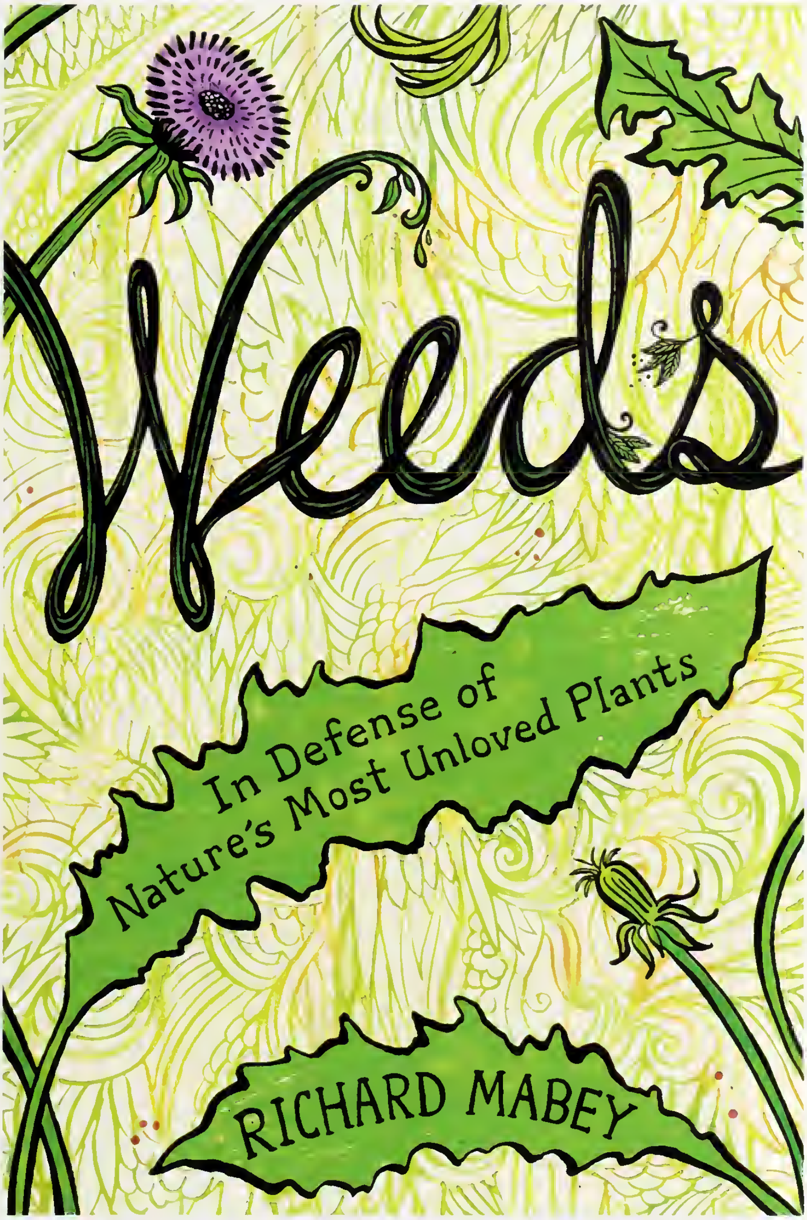
BOOK REVIEW:

Weeds: In Defense of Nature's Most Unloved Plants

Peter Del Tredici

Weeds: In Defense of Nature's Most Unloved Plants
Richard Mabey. Ecco, an imprint of HarperCollins Publishers.
324 pp. 2010
(United States publication 2011)
ISBN 978-0-06-206545-2



In his new book *Weeds: In Defense of Nature's Most Unloved Plants,* Richard Mabey presents a refreshingly non-judgmental look at some of the most vilified plants on earth. While acknowledging the problems that some of these notorious plants can cause for both gardeners and ecosystems, he also presents their not insubstantial positive contributions in terms of recolonizing derelict land in cities, restoring war-ravaged landscapes in Europe, and, over the millennia, providing abundant food and medicine for people. In short, the author takes a balanced approach to the subject of weeds and he puts the focus where it belongs—on their intimate association with human culture going back to the dawn of agriculture itself.

As Mabey presents it, the subject of weeds is nothing less than a microcosm of human culture, an observation that he reinforces with numerous quotations from famous writers including Shakespeare, Ruskin, and Thoreau, and, of course, from the Bible. Not stopping here, he also provides a lengthy discussion of the significance of weeds in visual arts, as exemplified by a discourse on the significance of Albrecht Dürer's famous painting from 1503, *Large Piece of Turf,* which he describes as, "… not only the first portrait of a community of weeds, it is the first truly naturalistic flower-painting in Europe, and the herald of a new humanistic attitude towards nature."

A more modern example is his discussion of the science fiction classic *The Day of the Triffids* (first published as a book in 1951 and released in 1962 as a movie, now a cult favorite), which Mabey presents as a metaphor for

Great Piece of Turf (also known as *Large Piece of Turf*), 1503, by Albrecht Dürer (1471–1528). Graphische Sammlung Albertina, Vienna, Austria / The Bridgeman Art Library.

aggressive invasive species such as giant hogweed (*Heracleum mantegazzianum*) and kudzu (*Pueraria montana*). It should also be noted that the book is up-to-date in its discussion of the modern, scientific data on weeds, discussing in detail how the increased use of herbicides over the past fifty years has influenced weeds' evolution, and how genetically modified (GM) crops are interacting with weeds to make them hardier and more difficult to eradicate. In short, Mabey masterfully weaves the disparate fibers that constitute the cultural and natural history of weeds into a colorful tapestry of a book that few nature writers can match.

Weeds: In Defense of Nature's Most Unloved Plants is not without a few flaws however, one of which (for American readers) is its exclusive use of the British common names of plants throughout the text. There is a glossary at the end which provides the Latin equivalent to the common name, but the fact that many of the plants discussed in the book have different common names in North America than they do in England leaves the inquisitive American reader who doesn't know the Latin names of plants with little choice but to turn to the internet or reference books to figure out identities. In addition, the book is overwhelmingly focused on weeds that dominate the landscapes of the British Isles and on British writing on the subject, making the book somewhat less relevant to North American audiences than it perhaps needs to be. Certainly the history and behavior of North American weeds is discussed in the book, particularly the subject of their early introduction from Europe, but their treatment is minimal compared to the space devoted to weeds in Britain. There's also a surprising absence of any mention of the extensive pioneering German literature on the subject of urban ecology, particularly that done by Herbert Sukopp and his colleagues in post-war Berlin.

Despite the British focus of *Weeds: In Defense of Nature's Most Unloved Plants,* I found it a fascinating read—which is no small accomplishment given the fact that I have a large library of well-studied weed books at home. Mabey is an engaging writer with long-standing, highly personal interest in weeds that shines through on

Dandelion (*Taraxacum officinale*).

every page. He deserves kudos for his masterful integration of the scientific and cultural aspects of weed ecology and his fluid, often poetic, use of language. Here he describes watching weeds grow at an active construction site:

> "When I look at their comings and goings, as hectic as the movements of the bulldozers, I grope for metaphors to understand their meaning. I think of ants, but they're too organized, too determinedly earth-changing, like the excavating machinery itself. Then it occurs to me that they are like a kind of immune system, organisms which move in to repair damaged tissue, in this case earth stripped of its previous vegetation."

While this book has something for everyone, I suspect that its greatest appeal will not be to down-in-the-dirt gardeners but to those of the armchair persuasion who like their weeds with a touch of literature, humor, and taste.

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

A Venerable Hybrid Oak: *Quercus* x *sargentii*

Michael S. Dosmann

Scores of plant taxa—species, infraspecific variants, and hybrids—commemorate Charles Sprague Sargent with their epithets. They range from the cherry palm of the Caribbean, *Pseudophoenix sargentii*, to the vase-shaped Sargent cherry of East Asia, *Prunus sargentii*. In 1915, yet another plant was given the Sargent moniker when Arboretum taxonomist Alfred Rehder recognized the Arboretum director by providing a name for the hybrid between the English oak, *Quercus robur*, and the American chestnut oak, *Quercus montana* (formerly known as *Q. prinus*). While hybrids between these two members of the white oak subgenus (*Lepidobalanus*) had been known since the 1830s, this was the first time the taxon was recognized officially with its own name, *Quercus* x *sargentii*, the Sargent oak.

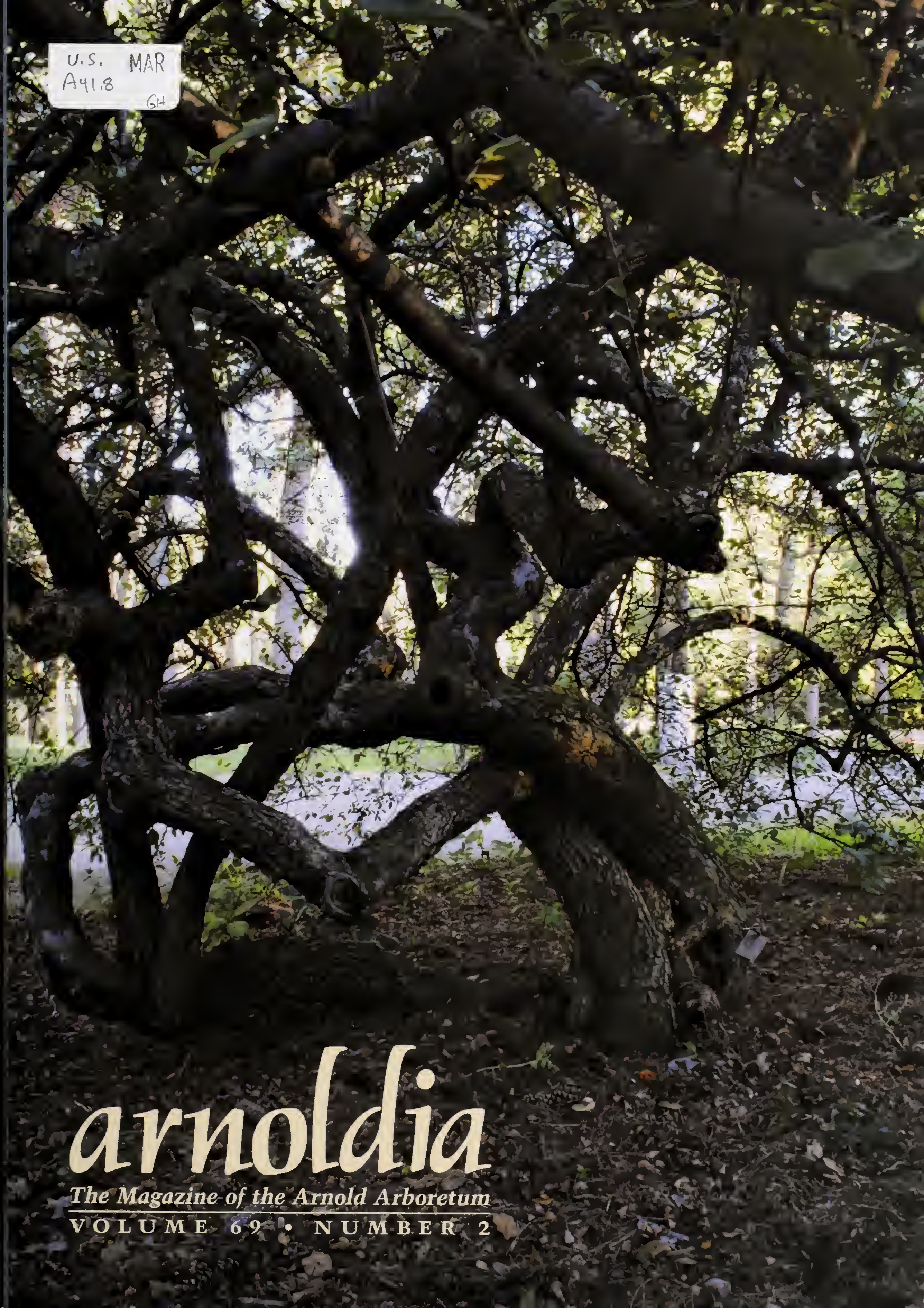
From *Q. robur*, the hybrid attains a certain nobility and majesty, not to mention a girthy trunk, broadly spreading canopy, and distinctive auriculate (earlobe-shaped) leaf bases. From *Q. montana* come the crenately toothed leaves, smaller-stalked acorns, and, with age, coarsely furrowed bark.

The Sargent oaks that grow in the Arboretum's living collections can all be traced to the initial lot of acorns collected from a magnificent tree at Holm Lea, Sargent's estate in Brookline, Massachusetts. The seeds arrived at the Arboretum on October 6, 1877. They germinated and yielded multiple seedlings that were planted in the permanent collections and cataloged under accession number 5883. Currently, three plants (A, B, and C) remain in the collection, each looking exceptional for being over 130 years old. Perhaps the most spectacular is 5883-A, a majestic specimen located near the junction of Bussey Hill Road and Beech Path, at the base of the *Forsythia* and *Syringa* collections. With a current height of 84 feet (25.6 meters) and DBH (diameter at breast height) of 55.7 inches (141.5 centimeters), this tree commands attention. Visitors strolling down Beech Path often pause in awe to admire the tree's massive limbs and rounded crown. Recent landscape renovations to this area, known as State Lab Slope, will not only maintain the health and vitality of this specimen and the surrounding plantings, but also improve visual access. I should note that its siblings (plants B and C) may be slightly smaller, but are also notable and worth a visit. Both are located further along Beech Path, near the edge of the *Fraxinus* collection.

Q. x *sargentii* is extremely rare in cultivation, and our understanding of it is essentially limited to the specimens grown in our collection as well as those of a few other botanical gardens and arboreta. Certainly, our three trees are exceptional and have stood the test of time, but it would be premature to say much more without further study. I am particularly interested in this hybrid's potential use as a tree tolerant of the vagaries of the managed landscape, especially in urban areas where soils are prone to drought and other limitations. As *Q. montana* is an upland species typically found growing in dry and rocky habitats, one could hope that the Sargent oak is similarly tough. Oaks are difficult to propagate clonally, and attempts over the years to clone the Arboretum's trees have been in vain. However, because *Q. robur* is a species that can sometimes be rooted from cuttings, Manager of Horticulture Steve Schneider and I are conducting several experiments to see if ease of propagation from this parent was passed along to the hybrid. If that is the case, it opens up a great deal of potential for additional study and, perhaps, the Sargent oak's use as a street tree near you.

Michael S. Dosmann is Curator of Living Collections at the Arnold Arboretum

For additional information on this hybrid and its interesting history, see: Hay, I. 1980. Outstanding plants of the Arnold Arboretum: *Quercus* x *sargentii*. *Arnoldia* 40(4): 194–199.



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The ARNOLD ARBORETUM of HARVARD UNIVERSITY

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Front cover: This specimen of *Malus sargentii* (accession 20408-D), collected by Charles S. Sargent during his 1892 expedition to Japan, has no single leader but instead has several trunks and a uniquely intertwined branching structure. Photo by Miles Sax.

Inside front cover: Eucalyptus leucoxylon subsp. *megalocarpa*, seen here in flower at the Chelsea Physic Garden, London, is one of the trees featured in *New Trees: Recent Introductions to Cultivation*. Photo by John Grimshaw.

Inside back cover: A mass planting of royal azalea (*Rhododendron schlippenbachii*) in the Arboretum's Explorers Garden displays lovely spring bloom and colorful autumn foliage. Photos by Nancy Rose.

Back cover: The bright red fruits of *Malus sargentii* provide color (and food for birds) in autumn and early winter. Photo by Nancy Rose.

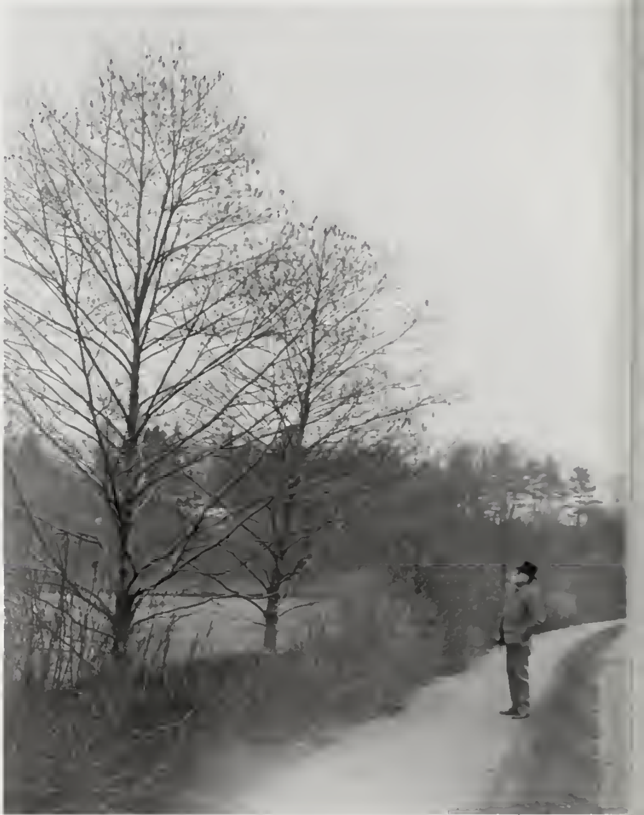
One Hundred Years of Popular Information

Peter Del Tredici

PUBLICATIONS HISTORY

On May 2, 1911, the Arnold Arboretum published the first issue of the *Bulletin of Popular Information.* Arboretum director Charles Sprague Sargent was the editor, and he stated that its specific goal was to meet the complaints of people who "... do not know when the trees and shrubs in the Arboretum bloom and therefore miss flowers which they want to see." These first bulletins came out once a week during the spring, early summer, and fall and were "mailed without charge to anyone interested in trees and shrubs and their cultivation." They were four pages long and without illustrations. The intention of the publication was to tell people who lived in the area what exciting things were happening on the grounds of the Arboretum and to provide some basic facts about selected plants, including their history of cultivation and suitability for New England gardens. The fact that the *Bulletin* came out thirty-nine years after the establishment of the Arboretum in 1872 suggests that public outreach to visitors was not originally very high on Sargent's to do list. By 1911, however, he apparently felt that the time was ripe to connect with the gardening public who wanted to know more about the collections. Despite its tardy introduction, the *Bulletin of Popular Information* established an Arboretum tradition of outreach through publications that continues today.

After four years of publication, Sargent initiated a "New Series" of the *Bulletin* on April 28, 1915. Unlike the first series, this one had volume numbers and an index and established a subscription rate of one dollar. The first issue of the second series concluded with the rather quaint note that, "Automobiles are not admitted to the Arboretum, but visitors who desire carriages to meet them at the Forest Hills entrance can obtain them by telephoning to P. J. Brady, Jamaica 670, or Malone & Keane, Jamaica 344." From the perspective of today's digitally connected world, it's hard to imagine a time of when entire telephone numbers rather than just area codes consisted of three digits.



Charles S. Sargent, first director of the Arnold Arboretum, photographed at the Arboretum in 1904.

Series Three of the *Bulletin* began in April 1927—a month after Sargent's death—edited by Ernest H. Wilson. It was printed on coated paper for the first time, which allowed for the insertion of a full page black-and-white photograph in each issue. Following Wilson's untimely death in an automobile accident on October 15, 1930, long-time Arboretum staff member

J. G. Jack took over the task of producing the *Bulletin* with contributions from Oakes Ames, W. H. Judd, and the young Edgar Anderson. Anderson took over full responsibility for the publication in 1932 and initiated a fourth series in 1933. In 1935, Anderson left the Arboretum to work at the Missouri Botanical Garden and horticulturist Donald Wyman took over the *Bulletin*, publishing his first article on "Tree Troubles" in March 1936. Elmer Drew Merrill had been appointed director of the Arboretum in 1935 and in March 1941 he made the decision to change the name of the *Bulletin* to *Arnoldia*. He had two reasons for doing so: first, he thought that the title *Bulletin of Popular Information* was too cumbersome, and second, that it was difficult to cite in scientific papers because it had been published in four separate series without sequential volume numbers. He also felt that changing the name to *Arnoldia* would not only "reflect proper institutional credit on its sponsoring institution." Merrill retained Wyman as editor of the newly christened publication, a post Wyman held until 1969—a 34-year record of longevity that no one is ever likely to top. During the entire period of Wyman's editorship, *Arnoldia* came out more or less twelve times per year with each issue being of variable length.

Following Wyman's retirement in 1969, Richard Howard, who served as director from 1954 through 1977, changed *Arnoldia* from its pamphlet format to a magazine format in 1970. A card-stock cover with a full-bleed (printed

NANCY ROSE

Bound copies of every issue of the *Bulletin of Popular Information* and *Arnoldia* are housed in the Arboretum's library. All issues are also available through the Arboretum's website (http://arnoldia.arboretum.harvard.edu).

all the way to the edges) photograph was added, and it was published six times per year (including the Director's Report) with a subscription price of $3.50 per year. Interestingly, no one was listed as editor in the front of the magazine, but in the staff list at the end of the 1972 Director's Report, Jeanne S. Wadleigh was listed as "Editor of Arnoldia," a position she held until 1979. During this period of time, the content of the magazine changed considerably from what it had been under Wyman's leadership. For one thing, many of the articles were written by non-Arboretum staff and for another, there were a number of "theme" issues that were later republished as stand-alone books, including "Low-Maintenance Perennials," "Colonial Gardens," and "Wild Plants in the City." Dr. Howard himself wrote many articles for *Arnoldia* covering many aspects of the Arboretum's history, including the important two-part "E. H. Wilson as Botanist" (Volume 40, Numbers 3 and 4, 1980). Shiu-ying Hu, who first came to the Arboretum as a graduate student in 1948, brought the Arboretum's China connection up to date with some fascinating articles about her return to mainland China in 1975 (Volume 35, Number 6, 1975; Volume 37, Number 3, 1977).

The first full-color *Arnoldia* cover appeared in 1981, featuring a photograph of *Hamamelis* x *intermedia* 'Arnold Promise' by Al Bussewitz, a long-time Arboretum volunteer.

When Peter Ashton became director of the Arboretum at the end of 1978, he was determined to have *Arnoldia* reflect the broader research mission not only of the Arboretum but also of the Organismic and Evolutionary Biology Department of Harvard University. He also wanted *Arnoldia* to reach a broader audience of readers. To this end, he added color covers to *Arnoldia* in 1981, reduced its publication cycle from six times per year to four in 1982, and increased its dimensions (from about 6 by 9 inches to about 7½ by 10) in 1983. In addition to these stylistic changes, the magazine expanded its former focus on plant collections, botany, horticulture, and landscape history to include articles about cutting-edge research on ecology, molecular biology, rare plant conservation, and tropical forest biodiversity. Ashton felt that scientists affiliated with the Arboretum needed to be able to explain the relevance of their research to the greater public, especially the Arboretum's membership. Since then, *Arnoldia* has continued to publish articles on a wide range of topics that embody the mission of the Arboretum, and to provide a means for scholars to share their research with interested readers.

WRITERS AND CONTENT

It is worth noting that the editors of the publication during its first fifty-eight years—Sargent, Wilson, Anderson, and Wyman—were also its principle writers. This aspect gave it both a highly personal and authoritative tone. The people who were writing about the plants knew what they were talking about and, because the Arboretum was a research and not a commercial institution, they could be counted on for unbiased information. All of these botanists wrote with a high level of confidence based on the completeness of the Arboretum's collections and on the soundness of their observations and judgment.

Issues of the *Bulletin* from the Sargent years, in particular, make for fascinating reading because they tell the story of the early introduction of many now-familiar plants. Sargent was also very adept at capturing the essence of plants, sometimes in completely unexpected ways, such as his description of *Populus tomentosa* leaves, which "hang on long flattened stalks and, fluttering in the slightest breeze, make, as the blades come together, a noise like drops of rain in a heavy shower falling on a tin roof" (July 2, 1915). Many of the plants that were first described in the *Bulletin* have gone on to become famous ornamentals, and a few have become infamous invasive species. To illustrate the latter category, I found this quote about Amur corktree in the June 14, 1911, issue of the *Bulletin*: "*Phellodendron sachalinense* [now classified as *P. amurense*], which is a native of Saghalin [Sakhalin] and the northern island of Japan, has grown in the Arboretum into a tree about thirty feet high, with a tall, straight trunk, and wide-spreading branches forming a shapely flat-topped head. The seedlings springing up naturally near the old trees indicate that it is likely to hold its own in New England. The hardiness of this tree, its rapid growth, and the fact that it is not injured by insects, suggest that this is a good subject to plant in narrow streets. Seeds will be sent from the Arboretum in the autumn to anyone who may desire to grow this tree."

This fascinating quotation reveals much about the early history of the Arboretum that, had it not been written down, would have been

NANCY ROSE

The picturesque forms and thick, corky bark of the mature corktrees along Meadow Road often draw the attention of Arboretum visitors (*Phellodendron amurense* var. *lavallei* seen here).

forgotten. To begin with, the observation that Amur corktree is capable of spreading on its own is the earliest record of the species' invasive tendencies, which landed it on the Massachusetts Prohibited Plant List in 2009. Second is Sargent's unequivocal, but somewhat misguided, recommendation to plant it on narrow streets. And finally there is the offer of free seeds for anyone who wants to grow the tree. Taken together, these statements provide a stunning example of the role that botanical gardens have played in popularizing and distributing plants. The rules seem to have been, first test it, then evaluate it, and then distribute it. What's remarkable is that it only took one hundred and twenty-seven years for Amur corktree—which the Arboretum introduced from St. Petersburg, Russia, in 1882—to go from its initial introduction in Massachusetts to being banned by the state. This quotation illustrates the treasure trove of information that these early bulletins contain about the plants grown and introduced by the Arboretum. Since the *Bulletin* was written as a running narrative of seasonal events (rather than separate articles) it takes a little more effort to sort through the information contained in the issues, but reading through them page by page leads to the discovery of many buried gems. (All past issues of the *Bulletin* and *Arnoldia* are available on the Arboretum's website at http://arnoldia.arboretum.harvard.edu)

The *Bulletin* issues written by E. H. Wilson are as fascinating as those of Sargent because he describes the origin and cultivation of many of his Chinese plant introductions with words that generations of horticultural writers have shamelessly copied without proper attribution. It's particularly interesting to read how excited he got about the first blossoms of his newer introductions, many of which he had not seen before. In a very real sense, Wilson's *Bulletin* entries contain the raw observations that became the basis of his later articles and books.

ARCHIVES OF THE ARNOLD ARBORETUM

From Bulletin—May 16, 1927 (Series 3, Volume 1, No. 6)

"Exochorda Giraldii Wilsonii. In the Shrub Garden and on Bussey Hill large plants of this vigorous growing Pearl Bush are now rapidly opening their flowers. These are pure white, each one and a half inches across, and borne on erect six- to eight-inch long racemes. It is native of central China and has been growing in the Arboretum since 1907, when seeds were received from Wilson. So far the plant has never suffered winter injury and it blooms more abundantly each succeeding year. It is a shrub of almost tree-like dimensions and easily the finest of the tribe."

—Ernest H. Wilson

Noted Arboretum taxonomist Alfred Rehder photographed this large specimen of *Exochorda giraldii* var. *wilsonii* growing by his home in Jamaica Plain, Massachusetts, in May 1921.

This photo by Donald Wyman shows tree damage at the Arboretum from the hurricane of September 21, 1938.

Weather Talk

ONE THEME that runs through the Arboretum publications is a thorough discussion of weather and its effects on the collections. This seemed to be especially true for the *Bulletin,* which was aimed primarily at a local audience and often emphasized the immediacy of the growing season. Take, for example, the October 16, 1929, entry by E. H. Wilson, "The phenomenal drought which Massachusetts in common with other states has endured will long be remembered for it caused grave anxiety among all who garden. In late June the Arboretum enjoyed one good rainfall but not another worth mentioning until October 2nd. For fully two months supplying water to suffering trees and shrubs was the principal work engaged upon. Fortunately, there was no great heat but at the height of the drought it looked as if a great many plant must die. Thanks to the water stored from the heavy rains of spring the trees suffered but little and as autumn arrived a general freshening among all woody plants was noticeable. Today it is difficult to realize that extreme drought has been experienced. The power of resuscitation enjoyed by plants is, indeed, marvelous."

Perhaps the most famous weather event to affect the Arboretum was described by Wyman in the October 7, 1938, *Bulletin*: "Rain had been falling rather consistently for four days when on September twenty-first, over large areas in New England, the downpour assumed the proportions of a deluge. Rivers in western Massachusetts were at flood stage, and everywhere the ground was soggy from excessive rain. By late afternoon the rain slackened and the wind increased to a gale. At 4:50 p.m. when the lights went out in the Administration Building staff members expected a "blow", but certainly did not anticipate the hurricane which caused frightful damage throughout New England. The Arboretum lost approximately 1500 trees, and a recent newspaper estimate of the number of trees lost in Massachusetts—only one of the New England states touched by the storm—reached the appalling figure of 100,000,000. There is no way of checking such an estimate, but with definite information concerning the number of trees destroyed in a few Boston suburbs, this figure seems possible... Hemlock Hill in the Arboretum is one of the higher points between Boston and the Blue Hills. With wind velocities at times approximating 125 miles an hour it is understandable that great damage was done to the particular plantings on the southern or exposed side an the top of that hill. To the older friends of the Arboretum, this damage will seem the most serious." (The tradition continues with an annual report in *Arnoldia* recapping the previous year's weather and its effects on Arboretum collections.)

Science at the Arboretum: Seeing the Forest Through the Trees

William (Ned) Friedman

THE ARNOLD ARBORETUM is all about science, and has been since its founding in 1872 by Harvard University. The Arboretum's mandate as stated in the original deed—to grow all of the trees and shrubs from anywhere on Earth that could be grown here—was a long-term research proposal in itself, one that continues to this day. Over the decades research in many fields has been conducted at the Arboretum by our scholars as well as colleagues from institutions around the world.

The opening of the Weld Hill research building early this year brings a new era of science to the Arboretum. Weld Hill's state-of-the-art facilities include laboratories, greenhouses, and spectacular teaching equipment for undergraduates. Microscopes with lasers allow scientists to peer into the microscopic world of plants; molecular biology equipment allows us to unravel the DNA that codes for the processes that make each plant and plant species unique and exquisitely responsive to its environment; and highly sophisticated banks of growth chambers permit botanists to study the effects of climate change on plants under controlled conditions. Importantly, Weld Hill allows Arboretum researchers formerly based at Harvard's Cambridge campus to expand their work at the Arboretum. It also provides great new opportunities for students, scientists, and visiting scholars to conduct research using the living collections and the Weld Hill facilities. In essence, the Arnold Arboretum of Harvard University is poised to become a worldwide hub for the study of plant biodiversity. With over 15,000 curated living organisms, there are unlimited and unique opportunities to conduct botanical research at the Arboretum.


JON HETMAN

The Weld Hill research facility at the Arnold Arboretum.

Research has limited value until it is shared with others, of course. A vital part of the Arboretum's mission over the years has been to translate the science of the Arboretum to a wide audience. Arboretum publications, especially *Arnoldia* and its predecessor, the *Bulletin of Popular Information,* have been important vehicles for disseminating information about the fascinating world of plant science to Arboretum friends and colleagues around the world. As research grows at the Arboretum we will continue to share it through *Arnoldia* as well as our much expanded website and education programs.

William (Ned) Friedman is Director of the Arnold Arboretum and Arnold Professor of Organismic and Evolutionary Biology at Harvard University.

While these later publications were more complete and formal, the original *Bulletin* observations provide a more intimate connection to the seasonal cycles of the Arboretum.

For me, the most remarkable thing about the Sargent and Wilson contributions is their timelessness. Having worked at the Arboretum for over thirty years, I can read their words and get the feeling that I can go right out onto the grounds and see the exact same scenes (or close to them) that they were describing.

> "Bussey Hill, where the new and rarer plants from the Orient are quartered, is perhaps the most interesting place in the Arboretum at the moment [May 16, 1927]... From the overlook itself looking toward the south, the Hemlock Grove looms majestic; westward across the Oaks, over and beyond the steely gray, misty, cloud-like clump of American Beech, Spruce, Fir, and Pine stand conspicuous. Everywhere wholesome scented air, opening bud, blossom, and green grass—everything fresh and clean—the Arboretum in spring is rich in charm and beauty."

RICHARD SCHULHOF

Bussey Hill still provides magnificent views and beautiful plants, including this 102-year-old sand pear (*Pyrus pyrifolia*) in the open area just below the summit.

When it comes to writing articles, no one was more prolific—in both the *Bulletin* and *Arnoldia*—than Donald Wyman. He published hundreds of pages of observations on the Arboretum's collections covering an amazing array of topics including crabapples (his specialty), rhododendrons, lilacs, winter injury, hurricane damage, trees with interesting bark, the order of bloom of Arboretum plants, seashore gardens, hedges, vines, and a number of arcane topics such as the use of spent hops for mulch (in *Arnoldia* Volume 7, Number 12, December 12, 1947). More than any other of the Arboretum's horticulturists, he had no qualms about passing judgment on the suitability of plants for specific purposes, based on his notes on the performance of the collections over the years. In horticultural circles of the 1940s and 1950s, Wyman was the voice of authority in the northeast when it came to recommending (or condemning) plants.

THE FUTURE

In reading through Arboretum publications from the past hundred years it's interesting to note how some things change and some stay the same. Many horticultural recommendations published in the *Bulletin* and *Arnoldia* are still valid today, though a few (like planting Oriental bittersweet [*Celastrus orbiculatus*]) no longer hold, given the luxury of hindsight. Modern ecological challenges including climate change, urbanization, and globalization have increasingly become part of plant research and, subsequently, topics of *Arnoldia* articles. Concern over invasive plants and pests, greater emphasis on global plant conservation, and the need to improve our urban forests are some of the themes seen more often in the magazine in recent years. *Arnoldia* has also reflected some of the changes within plant science in recent decades, such as the use of molecular genetics to identify plants and new thinking about how plant groups are related. The opening of the Arboretum's Weld Hill research facility brings many exciting new research opportunities (see page 8) and *Arnoldia* will be a major venue for sharing new scientific knowledge with the public. And, as always, *Arnoldia* will feature articles on the plants of the Arnold Arboretum, the very thing that inspires so many of the the Arboretum's staff members and visitors to appreciate nature and care about the environment all around the world.

Peter Del Tredici is a Senior Research Scientist at the Arnold Arboretum. He served as editor of *Arnoldia* from 1989 through 1992.

RICHARD SCHULHOF

Through the pages of *Arnoldia* and our website, we will continue to share the magnificent plants of the Arnold Arboretum with all. Seen here in autumn color, a three-flowered maple (*Acer triflorum*) and Japanese stewartia (*Stewartia pseudocamellia*) in front of the Arboretum's Hunnewell Visitor Center.

Can *Taxodium* Be Improved?

David Creech, Lijing Zhou, Yin Yunlong, and Teobaldo Eguiluz-Piedra

COURTESY OF STEVEN J. BASKAUF, HTTP://BIOIMAGES.VANDERBILT.EDU

Growing in wetland conditions, this stand of baldcypress (*Taxodium distichum*) displays the distinctive knees (pneumatophores) characteristic of the species.

Degradation of coastal forests and associated wetland habitats by excessive flooding and saltwater intrusion is a global problem, and may become even more so if predicted climate changes and consequent rises in sea level occur. In the United States, there's been great concern about the degradation of the entire Mississippi River Delta biotic system, much of which can be traced to man-made changes in the nature and flow of the Mississippi river. One example of this degradation is the loss of coastal forests south of New Orleans, which has left this city more vulnerable than ever to the impact of hurricanes. (Allen 1992; Earles 1975; Krauss et al. 1999)

These circumstances make it increasingly important to identify, select, and even improve tree species that have some innate tolerances to flooding and salinity. Such trees will be valuable for restoring degraded coastal areas as well as for urban landscapes and other greening projects. For this reason, we are particularly interested in *Taxodium distichum.*

TAXODIUM TAXA

Of all native swamp forest tree species in the southern United States, *Taxodium distichum* (baldcypress) has long been recognized as being among the most tolerant to flooding and salinity. This long-lived and generally pest-free deciduous conifer is a popular landscape tree in many parts of the world. Once established, *Taxodium* is tolerant of flooding, salt, alkalinity, and strong winds.

The precise nomenclature for *Taxodium* remains a matter of some debate. Once considered three species—*T. distichum* (baldcypress), *T. ascendens* (pondcypress), and *T. mucronatum* (Montezuma cypress)—we believe there's enough consensus in recent literature to list *Taxodium distichum* as a single species with three botanical varieties:

- *Taxodium distichum* (L.) Rich. var. *distichum* (baldcypress)
- *Taxodium distichum* var. *imbricarium* (Nutt.) Croom (pondcypress)
- *Taxodium distichum* var. *mexicanum* (Carriere Gordon) (Montezuma cypress) (Arnold and Denny 2007)

While baldcypress and pondcypress natural ranges overlap in many areas across the South, the commingling of baldcypress and Montezuma cypress natural ranges is less apparent. Hardin (1971) was the first to speculate on the nature of intermediates where baldcypress and pondcypress ranges overlap. The same is perhaps true for baldcypress communities in central and southwestern Texas. They are often Montezuma cypress-like, leading many to believe this is the result of natural introgression present between baldcypress and Montezuma cypress in this transitional zone.

Baldcypress is native to much of the southeastern United States, from Delaware to Texas and inland up the Mississippi River to southern Indiana. It occurs mainly along rivers with alluvial flood deposits. Baldcypress is a durable conifer particularly well adapted to wetland habitats. It is easy to grow from seed and is relatively free of pests and diseases. The tree is modestly to highly resistant to *cercosporidium* needle blight and tolerates compacted soils and low-oxygen or swampy soil conditions. It stands strong in the face of hurricanes, is amazingly long lived (1,000+ years) and, with time, can become quite large (70+ feet [21+ meters] tall). Baldcypress produces knees (pneumatophores), which are considered a negative in most landscaping situations since they can

Baldcypress
Taxodium distichum* (L.) Rich. var. *distichum

Pondcypress
***Taxodium distichum* var. *imbricarium* (Nutt.) Croom**

Montezuma cypress
***Taxodium distichum* var. *mexicanum* (Carriere Gordon)**

Range maps for *Taxodium*.

interfere with routine maintenance such as lawn mowing. While their exact function is unknown, knees may contribute substantially to wind throw resistance (Conner et al. 2002).

Baldcypress in the western part of its range (central and western Texas) is generally more salt and alkalinity tolerant, and is less prone to produce knees than baldcypress from more eastern sources. East Texas genotypes of *Taxodium* planted in San Antonio, Texas, where soils are highly alkaline, often turn chlorotic and perform poorly. As with pond cypress and baldcypress, botanists and horticulturists speculate that baldcypress in central to western Texas are perhaps commingled with Montezuma cypress and represent transitional genetics (Lickey and Walker 2002).

This very large, old pondcypress grows at Shangri La Gardens, in Orange, Texas. While outside the normally accepted range for the species, this pondcypress appears to be spontaneous, not planted.

"Árbol del Tule," the giant Montezuma cypress at Oaxaca, Mexico, is considered to be one of the world's largest trees.

Pondcypress occurs in the southern portion of the range of baldcypress and only on the southeastern coastal plain from North Carolina into Louisiana. While southeast Texas is not normally included as part of the pondcypress natural range, an approximately 1,200-year-old pondcypress at Shangri La Gardens, Orange, Texas, appears to broaden the range. Pondcypress occurs in blackwater rivers, ponds, bayous, and swamps, usually without alluvial flood deposits. Pondcypress is relatively easy to distinguish by its feathery foliage, which is ascendant, rather than more splayed and flat as in baldcypress, but this may not always be consistent. Landscapers often use pondcypress as a specimen, particularly when moist soil conditions exist and a smaller stature (40+ feet [12+ meters]) is desired.

Montezuma cypress should probably be named Moctezuma cypress because by all accounts it has the name of the fifth Aztec King, Moctezuma (1466–1520), whose reign included the first contact between the Mesoamerican civilization and Europeans. It is popular in Mexico among pre-Hispanic cultures and is widely planted in public parks and gardens in most major cities in Mexico. A Montezuma cypress near Oaxaca, Mexico, the famous "Árbol del Tule," features a trunk over 56 feet (17 meters) in diameter and is estimated to be over 2,500 years old.

A 10-year-old Montezuma cypress from the Viveros Genfor nursery being transplanted into a landscape near Texcoco, Mexico.

Montezuma cypress is native to Mexico (in 27 of the 32 states), some areas of Guatemala, the tip of South Texas, and, perhaps, a few populations in New Mexico. It typically grows next to water sources such as creeks, rivers, lakes, and ponds and performs better in deep loamy soils than in volcanic soils where firs, pines, and oaks are found. While it will grow in a hot tropical climate, it does not perform best there.

Montezuma cypress differs from baldcypress and pondcypress in several ways: it is substantially evergreen, produces smaller seeds, never produces

"Paseo de los Ahuehuetes," a beautiful allée of Montezuma cypress near Texcoco, Mexico.

distinct knees, is generally more tolerant of salt and alkaline soils, and is less tolerant of extended flooding. At Stephen F. Austin State University Gardens in Nacogdoches, Texas, Montezuma cypress forces new growth early in the spring and continues to grow late into the fall. Observations of Montezuma cypress in USDA plant hardiness zone 8 (average annual minimum temperature 10 to 20°F [-12 to -7°C]) and lower suggest that there may be hardiness and winter damage issues, particularly with trees derived from lowland, subtropical Mexican genotypes. This may be a seed source provenance problem, and there is good reason to believe that Montezuma cypress can be grown much further north if the proper genotypes are selected as seed sources.

Montezuma cypress is not usually considered a superior landscape tree in the southern United States since it often fails to form a strong central leader and is generally more susceptible to *Cercosporidium* needle blight than baldcypress, especially when grown in humid areas. However, there are exceptions, and further breeding and selection may bring better choices. At Stephen F. Austin State University Gardens there are several Montezuma cypress specimens worth noting, including one that survived the December 23, 1989 freeze (0°F [-17.8°C]) with no damage. Over the years, Montezuma cypress has withstood droughts of considerable magnitude at Stephen F. Austin State University Gardens. In fact, we note that Montezuma cypress can shed almost all its foliage in a summer drought, yet it will push new growth when rain or irrigation finally returns. Montezuma cypress kept in a high state of vigor often keeps foliage through mid-winter.

In Mexico, Montezuma cypress is much appreciated, but little genetic improvement has been undertaken. Coauthor Teobaldo Eguiluz-Piedra is supervising a large planting of genotypes near Texcoco, Mexico, that includes ten provenances. While just in the first year, there are already apparent differences in foliage color, tree form, growth rate, and branching characteristics. In Mexico, Montezuma cypress is considered quite variable from one provenance to another and nursery conditions can greatly impact growth rate and form. The Viveros Genfor nursery in Texcoco has grown Montezuma cypress for the last twenty years and reports that it requires no more water than ash, oaks, or other conifers, contrary to what might be expected from Montezuma cypress's natural preference for a riparian habitat. Most of the nursery's propagation is by seed collected from mature trees that are more than 500 years old. Viveros Genfor is also cloning the oldest Montezuma cypress trees nearby using juvenile tissue from rooted cuttings with a modest success rate.

TAXODIUM CULTIVARS

While most *Taxodium* plants sold in the United States are seedlings, there are a number of cultivars available, primarily of baldcypress. Mostly available as grafted trees through specialty nurseries, baldcypress cultivars vary in form, ultimate size, and foliage color. For over twenty years, Stephen F. Austin State University Gardens has acquired a wide array of cultivars from specialty nurseries, arboretum and botanical garden collections, and private conifer enthusiasts. Baldcypress cultivars at the Gardens

The "Treehenge" planting of 'Cascade Falls' baldcypress at Stephen F. Austin State University Gardens.

ROBERT MAYER

Foliage and cones of the baldcypress cultivar 'Pendens'.

include 'Sofine' (Autumn Gold™), 'Pendens', 'Mickelson' (Shawnee Brave™), 'Fastigiata', 'Contorta', 'Secrest', 'Hurley Park', 'Peve Minaret', 'Peve Yellow', 'Jim's Little Guy', 'Cody's Feathers' (synonym 'Wooster Broom'), 'Cave Hill', 'Cascade Falls', and 'Falling Water'. Only two pondcypress cultivars are listed—'Prairie Sentinel' and 'J.B.'—and two cultivars of Montezuma cypress, the mounding weeper 'McClaren Falls' and modestly weeping 'Sentido', can also be seen in the collection. In addition to cultivars, Stephen F. Austin State University Gardens has numerous specimens of baldcypress, pondcypress, and Montezuma cypress from a wide range of documented provenances.

TAXODIUM HYBRIDS

Controlled *Taxodium* hybridization (crosses between botanical varieties of *Taxodium distichum*) can combine the best characteristics of superior parents and allow for selection of superior clones from the progeny. Much hybridization work has occurred at the Nanjing Botanical Garden, where selection criteria for controlled cross and open pollinated seed crops include growth rate, salinity and alkalinity tolerance, flooding tolerance, *Cercosporidium* needle blight resistance, form, and ease of cutting propagation. In several studies in China, *Taxodium* hybrids often demonstrated improvements in growth rate, salt tolerance, form, and vigor.

One *Taxodium* hybrid was given the cultivar name 'Nanjing Beauty' and was cooperatively introduced in 2004 by Nanjing Botanical Garden and Stephen F. Austin State University Gardens. A baldcypress × Montezuma cypress cross, this clone was originally selected in 1988 from the breeding work of Professor Chen Yong Hui at the Nanjing Botanical Garden. Chen and others report that the selection's attributes include 159% faster growth than baldcypress, longer foliage retention in fall and early winter, and no knees. It also tolerates alkaline soils and fairly high salt concentrations. Cuttings root at good percentages and the clone is commercially available in China. 'Nanjing Beauty' is currently under evaluation in over 30 locations in the southern United States and is offered by several nurseries across the South.

Additional crosses made at the Nanjing Botanical Garden in 1992 used pollen from a superior selection of Montezuma cypress applied

A row of the *Taxodium* hybrid cultivar 'Nanjing Beauty' growing at a nursery near Jinjiang, Jiangsu, China.

Planted at the Stephen F. Austin State University Gardens in March 2010 as small one-gallon-container plants, these specimens of "merit" clone T406 from China had a very fast growth rate. This photograph is from July 2011.

Peter Raven (left), President Emeritus of the Missouri Botanical Garden, views the *Taxodium* advanced selection blocks with Yin Yunlong at the Nanjing Botanical Garden, Nanjing, China.

to female flowers of 'Nanjing Beauty' (then known as selection T302). Fifteen selections were made in 1995, with the main characteristics for selection being fast growth rate, dark green leaf color during the growing season, and red-orange leaf color in the autumn. Several of these clonal selections are now widely used in China. Additional Montezuma cypress × baldcypress hybrids have been selected, including four "merit" clones that have been verified by molecular identification, and tested in the field for salt tolerance, growth rate, form, etc. (http://sfagardens.sfasu.edu/UserFiles/File/PLANTS/Taxodium%20breeding%20brochure%20feb%2020100.pdf). These selections are rapidly multiplied by cutting propagation, with high rooting percentages the norm. Acceptance of "merit" clones by the industry in China indicates that more and more *Taxodium* cultivars will enter the commercial market in the future. With great potential for use as timber, energy biomass, carbon sinks, and water conservation forests, *Taxodium* hybrids can be widely used for urban and rural greening, shelterbelts for farmland, and forests for coastal areas in southeastern China.

ASEXUAL PROPAGATION OF *TAXODIUM*

For superior *Taxodium* clones to make a substantial impact on nursery numbers, it is important to propagate asexually. While grafting is common (especially for ornamental cultivars such as those with dwarf or weeping forms), it is expen-

落羽杉

Baldcypress

墨西哥落羽杉

Montezuma cypress

池杉

Pondcypress

Taxodium in China

TAXODIUM varieties and hybrids play a very important role in the southeastern China coastal vegetation plan, particularly in the floodplains of the delta and associated bottomlands and estuaries of the Yangtze River. The planting of coastal windbreak forests in this area was initiated in 2005. There are many reforestation projects under way on the mainland side of dikes that run along the sea, both north and south of the mouth of the Yangtze. These projects have received massive provincial and federal financial support and millions of trees will be planted by midcentury.

Taxodium hybrids have also found a place in many of the large parks being constructed in the major cities of southeastern China. As grand allées or individual specimens, many Chinese foresters feel that in this region of China baldcypress is indeed a special tree. It has become more and more popular in the nursery industry, competing primarily with *Metasequoia*, *Glyptostrobus*, and others.

sive. Cutting propagation of *Taxodium* is generally reported as difficult, but rooting success is influenced by genotype, the physiological age of the clone, rooting hormones, substrate, and the vigor of the cutting wood. (Pezeshki and DeLaune 1994; St. Hilaire 2003; Zhou 2008).

Young trees generally root with greater ease than older trees. Coauthor Yin Yunlong reports that the original plant of 'Nanjing Beauty', selected in 1988, has over time become more difficult to root, a condition attributed to chronological and physiological age factors.

To counter lower rooting percentages, a strict protocol for achieving cutting propagation success has been developed. Small well-rooted liners are field planted at close spacing and grown for one year, with trees often reaching 3.3 to 6.6 feet (1 to 2 meters) in the first growing season. Then, in that first winter, they are cut back to 1 foot (0.3 meters) tall. These pollarded trees produce vigorous upright shoots in the spring. Cuttings are collected in early summer and one upright shoot is left on the stock tree to grow for the rest of the season into a straight tree, 6.6 feet (2 meters) tall, ready for sale in the winter. Yin Yunlong notes that collecting cuttings from upright shoots produces upright growing plants of better form than trees produced from cuttings taken from side branches, a technique to avoid the problem of plagiotropic growth.

Early summer cuttings are rooted under part shade to sun, using intermittent mist and a well drained mix in deep rooting beds. While rooting hormones are utilized, cutting wood quality and maintaining good turgor are recognized as critical factors for high rooting percentages (80+%). Four cutting trials in 2006 at Stephen F. Austin State University Gardens indicated that a high concentration of K-IBA (5,000 to 10,000 ppm) improved rooting as did slightly wounding the basal portion of the stem. Other studies indicate better rooting with hormones, very well drained substrates like perlite, and no wounding (Zhou 2007, King et al. 2011).

IMPROVING *TAXODIUM*

Several *Taxodium* germplasm collections exist in the southern United States but they remain relatively unexploited. In addition to the *Taxodium* collection at Stephen F. Austin State University Gardens, Dr. Donald L. Rockwood, University of Florida, Gainesville, Florida, manages a large planting of varied genotypes, many of which serve as seed sources for superior seedlings, with plantings that target tolerance of fly ash, salinity, or polluted soils. Dr. Ken W. Krauss, at the United States Geological Survey, National Wetlands Research Center, Lafayette, Louisiana, is collecting seed from survivor trees in the Mississippi Delta that have been exposed to increasing inundation and salt surges (Krauss et al. 2000; Conner and Inabinette 2005). By cruising the massive "ghost cypress forests" (large stands of dead or declining baldcypress) of the southern delta, individual survivor trees can be found that perhaps have good resistance to subsidence and high salinity. Their progeny may offer promise for reforestation projects in marginal sites, and the opportunity for selecting superior clones is immense. Finally, Dr. Mike Arnold, Texas A & M University, College Station, Texas, has planted a large collection of baldcypress genotypes from across the South; the collection includes central and western Texas provenances, as well as a collection of Montezuma cypress from Mexico and southern Texas (McDonald et al. 2008)

At the government nursery near Jinjiang (Jiangsu, China), I viewed over a million *Taxodium* cuttings in the one-acre field of propagation beds during a visit in September 2011. The nursery manager, Mr. Zho, employed a half-dozen ladies who used high-pressure hoses to hand mist the cuttings. Every day, for 8 to 12 weeks, each worker managed her own long run of propagation beds, dragging her hose and wand and waving a stream of mist over the crop. After each run, the ladies would rest and visit with each other, waiting until the beads of water on the cuttings had evaporated, the signal that it was time to repeat the process. When I asked why he used this strategy, Mr. Zho reflected that he had previously used automated boom misters on a timer, but he had found that the ladies knew better when the cuttings needed water—they had a feel for the crop—and rooting percentages were now very high.

—David Creech

Taxodium has many positive environmental attributes as a wetland species and as a landscape plant. It is fortunate that there is such great diversity available in the baldcypress, pondcypress, and Montezuma cypress gene pool, since with great diversity comes great opportunity for selection. No doubt superior *Taxodium* clones can be found in the progeny from controlled cross and open pollinated seeds. Improvements in salt and alkalinity tolerance, growth rate, resistance to *Cercosporidium* needle blight, drought resistance, and form could be expected from a breeding program. In the United States and Mexico, where *Taxodium* is used primarily as an ornamental, the market for improved *Taxodium* cultivars is relatively small in comparison to China, where *Taxodium* has a huge market built on hundreds of "greening" companies vying for government contracts. Millions of trees are needed for a wide array of development projects: large gardens and parks, highways, railroad lines, canal edges, and the coastal windbreak forest project. We have much to gain by connecting the native *Taxodium* germplasm resources in the United States and Mexico with the many *Taxodium* improvement projects under way in China.

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Introduction of merit *Taxodium* clones of the Nanjing Botanical Garden http://sfagardens.sfasu.edu/UserFiles/File/PLANTS/Taxodium%20breeding%20brochure%20feb%2020100.pdf

For a more extensive literature review, access the MS thesis and PhD dissertation of coauthor Lijing Zhou under "Arboretum" then "Links" on the Stephen F. Austin State University Gardens website http://sfagardens.sfasu.edu

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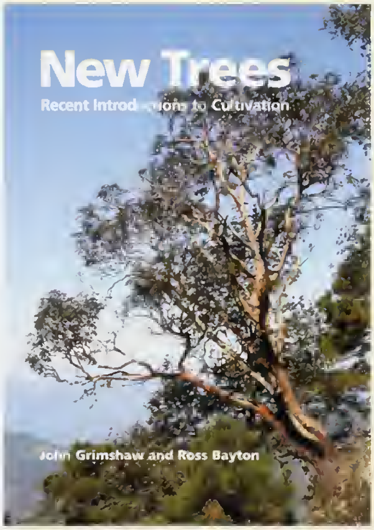
The Writing of *New Trees: Recent Introductions to Cultivation*

John Grimshaw



Editor's note: *New Trees: Recent Introductions to Cultivation* is an extensive new reference manual published by the Royal Botanic Gardens, Kew, in 2009. In this essay, co-author John Grimshaw describes the process of putting such a detailed publication together.

New Trees: Recent Introductions to Cultivation

John Grimshaw and Ross Bayton

Kew Publishing, Royal Botanic Gardens, Kew. 976 pp. 2009

ISBN 978 1 84246 1730

In 2002 I was living and working in the Netherlands. One afternoon the phone rang and a richly English voice identified its owner as Giles Coode-Adams. Might I be interested in writing a book about recently introduced trees?

Following early retirement from a career in finance, Giles had devoted his time to horticultural causes, first fund-raising for Kew and later becoming Treasurer and then President of the Royal Horticultural Society. Among his numerous commitments he was also Chairman of the International Dendrology Society's Scientific and Education Committee, reflecting his personal interest in trees and woody plants in general. While involved with Kew he had been the occasional recipient of young specimens grown from seed collected on expeditions, and indeed had taken part in a seed-collecting trip to Japan. The only problem was that, for so many of the recently introduced trees he was encountering, there was no useful literature to look them up in.

His proposal to the committee that a book on such trees would be valuable was accepted and they started looking for authors. I am still not quite sure how they found me, as I was then by no means dendrological, but I had recently co-authored and edited a well-reviewed book on snowdrops (*Galanthus*) that may have had something to do with it. To cut a long story short, the committee decided I was the right person for the job. Generous sponsors provided funding and the task could begin.

SETTING PARAMETERS

The assignment was to produce a book about all the tree species introduced to cultivation in recent decades, or those that had been in cultivation for longer but for which there was no good description. The standard reference in Britain is the venerated W. J. Bean's *Trees and Shrubs Hardy in the British Isles,* first published in 1914 and last updated in the 1970s to form the eighth edition. Its botanical descriptions are complemented by readable discursive text about the plant and its cultivation requirements, rather than the terse encyclopaedic format of, for example, Krüssmann's more comprehensive but less informative works (*Manual of Cultivated Conifers* and *Manual of Broadleaved Trees and Shrubs*). But Bean's book obviously fails to cover any introductions made since the 1970s, and many species, then poorly known, were covered in a footnote only. There are surprising omissions, too: the familiar American East Coast natives *Pinus taeda* (loblolly pine) and *Quercus muehlenbergii* (chinkapin oak) were first introduced to Europe

ERICH G. VALLERY, USDA FOREST SERVICE, BUGWOOD.ORG

New shoot and young cones of *Pinus taeda*, loblolly pine.

in the seventeenth century, but are not covered by Bean, probably because they have never been very successful in the British Isles.

It was therefore decided that the text should follow the format of description and discussion, and that any tree not discussed fully by Bean and now established in cultivation should be included in the new book. Its working title was *New Trees,* and as nobody could think of anything better, that stuck, with the addition of the subtitle *Recent introductions to cultivation.* But there were many other thorny issues for the Editorial Subcommittee. What geographical area should it cover? What is a tree?

On paper the last is easily answered. We applied the definition "a woody plant, normally with a single trunk reaching or exceeding 5 meters (16.4 feet) in height, at least in its native habitat," thus excluding shrubs with multiple stems developing from below or close to the ground. In reality, of course, the distinction is much less simple and some things snuck in that are on the shrubby side, while some large shrubs are omitted. The difficulty is well-illustrated by *Heptacodium miconioides* (seven-son flower), a shrub that can achieve 10 meters (32.8 feet) or more in height and be pruned to a single trunk: it was excluded.

The book was to cover trees already in cultivation, rather than possibilities in the wild, so its coverage was determined by which species were established in collections in public and private gardens (ascertained by comparing accessions lists). Unlike Bean's coverage, however, the new book was to be international in scope, reflecting the nature of the International Dendrology Society (IDS), but retaining the view that the trees should be hardy in temperate climates such as that of Britain. Where to draw the boundaries was less easy, but in Europe there is a clear distinction between the continental and

Tree or shrub? *Heptacodium miconioides* (seen here displaying showy pink calyces in early autumn) was deemed too shrublike to fit into *New Trees*.

maritime climates of the north and the Mediterranean climate to the south. An obvious vegetational difference is the commercial cultivation of olives in the Mediterranean and this matches, with remarkable precision, the area of southern Europe experiencing USDA Zone 9 winter temperatures (average annual minimum temperature 20 to 30°F [-6.6 to -1.2°C]). Maritime areas further north may also have Zone 9 winter averages, but it is impossible to grow the subtropical species that thrive in the Mediterranean basin here. We also excluded such remarkable "hotspots" as the Isles of Scilly (Zone 10) whose diversity of species otherwise ungrowable in northern Europe would skew the book too far away from its core audience.

North America, with its diversity of climates, presented a different challenge. The southeastern corner of the United States, southern California, and the southwestern deserts all have a very distinct garden flora appropriate to their climatic conditions, again deviating from the key sense of temperate. So we decided that we'd include collections north of San Francisco on the west coast, and anything from North Carolina northwards in the east, and just strike boldly across the continent between those two points in defiance of geography, hardiness zones, etc. I don't think we missed many significant collections by this approach.

RESEARCHING NEW TREES

With these parameters set it was possible to go through collection lists and work out what we would be covering. I forget how many names were on the original list but in the end we covered about 850 species in full, and mentioned many others that had a toehold in cultiva-

Drawing of *Magnolia laevifolia* by Hazel Wilks (Figure 56, p. 477, *New Trees: Recent Introductions to Cultivation*).

Picture This

ILLUSTRATING a book of this nature is a challenge. Many of the species covered are very little known in cultivation, and then are usually rather young specimens. In addition, taking a good picture of a tree is not very easy: the light must be right and there needs to be a vantage point for the photographer. A wide appeal for images was made and resulted in a diverse haul showing either details or the whole tree, in cultivation or in the wild, enabling us to produce (eventually) a well-illustrated book.

In addition to photographs, the book includes a series of 100 exquisite line drawings to illustrate species covered, all drawn by artist Hazel Wilks. She was also based in the Kew Herbarium and worked from dried and living specimens sourced from the Kew collection or further afield. Some complicated arrangements had to be made for receiving fresh material from elsewhere—I recall some anxiety when a precious box of fresh *Magnolia* flowers was delayed in the post.

tion. At this point I was joined by Ross Bayton, who was completing his Ph.D. at the University of Reading. With a horticultural as well as botanical background he was ideally suited to his task of preparing the botanical descriptions for each species. He worked at the Royal Botanic Gardens, Kew, where the authorities generously provided us with desk space in the herbarium (in Sub-basement A—which was better than it sounds) and all facilities, and so was able to tap the unique resources of Kew for information. Much came from published sources, but herbarium and living material was consulted for many descriptions.

Each description covers the morphological characters in detail, and provides notes on the tree's geographical distribution, its habitat, conservation status, hardiness zone, and sources of useful illustrations. The taxonomy was taken from recent authoritative sources and where there are issues (such as differing opinions on correct name) a note was provided. A unique feature of the book is its cross-referencing to the works of Bean and Krüssmann, which enables the reader to locate a description of an "old" tree quickly, and the opportunity was taken to supply up-to-date names for these taxa where there has been a change. *New Trees* therefore acts as an index to descriptions of almost all temperate cultivated trees, under almost any name. When using the book, please take time to read the introduction carefully.

GRADY W. REED

The venerable 1900 accession of *Larix sibirica* in the conifer collection at the Arnold Arboretum.

In addition to directing the whole enterprise, my task was to produce the horticultural commentary for each species. This entailed gathering information about the tree from growers across the area on provenance and performance, then trying to make sense of it. That makes it sound easy! In reality it required a huge amount of traveling and endless emails and phone calls, as well as online and library research. In the process, however, I had a wonderful time, visiting arboreta all over North America, Europe, and the British Isles, meeting a host of interesting people. The generosity with which contacts gave their time to help with the project was remarkable.

Traveling to see collections was the highlight for me. I usually had a list of specimens to see, so I'd concentrate on those, but of course one can't just ignore good trees, so I quickly gained a comprehensive education in all sorts of woody plants, not just recent introductions. Unfortunately, the only chance I had to visit the Arnold Arboretum was on a foul wet day in June 2006 when I and my guide Eric Hsu, then a Putnam Fellow at the Arboretum, got soaked to the skin. These were not conducive conditions for recording details of trees, but one that really interested me was a large specimen of *Larix sibirica* whose label recorded that it had come from H. J. Elwes in 1900: I connected with this tree on several levels.

Henry John Elwes (1846–1922) was an important landowner in Gloucestershire, where he lived on the family estate at Colesbourne Park, where I now manage the gardens for his great-grandson, Sir Henry Elwes. With ample financial resources, Henry John Elwes was able to travel widely, and developed interests in many areas of natural history. He was a noted ornithologist and lepidopterist and a keen big-game hunter, but gardeners principally remember him for his discovery of *Galanthus elwesii* (in Turkey in 1874). A quest for wild sheep took him to the Altai mountains of central Siberia in 1897 (where I followed his route, by chance, a hundred years later), but while there he saw magnificent forests of *Larix sibirica* and arranged for seed to be sent to him. About this time he became seriously interested in trees, having plans to plant large areas of woodland on the Colesbourne estate, and he started corresponding with notable dendrologists, including Charles Sprague Sargent at the Arnold Arboretum. This, presumably, is how the Arnold Arboretum received a seedling of *Larix sibirica*. Exchanges were mutual: a specimen of E. H. Wilson's collection of *Paulownia tomentosa* W769 made in Hubei in 1908 still grows at Colesbourne. *Larix sibirica*, on the other hand, was a failure here. Despite the local opinion that Colesbourne lacks a *d* in its first syllable, our climate is in reality not cold enough. Like most Siberian conifers, *Larix sibirica* comes into growth too early in mild maritime climates, and then the young shoots get frosted.

In consequence of its general uselessness in the British Isles *Larix sibirica* was given only a cursory note by Bean, but in other countries it is much more successful—in the United States, as evidenced by the Boston tree, and, for example, vigorous, healthy specimens in Minnesota; in Scandinavia; and in Iceland and Greenland, where it is the best tree for forestry planting. So, although not a recent introduction, it was an important species to cover in *New Trees*.

WHERE IN THE WORLD?

Once all the accounts were complete I counted the species that had come from different geographical regions. Introductions had come from all over the world, but as expected, nearly 50% were from China and the Sino-Himalayan region, which seems to be an inexhaustible source for garden plants of all kinds; one sometimes wonders what Wilson, Forrest, et al., were doing, when so much was missed! That, of course, is unfair. They had different targets, searching different areas and altitudes, and the difficulties of travel must have meant that many collections simply failed to arrive in a viable state. We also know, from the analysis made by Michael Dosmann and Peter Del Tredici of the survivorship of the collections made by the Sino-American Botanical Expedition (SABE) in 1980, that many species collected

TONY KIRKHAM

New foliage of *Liquidambar acalycina* is attractively flushed with bronze to red tones.

on any expedition soon fall by the wayside, or become represented by very few individual specimens in cultivation.

The SABE trip of 1980 remains one of the most significant of expeditions to China in terms of the species it brought back; *Liquidambar acalycina* is outstanding and so are *Sorbus hemsleyi* and *Sorbus yuana*, although the latter is still poorly known and needs to be more widely distributed, preferably in pairs of unrelated clones to ensure a good set of its spectacular fruits. The stamp-collecting habit of only planting one individual is a great problem in arboreta across the world: we really need to encourage people to plant groups to maximize genetic diversity, especially as conservation in cultivation is one of the justifications for many a collecting trip.

The thirty-year run of mild winters in the British Isles has encouraged us to broaden our horizons into genera that would previously have been considered too tender for all but the mildest of gardens, with explorers trawling lower and lower altitudes, especially for broad-leaved evergreens. Among their haul in Asia have been a mass of evergreen magnolias (formerly in the genera *Michelia* and *Manglietia*), diverse oak relatives such as *Castanopsis* and *Lithocarpus*, evergreen maples and a whole string of genera that are unfamiliar at best and previously unknown to horticulture: *Bretschneidera*, *Dipentodon*, *Exbucklandia*, *Huodendron*, *Sinopanax*, and *Sloanea*, to name a few. Other genera such as *Daphniphyllum* have had their diversity in cultivation greatly increased, while genera known as indoor plants have produced some surprisingly tough hardy species, *Schefflera* being a notable case.

The Sino-Himalayan region is vast, providing many frontiers on which to explore. In recent years Taiwan has been a popular destination, yielding both evergreen and deciduous species of great garden value, while Vietnam has become recognized as another hotspot. The mountains in the north, such as Fan Si Pan and elsewhere in the region round Sapa, are just

JOHN GRIMSHAW

***Lithocarpus kawakamii*, an evergreen species native to Taiwan, growing at Tregrehan in Cornwall.**

high enough and just far north enough for their plants to have a sporting chance of being hardy in milder areas. One of its special trees is what is known as *Aesculus wangii,* although the name is technically invalid, which produces nuts 10 centimeters (3.9 inches) across—they are a trophy in themselves. Upon germination, seedlings rocket up to over a meter (3.3 feet) within weeks. Its habit of coming into leaf early may be a problem, but the tree itself seems to be winter hardy in Britain, at least.

Strange though it may seem, Australia was the next most prolific source for recent tree introductions. This apparent anomaly can be explained by the single genus *Eucalyptus,* although there are several *Acacia* and *Callitris* species plus odds and ends from other genera too. Although of negligible interest in much of the area covered, *Eucalyptus* has a devoted fan club in the milder parts (maritime Europe, the Pacific Northwest). These enthusiasts have been searching out populations in the coldest part of each species' range, a classic example of intelligent plant-hunting, unlike the usual grabbing of material from the first population found. Whether or not such sourcing has done them any good after a series of hard winters in both of these regions remains to be seen—many eucalypts have been devastated. As they grow so fast, however, it won't be long before we see another crop appearing. *Eucalyptus nitens,* the shining gum, holds the record for the fastest-growing tree in Britain, achieving 20 meters (65.6 feet) in six years in Oxfordshire, making a splendid-looking tree in that time, but alas, it was killed last winter.

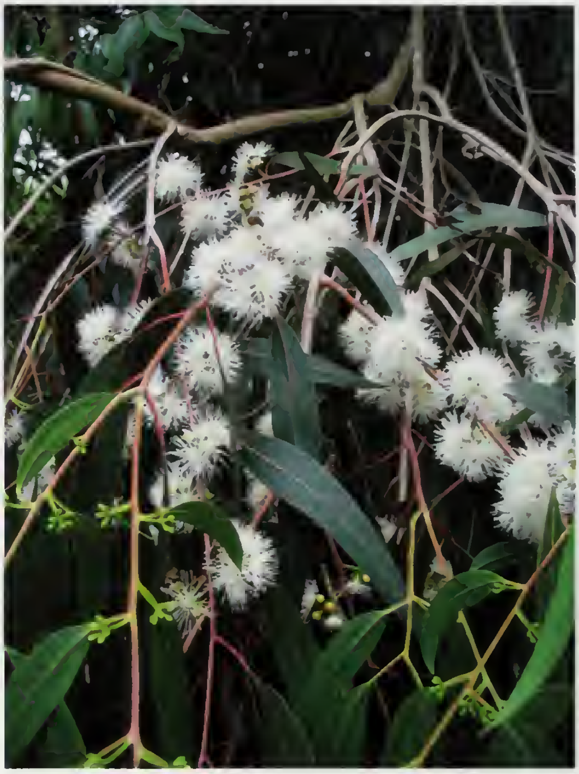
Mexico has also been an important destination for plant explorers in recent decades. With its huge diversity of ecosystems this is hardly surprising. Conifers and oaks are the two most important groups of Mexican trees for temperate gardens, but there are hardy *Cornus, Crataegus, Fagus, Platanus,* and *Tilia* too. It is always astonishing to think of "temperate" genera occurring in the tropics, but there is a huge diversity of *Magnolia* in tropical America, and rainforest maples and oaks are diverse in southeast Asia. Half the diversity of *Juglans* (walnut) is found in the Neotropics! Most of these tropical species are too tender for temperate horticulture, but this shouldn't prevent experimentation with species along the tropical fringes. Many Mexican evergreen oaks are proving to be remarkably tough, and even if they are defoliated by a severe winter will usually resprout next spring. Of all the new trees I studied for the book I was most impressed by *Quercus rysophylla,* an evergreen oak with big leaves that emerge red or bronze, and which forms a stately and handsome tree, hardy in western Europe, the southeastern United States, and the Pacific coast. Experts continue to discover new species of oaks in the United States and Mexico, usually isolated on obscure mountain ranges. One such is *Q. acerifolia,* from a few mountains in Arkansas, a handsome red oak with excellent autumn colors. Liberated from its native habitat it is proving to be versatile, succeeding across the northern and eastern United States, including in the Arnold Arboretum.

JOHN GRIMSHAW

An impressively large nut from the tree known as *Aesculus wangii* (the name has not been validly published), native to Vietnam.

In general, trees from Chile and New Zealand are for specialist growers in mild moist climates, and one has to be bold to grow any African woodies: even species from the most temperate parts of South Africa and the high mountains of East Africa are very tender. But in the right conditions it is fun to try—and even

JOHN GRIMSHAW



Eucalyptus chapmaniana **(left) and *Eucalyptus macarthurii* (right).**

outside the right conditions too. Only by pushing the boundaries can we ascertain true hardiness limits, and although there will be many failures there will be some very welcome successes. In this period of climatic uncertainty and increasing pest and disease problems we need diversity to ensure our gardens remain vibrant with interesting trees and constant experimentation is the way forward. *New Trees*, published in 2009, documents a period of intensive exploration for plant material that at least equals the efforts of earlier generations, and provides a reference point for the future from which success or failure can be judged.

Working on this project and writing the book was an immense privilege and the appreciation it has received makes it even more worthwhile. I am only one player in the team, though, and the book could not have been written without the help of dozens of dendrologists around the world, the support of the sponsors and the IDS and the sterling efforts of my co-author Ross Bayton and artist Hazel Wilks. The editing and layout were done by the incomparable Sarah Cannon, with technical assistance from Lloyd Kirton at Kew Publishing. These latter-end stages are when the really hard part of writing any book comes, when it is being edited and put together as a volume, and deadlines are flying towards one. The ultimate deadline was the launch, a grand reception in London planned by the IDS with a set-in-stone date of May 19, 2009. The last changes were made to the text on March 30, and the finalized proofs were delivered to Kew next day, giving us six weeks. I call that brinkmanship, but the German printers stuck to their timetable and the books reached England with a week to spare. That was a relief.

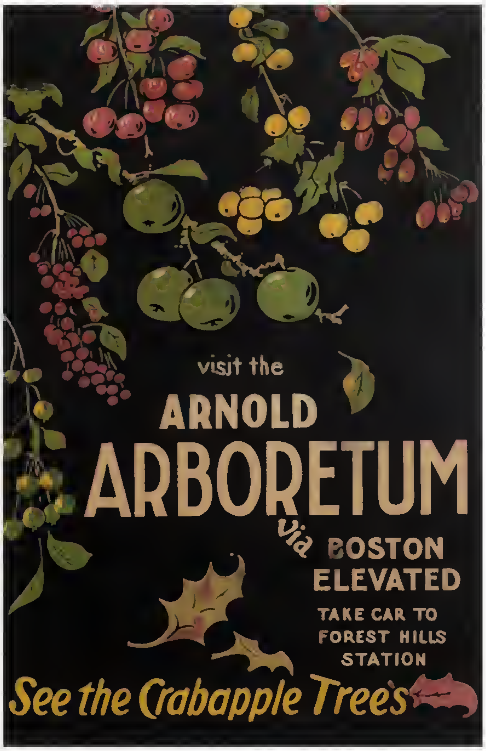
Dr. John Grimshaw is a gardening botanist based at Colesbourne in Gloucestershire, United Kingdom. He documents his horticultural activities in his blog John Grimshaw's Garden Diary (http://johngrimshawsgardendiary.blogspot.com/)

A Year With the Apples of the Arnold Arboretum

Miles Sax

I have spent the past year as a horticultural apprentice working in the *Malus* (apple and crabapple) collection of the Arnold Arboretum, a collection that has long been recognized for its importance to the horticultural and scientific worlds. Because of the Arboretum's many introductions and broad distribution of both cultivars and previously undiscovered *Malus* species from wild origin, it has been hailed as the "'Mother Arboretum' for flowering crabapples" (Fiala 1994). Once celebrated in an annual event known as Crabapple Saturday, this collection remains popular with Arboretum visitors, especially during spring bloom and fall fruit display.

The dynamic nature of arboreta, including ongoing change in the fields of taxonomy, nomenclature, and research technology, inevitably leads to the need for periodic large scale review of the plant collections. Although historically the Arboretum's *Malus* collection has been a high priority, in recent decades hor-



ARCHIVES OF THE ARNOLD ARBORETUM

An old poster touts the Arnold Arboretum's crabapple collection.

PHOTOS BY THE AUTHOR EXCEPT WHERE NOTED

Part of the Arnold Arboretum's *Malus* collection in spring bloom, including white-flowered *Malus hupehensis* (accession 324-55-B) at left.

ticultural maintenance had been deferred. In addition, the collection was in need of an infusion of new plant material. With the goal of providing an elevated level of plant care along with an in-depth collections review, my task as the Arboretum's horticultural apprentice became defined. Working within both the horticulture and curation departments, I jumped into the job of evaluating and renovating the *Malus* collection of the Arnold Arboretum.

COLLECTIONS AND THE CURATORIAL REVIEW PROCESS

Collectors of all sorts often collect items in sets, and it is this action that gives the collections defined parameters and scope. At the Arnold Arboretum the objects we collect are woody plants, but the question of how we define our "sets" is one that is not so easily answered.

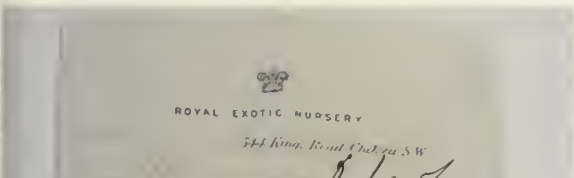
Since the Arboretum's inception in 1872, this idea of collections has always been at the heart of the institution's mission. A phylogenetic planting order (Bentham and Hooker's then-new taxonomic system) was used in the original landscape design; Charles S. Sargent understood that placing plants in the same genus together would allow scientists to observe different species concurrently. Far-flung plant explorations introduced a steady flow of new plants to the Arboretum's collection, but as time passed it became clear that simply having a large collection of plants wasn't enough. With finite resources and space, a more focused approach must be utilized in order to answer the question of scope, that is, "What does a comprehensive collection look like?" To answer this fundamental question of scope we use curatorial review, a process by which a collection is examined to quantify its value and determine goals for its development. Curatorial review is an important step in making sure that the Arboretum's mission is being achieved.

Specimens within a living collection have finite life spans, so the collection development process must be ongoing. At the Arnold Arboretum this process is primarily driven by the framework of the Living Collections Policy, which defines and prioritizes the scope of our collection. Guided by the Living Collections Policy I conducted my review of the *Malus* based on two subcategories within the policy, those for Core and Historic collections. The Core Collection of the arboretum is made up of accessions that are central to the mission of the Arnold Arboretum; plants that fall into this category are of highest importance for collection expansion and acquisition of new material and represent the heart and soul of the Arboretum's collections. The Historic Collection subcategory holds groupings of plants that are associated with the Arboretum's past expansion and influence in the horticultural world. These collections, which include historic (pre-1953) cultivars and cultivars that originated from the Arboretum, are maintained but not usually expanded. Subcategories within the Living Collections Policy are not mutually exclusive and some accessions, including many in the *Malus* collection, fall into multiple categories.

The crabapple cultivar *M.* x *purpurea* 'Aldenhamensis' (accession 303-50-B seen here) originated in England and was introduced to the United States by the Arnold Arboretum in 1923.

My review process for the *Malus* collection started with a taxonomic review, which included verification of identity. In autumn 2010 all of the *Malus* on Peters Hill (the location of the *Malus* collection) were examined and data were taken on size, shape, and color of the fruit. In spring 2011 a similar review was done by recording the size, shape, and color of flowers along with other morphological characteristics. This information was compared to existing descriptive references. For cultivars, the late Father John Fiala's book *Flowering Crabapples: The Genus* Malus was the primary resource used in determining identity and exploring the ornamental history of the genus. Because there is no current monograph of *Malus*, for accessions of wild provenance we used the flora pertinent to the region in question, e.g., *Flora of China*. This initial review was done to verify the plant material and confirm its correct taxonomic identity, allowing us to update nomenclature and ultimately make sure our plants are correctly labeled.

The petaloid stamens of this *Malus sieboldii* 'Fuji' (accession 418-68-C) flower are an example of the importance of field observation in a curatorial review. These petal-like structures, viewed from afar, make the flowers appear to be double. This curious discovery was not noted in Fiala's previous descriptions of this selection.



ROYAL EXOTIC NURSERY
544 King's Road Chelsea S.W.

Oct. 23/99

Dear Sir; I received your letter dated Sept 6 from Mendoza and was very glad to hear you had got through so well and that you were getting near to Dr Henry — On the return journey I hope you will get some seeds if not plants. One of the Begonias you

The archives of the Arnold Arboretum hold a treasure trove of documents, including many examples of Ernest H. Wilson's correspondence.

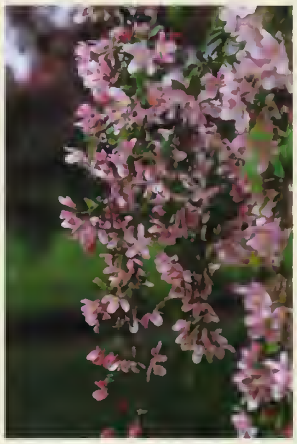
Plant Detectives

OBSERVING physical characteristics (flower color, leaf shape, etc.) is the most common way of identifying plants but it's not the only way. A trip to the Arboretum's curation department can give a researcher access to records detailing the origins or place of collection for many plants located on the grounds. Another resource is the cache of maps—many hand drawn—detailing the exact locations of plants come and gone. The herbarium in the Arboretum's Hunnewell building and the main Harvard University Herbarium yield pressed specimens of wild plants that we enjoy as landscape ornamentals today. A trip to the Arboretum's library may uncover volumes of floras spanning the world, or historical horticultural periodicals detailing the latest plant introductions that were in vogue at the time. The library's extensive archives provide a wealth of original documentation such as Ernest H. Wilson's journals and letters to Charles Sprague Sargent from his many far-flung plant collectors. To have these resources condensed in a single place allows for research and discovery to be made in a way that is unique to the Arnold Arboretum.

But sometimes even all these resources are not enough to make a definitive conclusion on a plant's true identity or origin. In recent years the ability to look at a plant's genetic makeup has proved to be a very powerful tool in plant systematics. To that end, the USDA Plant Genetic Resource Unit in Geneva, New York, has graciously offered to genotype a handful of the Arboretum's mystery *Malus*. When the results are returned we can look forward to some answers from this unique plant identification technology.

New Cultivars for the *Malus* Collection

WHILE typically collections at the Arnold Arboretum aren't built with a strong focus on cultivars (cultivated varieties, which are plants that have been selected for a particular trait, named, and clonally propagated), an exception is made for the *Malus* collection because of its unique history and its role in the dissemination and promotion of the flowering crabapple. But many of the currently accessioned cultivars originated prior to the 1960s, so in the curatorial review process we have identified an infusion of newer cultivars for collection expansion. Here are a few of the cultivars that are of high interest to us and that Arboretum visitors may be able to see on Peters Hill in the future:



NANCY ROSE

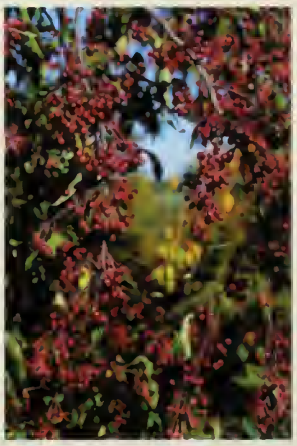
'LOUISA'

Malus 'Louisa'

A small tree with a weeping habit, flower buds rose, opening pink. The small fruits are yellow with a red cheek. This disease resistant crab apple is a Polly Hill introduction and named in honor of her daughter.

Malus 'Molten Lava'

A broadly weeping tree that features good disease resistance, lots of eye-catching orange-red fruit, and interesting winter bark. A John L. Fiala introduction.



NANCY ROSE

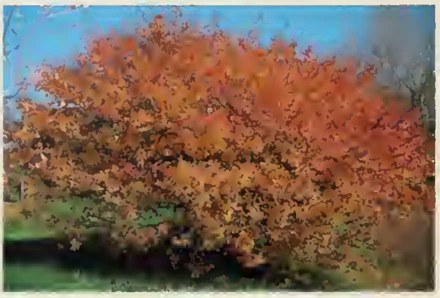
'MOLTEN LAVA'

Malus sargentii 'Select A' (Firebird®)

This cultivar is of note because of its low, spreading form and the small, bright red fruits that are retained well into the winter months. A Johnson Nursery introduction by Michael Yanny.

Malus ioensis 'Klehm's Improved Bechtel'

A cultivar of the North American native prairie crabapple. This selection features large, fragrant, double pink flowers and sparse fruit production. It is somewhat more disease resistant than *M. ioensis* but is susceptible to cedar-apple rust. Selected by Clyde Klehm.



COURTESY KLEHM'S SONG SPARROW NURSERY

'SATIN CLOUD'

Malus 'Satin Cloud'

A small rounded branching tree that has spicy fragrant blooms that lead to a profusion of small yellow fruit. It has exceptional disease resistance and striking fall foliage color of purple, red, and orange. This unique octoploid was hybridized by John L. Fiala and introduced by Klehm Nurseries.

Knowing what the collection actually comprises was the first step in being able to ask the question, "What is the collection missing?" There was no way to assess what additions would be required without first understanding all the options. The Arboretum's collections focus primarily on plants of documented origin, in particular wild provenance, so that became the framework for the assessment. We assembled a list of all known *Malus* species and their infraspecific taxa (e.g., subspecies, varieties) from around the world and compared it with our existing accessions, with the goal of identifying key areas where the collection lacked diversity.

Armed with this information, the curation department now has a desiderata (wish list) of plants and we can request material from other botanical institutions and germplasm repositories. The list will also be useful when determining goals for future plant collecting expeditions.

HORTICULTURAL CARE OF THE COLLECTION

Horticultural care and maintenance of the *Malus* collection was a major part of my apprenticeship. One of my primary goals was to take a hard look at "best practices" for growing apples in order to develop an action plan that would reflect some of the new thinking on orchard cultural practices.

The Arboretum collection grows primarily ornamental crabapples rather than eating apples, but many of the horticultural concerns are shared. Eating apples have been cultivated for centuries in a variety of settings, so apple orchards provide an interesting model system for understanding how we manage human created plant ecosystems. Consumer interest in organic products has increased, as have demands that growers utilize better practices that are more environmentally friendly. What initially started with farmers is now spilling over into

MICHAEL DOSMANN

The author pruning in the *Malus* collection.

Detailed information was collected on each accession in the collection. Seen here, the colorful fruit and fall foliage of *Malus* 'Henry Kohankie' (accession 604-61-A).

All of these observations were entered into our BG-BASE, the Arboretum's plant records database; having this information readily available allowed us to develop management priorities and gave structure to a process that could otherwise be overwhelming.

As the next step, I attempted to view each specimen as a whole and then break it down to the individual parts that allow it to function. So when observing a single specimen I don't just see a "tree," I see the trunk, branching structure, differences in vigor and type of growth (e.g., normal, water sprouts, or root suckers), leaf canopy (or lack thereof), leaf biology, disease presence and extent, observable roots, and understory plant communities. All of these factors may play a part in disease, pest, and health issues for individual specimens, and we can then use individual tools to assess the details of needed plant care.

Finding out about the soil—its physical properties, chemistry, biology—was an essential step in determining care for the collection. I conducted a traditional soil chemistry test to assess pH, organic matter, and micro- and macronutrients. Soil tests can be useful in plant management, but having optimal pH and available nutrients doesn't ensure that plants can fully utilize the resources, especially if there are other factors, such as soil compaction, that inhibit the plants' roots from being able to access the nutrients. Taking this into consideration, we used a soil penetrometer to test for compaction and found that soil in the main *Malus* collection on Peters Hill had a compaction layer at roughly 6 inches deep. Compaction is a common phenomenon in urban and rural environments where years of machine use, driving, grazing of animals, or even walking can put pressure on the soils. The air spade, a tool that uses a stream of compressed air to physically loosen the soil, is used regularly at the Arboretum to improve root health, but to treat the more than 350 specimens of *Malus* in the collection would be impractical.

the fields of commercial and public horticulture. Integrated pest management (IPM) practices, including using products that are more environmentally friendly (and many of which use biology to outcompete pests), are used increasingly by commercial orchardists as well as by public gardens such as the Arnold Arboretum. In recent years some apple growers have gone beyond the principles of IPM to develop holistic management practices that not only produce desirable fruit but also healthy trees in a robust environment. Holistic management practices see the orchard environment as a series of intertwining cyclical systems, each of which are evaluated and management practices are devised to work with their unique characteristics.

After learning more about this holistic approach I wanted to incorporate it into the management of the Arboretum's *Malus* collection. The goal is to end up producing high quality ornamental fruit, but as a secondary benefit of growing healthy trees. My initial step involved looking at the landscape on Peters Hill as a whole: the flora and fauna that interact there, the soil's physical structure, water movement, and other environmental factors that affect the site. Then during my curatorial review I visited each *Malus* specimen and made phenological observations relating to fruit development, pest and disease pressure, competing weeds, and overall tree health and vigor.

My Favorite *Malus*

THE ECLECTIC mix of wild germplasm, hybrids, and early cultivars in the Arnold Arboretum's *Malus* collection gives inquisitive visitors a chance to see crabapples rarely found in the commercial trade. Here are a few of my favorites:

NANCY ROSE

Malus 'Mary Potter'

FEATURES: A medium height, wide-spreading tree with high disease resistance, offering abundant white flowers and small (0.4 inches [1 centimeter] diameter) red fruits.

DESCRIPTION: This specimen is the original selection of the cultivar. Introduced by the Arnold Arboretum, this Karl Sax selection is considered by many to be his best *Malus* hybrid. Named in honor of C. S. Sargent's daughter, this hybrid is a result of cross between *M. sargentii* 'Rosea' x *M.* x *atrosanguinea.*

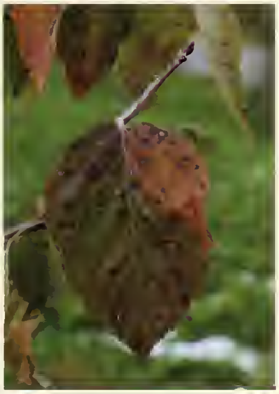
ACCESSION NUMBER: 181-52 B
LOCATION: 51-SW
ORIGIN: Arnold Arboretum

Malus kansuensis var. *calva*

FEATURES: Rare in cultivation, its small stature and unique flowers and fruit make this an interesting apple in the collection.

DESCRIPTION: Small, slow-growing tree; flowers are creamy white and fruits develop a caramel yellow color with a red cheek. The fruit is somewhat flattened on the top and bottom and has vertical ridges around it, giving it a pumpkin-like appearance.

ACCESSION NUMBER: 134-43 A
LOCATION: 49-SE
ORIGIN: China



NANCY ROSE

Malus tschonoskii

FEATURES: Silver-white, tomentose undersides of leaves, attractive orange to red fall color, tall (40+ feet [12+ meters]) upright-pyramidal shape.

DESCRIPTION: This accession is the Arnold Arboretum's oldest apple in the collection as well as one of the tallest. Collected by C. S. Sargent in 1892 during his expedition to Japan. The flowers and fruits of this specimen are insignificant, but the unique leaves and form look unlike any other apple. To the casual passerby it would be difficult to identify it as an apple tree at all.

ACCESSION NUMBER: 3678-A
LOCATION: 17-SW
ORIGIN: Japan

Malus hupehensis

FEATURES: The fruits are yellow with a red cheek and provide a nice contrast with the crimson to purple fall leaf color.

DESCRIPTION: Wide-branching, vase-shaped tree. Leaves and copious fruit develop out of short branch spurs, giving a distinctive appearance. Leaves have reportedly been used as a tea substitute in parts of China. The species was introduced by the Arnold Arboretum and was first collected from China by E. H. Wilson in 1908.

ACCESSION NUMBER: 324-55 B
LOCATION: 50-SW
ORIGIN: China

Malus x *robusta* 'Arnold-Canada'

FEATURES: A rare cultivar that is a towering giant of an apple tree. By far the tallest specimen in the collection.

DESCRIPTION: Primary scaffolding branches alone are larger than the main trunks of many other *Malus.* The distinctive bark has an appearance somewhat similar to *Prunus* (cherry). This specimen features copious fruits that are orange-yellow with a bright red cheek. Rarely found in other collections outside the Arnold Arboretum

ACCESSION NUMBER: 172-52 B
LOCATION: 50-SE
ORIGIN: Hybrid

Instead, to deal with soil compaction on Peters Hill we've recently started an experiment using forage radishes (*Raphanus sativus* var. *longipinnatus*) in four 1/8-acre plots. These radishes (also known as daikon) are noted for their extensive taproots—the thick upper portion grows up to 20 inches long and the slender lower section can extend several additional feet (Weil et al. 2009). Sown under trees and in fields in late summer or early fall, they develop roots and eventually are killed by freezing temperatures. In the spring the roots decompose, adding nitrogen to the soil and leaving deep fissures that allow water, air, and nutrient infiltration. If results in our trial plots are positive this low time- and resource-use solution could be an appropriate option for the *Malus* collection.

We are also looking deeper into the collection's soil ecology through analysis of the "soil food web," a system involving a variety of soil organisms including protozoa, nematodes, mycorrhizal and other fungi, and bacteria (Ingham 2009). (The relative ratios of fungi and bacteria can be quite important to soil health.) The results of this analysis may lead us to options such as introducing beneficial predatory nematodes to control existing damaging nematodes or applying specific mycorrhizal fungi. This is the benefit of a holistic perspective and having the technologies available to view and interpret these complex life systems.

THE TALE OF *MALUS SPONTANEA*

As I discovered through my curatorial and horticultural work, there are many interesting stories—and even a few mysteries—among the plants in the *Malus* collection. One of these stories involves an unusual specimen (accession 10796-2-A, a *Malus spontanea* previously listed as *Malus halliana* var. *spontanea*) that sits at the bottom of Peters Hill. The main trunk and scaffolding branches of this specimen lie horizontal to the ground with smaller branches reaching skyward. On first glance it appears this apple has developed a low, spreading form with a well-developed branching system, but closer inspection reveals a hollowed tree base, indicating that this tree once stood upright. The records are inconclusive as to how this specimen reached its unusual position but theories range from hurricanes to head-on collisions with stolen cars pushed down Peters Hill.

Fire blight killed this specimen of *Malus yunnanensis* (accession 915-88-A) on Peters Hill.

FIRE BLIGHT (caused by the bacterium *Erwinia amylovora*) in the *Malus* collection has become a disease of particular concern because it can kill trees quickly. In the last few years over a dozen specimens were severely damaged or killed by the disease including the type specimen of *Malus toringoides*. Managing this disease has been a primary focus for me. To address this bacterial pathogen the majority of my pruning efforts have been aimed at systematically removing the cankers this disease creates. By removing these sources of inoculum from the environment the hope is to reduce the bacteria to a manageable level. Additionally, in the spring an organic copper spray was used to prevent new infections this year. This spray worked as a preventative from fire blight on the trees and also had the added benefit of supplying the soil with copper, which tests indicated was on the low side. This treatment will be conducted for two years in tandem with the pruning efforts to knock down the disease to a manageable level. In subsequent years regular monitoring and sanitation pruning should prove adequate for control of the disease.

This specimen of *Malus spontanea* (accession 10796-2-A, previously listed as *Malus halliana* var. *spontanea*) has an interesting shape and an interesting history.

Perhaps because of its provenance or its status as an E. H. Wilson-collected lineage it was preserved and is now growing perfectly well in its new orientation.

Initially struck by its unusual form, I came to realize that this *Malus* had an interesting tale to tell. While conducting my curatorial review I was searching through our plant records in an effort to verify the identities of the *Malus* in our collection. My research brought me upon four living specimens of *Malus halliana* var. *spontanea*, all of which are the Wilson lineage and one of which was the *Malus* in repose. Looking at the provenance information I noticed that the original accession (10796-A) was wild-collected from Japan by Wilson during his 1918 expedition. Although the taxonomy of *Malus halliana* is a bit unclear, what struck me as odd is that this species is reported as a native of China. My initial thought was that this was an accident in nomenclature and so I began to pursue the tree's true identity. Accession information stated that the plant was wild-collected by Wilson, but without providing an exact location. *Malus halliana* has been cultivated as an ornamental in Japan for generations, but since the Arboretum's specimens were supposedly from wild origin I realized something wasn't adding up and exact provenance information would have to be unearthed to get to the true identity of this specimen.

Weeks later, while conducting the conservation portion of my curatorial review, I was searching *Malus* on the Botanic Gardens Conservation International's (BGCI) website. To my surprise I saw that on the 1997 IUCN Red List of Threatened Plants *Malus spontanea* (as a species, not a variety of *M. halliana*) was flagged as vulnerable. Realizing that the *Malus* in question might be of conservation value, I decided I had to give another go at this mystery apple. I figured that if our records indicated that this plant was wild collected from Japan, somewhere buried in the archives there must be conclusive evidence of the true identity of this tree.

After multiple searches in our herbarium, archives, and historic records, I eventually found the information I had been looking for in an article on new taxa by Alfred Rehder in the *Journal of the Arnold Arboretum* (Rehder

Historic Eating Apples

FEW CULTIVARS of eating apples are currently in the Arboretum's *Malus* collection. Pomologist and apple explorer John Bunker of Fedco Trees nursery in Maine kindly shared his biogeographic review of significant heirloom varieties in New England. These heirloom apples are both delectable and well suited for our region's climate. As the Arboretum's *Malus* collection expands, visitors may one day be able to stroll Peters Hill and explore the apples that once defined the Northeast's early orchards and fruit heritage. Listed below are some apple cultivars originating in individual New England states. See Bunker's book *Not Far From The Tree* for detailed cultivar descriptions and a historical perspective of New England orchards.

CONNECTICUT
'Black Gilliflower'
'Chandler'
'Hurlbut'
'Pumpkin Sweet'

MAINE
'Black Oxford'
'Cole's Quince'
'Starkey'
'Winthrop Greening'

MASSACHUSETTS
'Baldwin'
'Hubbardston Nonesuch'
'Roxbury Russet'
'William's Favorite'

NEW HAMPSHIRE
'Granite Beauty'
'Milden'
'Nodhead'
'Red Russet'

RHODE ISLAND
'Dyer'
'Peck's Pleasant'
'Rhode Island Greening'
'Tolman Sweet'

VERMONT
'Bethel'
'Malinda'
'Northern Sweet'
'Scott's Winter'

Color plates from *The Apples of New York*, 1905, by horticulturist S. A. Beach, show 'Rhode Island Greening', 'Hubbardston'(synonym 'Hubbardston Nonesuch'), and 'Roxbury'(synonym 'Roxbury Russet').

The *Malus* collection holds many unusual crabapples including this cultivar, 'Redford' (accession 277-42-A), which has large fruits with bright pink flesh.

1926). In his brief description of *Malus halliana* var. *spontanea* (which was his lumping based upon 1914 species determination of *M. spontanea* by Makino), Rehder gave details about Wilson finding and collecting this tree on volcanic Mount Kirishima on Japan's southern island, Kyushu, where *Malus spontanea* is known to be endemic. With this piece of information I could now confirm the provenance of the *Malus* in question. Additional review of more recent literature led me to recommend that the Arboretum disregard Rehder's lumping of the variety into *M. halliana* and elevate it to the species rank that it deserved.

Considering that this plant is of conservation value I realized simply confirming its identity wasn't enough. A review of other institutions' collections inventories revealed that the Arnold Arboretum, the USDA National Plant Germplasm System, and the Holden Arboretum were the only three collections with holdings of *Malus spontanea*. All three of these holdings are from the same Wilson-collected lineage. After bringing this to the attention of Arboretum curator Michael Dosmann, he put me in contact with Dr. Hiroyuki Iketani of Japan's National Institute of Fruit Tree Science. Dr. Iketani is the head of the genetic resource laboratory and has an interest in the relationships of Japanese *Malus* and *Pyrus* of wild and cultivated origin. He informed me that *Malus spontanea* is considered to be a national treasure in Japan and that fewer than 300 wild individuals exist. Recent volcanic activity in the area is putting further stress on these rare plants. In an effort to preserve this species at risk of extinction, Dr. Iketani offered to collect seed from the remaining wild populations and send them to both the USDA and the Arnold Arboretum. Once this plant material clears the importation process we look forward to the infusion of these plants of high conservation value into the collection.

CONCLUSION

Working as an Arboretum apprentice for the last year has been a fulfilling experience that has pushed me both intellectually and physically. The chance to engage with both the horticulture and curation departments led to many synergistic benefits. In 2010 I made 369 observations that resulted in data entries in BG-BASE, and in 2011 I added another 560 observations, for a total of 929 observations on 479 individual plants. These data will be valuable for long-range curatorial planning as well as current horticultural maintenance, and may also be of benefit to fellow botanical institutions who hold *Malus* collections. My apprenticeship has been extended for another year so I will be able to continue my efforts to push this collection toward the highest levels of care and curatorial value.

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Miles Sax is a horticultural apprentice at the Arnold Arboretum.

The Royal Azalea: *Rhododendron schlippenbachii*

Nancy Rose

Rhododendron schlippenbachii is perhaps most noted for its lovely spring bloom, but this deciduous azalea is also a standout in the autumn garden when its leaves turn striking shades of yellow, orange, and red. In addition, royal azalea displays attractive summer foliage and a handsome winter silhouette, making it that object most desired by gardeners—a plant with all-season ornamental interest.

Royal azalea has long been a favorite of mine, so I was tickled to find out that several illustrious Arboretum horticulturists have also written glowingly about this species. As Peter Del Tredici mentioned in the first article in this issue, many timeless bits of information and opinion can be gleaned by reading through old issues of the *Bulletin of Popular Information* and *Arnoldia*—here, Charles Sprague Sargent, first director of the Arboretum, describes royal azalea's native range and growth habit:

> *R. Schlippenbachii* is one of the commonest shrubs of Korea and often forms the dominant undergrowth in open woods. From Korea it crosses into northeastern Manchuria where it grows on the shores of Possiet Bay; it occurs, too, in two localities in northern Japan. Wilson found it extraordinarily abundant in Korea on the lower slopes of Chiri-san and on the Diamond Mountains, which were where he visited this region in June "a wonderful sight with literally miles and miles of the purest pink from the millions of flowers of this Azalea." In Korea this Azalea on the wind-swept grass-covered cliffs of the coast grow[s] less than a foot high but flowers abundantly. In the forests of the interior it often grows to a height of fifteen feet and forms a tall and slender or a broad and shapely shrub. (*Bulletin of Popular Information*, May 5, 1921)

Typically blooming in mid-May at the Arboretum, royal azalea is covered with large flowers in clear shades of pink, somewhat resembling a mass of pink butterflies resting on the branch tips. In the same *Bulletin* article quoted above, Sargent wrote, "The pale pink fragrant flowers, which are about three inches in diameter and marked on one of the lobes of the corolla with red-brown spots, are perhaps more beautiful than those of any other Azalea, certainly of any Azalea which has proved hardy in the Arboretum." And Ernest H. Wilson wrote in the May 16, 1927, issue of the *Bulletin*, "The blossoms on this lovely Korean Azalea are now open on the Bussey Hill. A sturdy bush of upright habit, bearing on naked twigs terminal clusters of large pale to pure pink blossoms. This is a very hardy and satisfactory Azalea." (Cold hardy through USDA Zone 5 [average annual minimum temperature -10 to -20°F/-23.4 to -28.8°C], and possibly into Zone 4.)

Royal azalea also has distinctive foliage. The large, broad-obovate leaves are arranged alternately, but they are crowded together at branch tips, giving a whorled appearance. Foliage color is medium green during the summer and, as Donald Wyman reported in the May 14, 1937, *Bulletin*, "One of its valued characteristics is the fact that in the fall the leaves turn from yellow to orange [and] crimson, thus enabling landscape gardeners to utilize it for autumn as well as spring color."

There are several accessions of *Rhododendron schlippenbachii* growing at the Arboretum, including several mass plantings in the Explorers Garden on Bussey Hill. One of the easiest and most impressive to view is a large group of plants of accession 465-70 nestled under towering oaks just off of Bussey Hill Road (seen in photos at right). If visiting at any time of the year (though especially spring and fall) be sure to see this lovely azalea species that has a long history of appreciation at the Arboretum.

Nancy Rose is a horticulturist and the editor of *Arnoldia*.

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The ARNOLD ARBORETUM *of* HARVARD UNIVERSITY

CONTENTS

Front cover: Japanese cornel (*Cornus officinalis*) blooms in early spring, typically March at the Arnold Arboretum. Photo by Nancy Rose.

Inside front cover: Trilliums (*Trillium* spp.) are part of the disjunct flora of eastern Asia and eastern North America. *Trillium erectum*, seen here, is a woodland native in much of eastern North America. Photo courtesy of Tom Barnes, University of Kentucky.

Inside back cover: At first glance the fruit of *Schisandra chinensis* appears to be a raceme of berries, but in fact each fruit consists of numerous fruitlets, each developed from an individual carpel within an elongate floral receptacle. In this photo, some carpels have matured into fruitlets (large, red) while others have not (small, greenish). Photo courtesy of Peter K. Endress.

Back cover: Harvested fruit from yellow-fruited spicebush (*Lindera benzoin* forma *xanthocarpum*), an unusual variant of the typical red-fruited form of spicebush (*Lindera benzoin* var. *benzoin*). Photo by Richard Lynch.

Picking Up the Pawpaws: The Rare Woody Plants of Ontario Program at the University of Guelph Arboretum

Sean Fox

It might surprise you to learn that, in Canada, species such as *Magnolia acuminata* (cucumbertree), *Betula lenta* (sweet birch), and *Morus rubra* (red mulberry) are among those that are listed as endangered in the wild (see Table 1). You may be thinking, "Really, *Betula lenta*? It grows all over the place in the eastern United States!" It's true that the majority of woody plant species at risk in Canada are quite secure in the United States, so why the concern? Is there really a need for conservation?

Conserving an organism at the species level is generally regarded as the most immediate and crucial objective of many conservation programs. In the case of a species that is critically endangered on a global scale, simply ensuring the survival of a few individuals is often a significant challenge. But even many globally common plant species have conservation needs. Often these species do not have a very high representation of diverse genetic material archived in ex-situ collections simply because they are not considered to be a high priority for conservation. To compound this, the limited germplasm that is archived is often accessed from similar populations from the core of a species geographic range. By collecting from more provenances, including those at the extremes of a species' range, we can come closer to fully conserving and representing the genetic diversity of the species.

After the Laurentide Ice Sheet began receding nearly 12,500 years ago, the forests of eastern North America began their march northward. Species migration is a dynamic and ongoing process, and while many species have already pushed into the tundra region in the far north of Canada, most other species have only extended into southern Canada far more recently. These regional populations, on the forefront of a long migration into northern latitudes, must adapt to an array of environmental conditions that are often very different from those found at the core of the geographic range. Adapted gene complexes enable a plant to adjust to the timing of the local annual growth cycle, including bud break, root growth, shoot and leaf elongation, bud development, diameter growth, and cold acclimation. The genetic variation present in

Notable for its bright yellow fall foliage, sweet birch (*Betula lenta*) is a rare find in Canada.

Flowering dogwood (*Cornus florida*) blooming in Ontario.

these range extensions is very significant from a conservation standpoint since these particular genotypes may provide crucial genetic material to allow a species to migrate and fill various regional niches.

The Ontario populations of woody species, at the northern extent of their natural range, represent adaptations to our northern conditions. *Liriodendron tulipifera* from Ontario are more likely to be suitable for forestry planting in that province than seedling stock from a Virginia source. *Cornus florida* from Ontario-based provenances have proven, in cold hardiness trials, to be more winter hardy in Canada than nursery stock sourced from farther south. As migration pressures increase due to a rapidly changing climate, it may become even more critical to conserve these northern genotypes. Unfortunately, the pace of abiotic change in the environment is likely to be far ahead of biotic survival for many species. The continued exploitation and segregation of suitable habitat adds another dynamic to an already challenging scenario for in-situ conservation.

UNDERSTANDING SPECIES AT RISK IN CANADA

Taking the time to thoroughly understand the legislative conditions regulating species at risk in Canada, as in many other parts of the world, can be an exercise in patience. The federal government of Canada's National Strategy for the Protection of Species at Risk is composed of the National Accord for the Protection of Species at Risk (NAPSR), established in 1996; the Habitat Stewardship Program (HSP), established in 2000; and the Species at Risk Act (SARA) established in 2003.

The National General Status Working Group (NGSWG) was formed in 1996 to support the mandate of the NAPSR, and is charged with establishing status rankings for all species in

Table 1. At-risk woody taxa listed federally in Canada (2011)

Taxon	Canadian Range	COSEWIC Status	SARA Status
Betula lenta	Ontario	Endangered	Endangered
Castanea dentata	Ontario	Endangered	Endangered
Celtis tenuifolia	Ontario	Threatened	Threatened
Cornus florida	Ontario	Endangered	Endangered
Fraxinus quadrangulata	Ontario	Special Concern	Special Concern
Gymnocladus dioicus	Ontario	Threatened	Threatened
Hibiscus moscheutos	Ontario	Special Concern	Special Concern
Juglans cinerea	Ontario, Quebec, New Brunswick	Endangered	Endangered
Magnolia acuminata	Ontario	Endangered	Endangered
Morus rubra	Ontario	Endangered	Endangered
Pinus albicaulis	Alberta, British Columbia	Endangered	No Status
Ptelea trifoliata	Ontario	Threatened	Threatened
Quercus shumardii	Ontario	Special Concern	Special Concern
Rosa setigera	Ontario	Special Concern	Special Concern
Salix brachycarpa var. *psammophila*	Saskatchewan	Special Concern	Special Concern
Salix chlorolepis	Quebec	Threatened	Threatened
Salix jejuna	Newfoundland and Labrador	Endangered	Endangered
Salix silicicola	Nunavut, Saskatchewan	Special Concern	Special Concern
Salix turnorii	Saskatchewan	Special Concern	Special Concern
Smilax rotundifolia	Ontario, Nova Scotia	Threatened (Great Lakes Population)	Threatened (Great Lakes Population)
Vaccinium stamineum	Ontario	Threatened	Threatened

Rosa setigera

Canada. The species that are assessed as potentially at risk are suggested as candidates for further review to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC was officially established in 1977, but was legally implemented as the authority for species at risk assessments under SARA in 2003. COSEWIC maintains a list of wildlife species in need of conservation initiatives and also a candidate list of species in need of further evaluation. The role of COSEWIC is advisory and the ultimate decision to place an organism on the Species at Risk List falls upon SARA and the federal government. SARA pro-

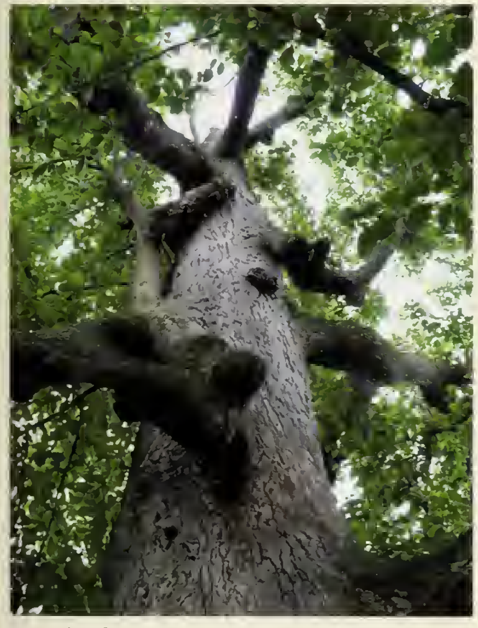
Cucumbertree (*Magnolia acuminata*): Canada's First Endangered Tree

Magnolia acuminata was the first tree in Canada to be listed as endangered by COSEWIC in 1984. In 2003, this species was re-evaluated as endangered under the SARA and plans for a recovery strategy were developed.

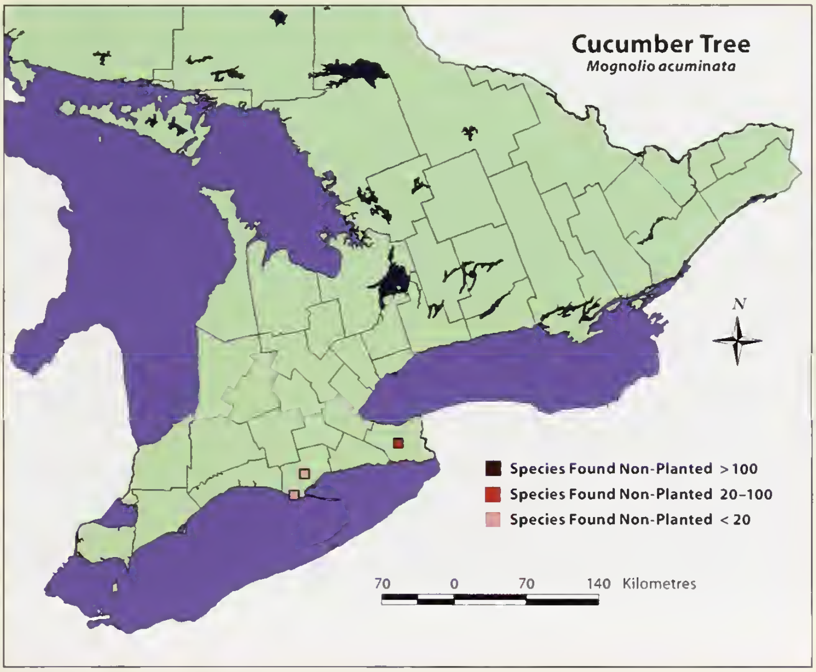
Cucumbertree has always had a very limited distribution in Canada and is currently only known to occur in two areas of southwestern Ontario. In total, only 283 naturally occurring individuals are known to survive in 12 small, extant populations. These individuals represent an extreme northern extension for a species that forms its most abundant core population in the central Appalachian range of the United States.

The cucumbertrees remaining in Ontario are generally in good health; however, the habitat that supports them is highly fragmented. This segregation has not only reduced the reproductive fitness of the remaining populations (perhaps due in part to a reduction in pollinator-supporting habitat), but it has also eliminated suitable conditions for seedling regeneration. The range of cucumbertree also happens to lie within the most heavily populated area of human settlement in Canada and one of the most rapidly-developing regions in North America.

In-situ conservation efforts to identify and protect individual trees in isolated woodlots have had some success. However, further steps are required to ecologically connect these remaining sites in order to allow this magnificent species to continue its natural migration within Ontario.



Canada's largest cucumbertree (*Magnolia acuminata*) is about 18 meters (59 feet) tall and has a trunk dbh (diameter at breast height) of 143 centimeters (56 inches).

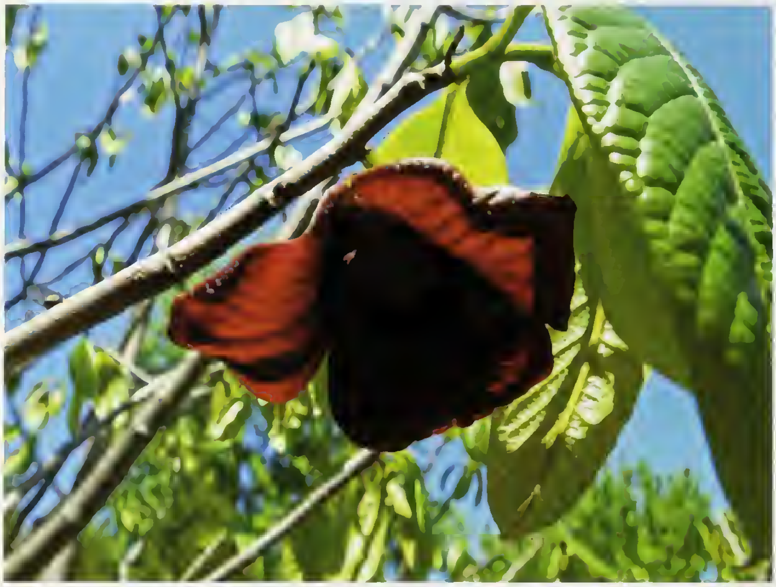


ROB GUTHRIE

The very limited natural Canadian range of cucumbertree (*Magnolia acuminata*) in the southwestern Ontario.

vides federal legislation aimed at preventing wildlife species from becoming extinct and to aid in their recovery.

COSEWIC only suggests species for listing after a detailed report is written, so only a limited number of rare species have been formally assessed. Therefore, a reduction in natural populations remains a strong concern, even with SARA in place. To add even more confusion, SARA does not apply to plant species on public land under provincial jurisdiction, so as signatories to the NAPSR, all provinces and territories are mandated to oversee their own programs to protect species at risk. In Ontario, the Endangered Species Act (ESA) was officially implemented in 2007.



The unusual flower and ripening fruit of pawpaw (*Asimina triloba*).

THE RARE WOODY PLANTS OF ONTARIO PROGRAM

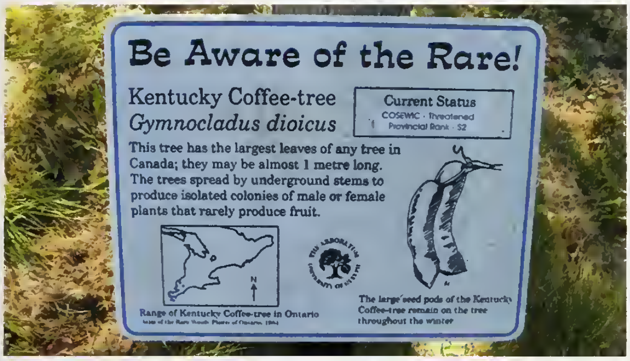
Back in 1978, well before terms such as climate change and global warming were used with any regularity, Dr. John Ambrose, curator of the University of Guelph Arboretum, embarked on a mission to begin evaluating and protecting rare woody flora in Ontario. His goal was not simply to cultivate an ex-situ accession of each species from an Ontario provenance, but to actually capture as much representation of the wild populations in Ontario as possible. With this target in mind, the Rare Woody Plants of Ontario Program was born.

The first phase of the program was lovingly dubbed "Picking up the Pawpaws" in reference to one of Ontario's most unique and seemingly out-of-place native plant species, *Asimina triloba,* which looks more suited to the tropics. The aim was to conduct extensive surveys of all of southern Ontario's rare woody species to better understand their distribution and relative abundance. This also doubled as an outreach program to educate the general public about some of Ontario's unique plant species that they had never even heard of before, let alone knew existed in Canada. Many property owners were excited to learn that the inconspicuous green shrubs in their back forty were actually rare and significant species. As a sense of pride and stewardship began to develop, some of these citizens moved forward in the following decades to become active members in non-governmental conservation and naturalist organizations. Some of these groups continue to play a prominent role in spreading the initial message of the program: the importance of in-situ conservation.

Much of the information gathered during the initial surveys also continues to prove invaluable in the ongoing development of legislatively-important COSEWIC assessments. Even after his retirement from the botanical garden world, Dr. Ambrose continues to play a leading role in protecting rare species in Ontario, including surveying and writing COSEWIC reports for at-risk species.

AN EXCELLENT SITUATION FOR EX-SITU CONSERVATION

The second phase of the Rare Woody Plants of Ontario program revolved around developing a strong ex-situ conservation program at the University of Guelph Arboretum, which spans 165 hectares (408 acres) with over 1,700



A series of interpretive plaques were created for Ontario's rare woody plants with support from BGCI Canada's *Investing in Nature: A Partnership for Plants* program. Here, Kentucky coffeetree (*Gymnocladus dioicus*) is highlighted in the University of Guelph Arboretum's World of Trees collection.

John Ambrose (right), with botanists Lindsay Roger and Gerry Waldron, upon their discovery of a new species to Canada, swamp cottonwood (*Populus heterophylla*), in 2002.

The Eastern Redbud (*Cercis canadensis*): O Canada—Its Home and Native Land?

A specific epithet like "*canadensis*" might lead one to believe that eastern redbud floods the understory of the great northern forests. But, despite its seeming patriotism to Canada, this beautiful species is not quite as common in the north as one might think.

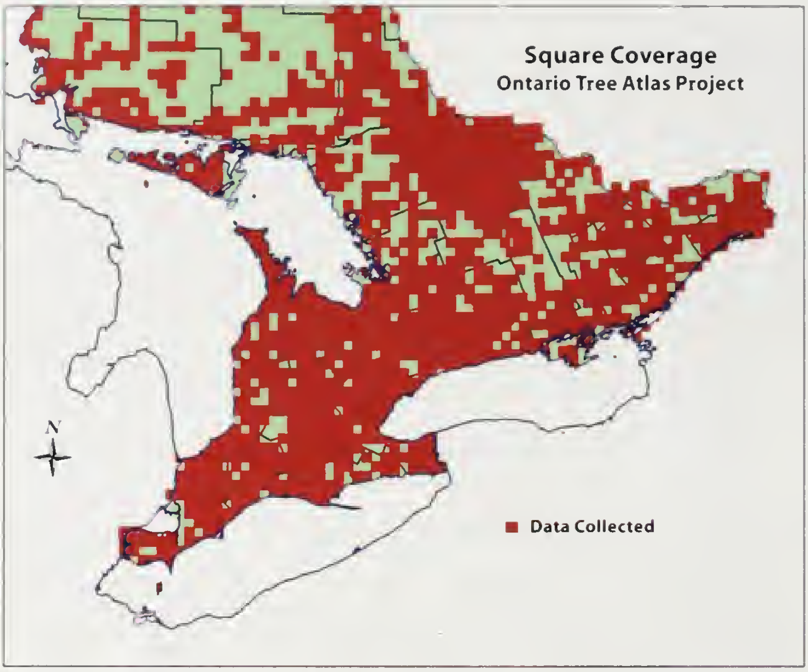
In Gerry Waldron's wonderful book, *Trees of the Carolinian Forest* (2003), he quotes the great Canadian botanist, John Macoun, as he recounts his first and only sighting of eastern redbud on Canadian soil in 1892:

These flower buds of eastern redbud (*Cercis canadensis*) show the species' interesting trait of cauliflory (flower and fruit production from woody stems). This accession (1988-0284.002) in the World of Trees collection at the University of Guelph Arboretum is from a cold-hardy provenance in Wayne County, Michigan.

> *... I was informed that a remarkable tree grew on the south end of the island, that many years ago produced an abundance of lovely red flowers in early spring before the leaves came out ... the next day I examined the south point and found the tree. It had been undermined by the waves and fallen inland, and more than half its limbs were dead, but it still bore leaves and what remained was quite healthy. It will soon disappear, but the record of its existence will remain.*

This tree that Macoun happened across remains the only naturally-occurring individual ever discovered in Canada. This plant grew at Fish Point, Pelee Island, in Lake Erie—the most southerly point in all of Canada, and, as he predicted, was eventually swallowed by the lake as the shoreline eroded away. While there are naturalized populations established in parts of southwestern Ontario, as escapees from cultivated stock, eastern redbud is now officially ranked as extirpated in Canada.

ROB GUTHRIE



Locations surveyed by the University of Guelph Arboretum for the presence of naturally-occurring, at-risk species are displayed in this map of southwestern Ontario.

taxa of woody flora represented in its collections. The major emphasis is on the woody flora of eastern North America, with special attention being given to the rare woody flora of Ontario.

After initial surveys were completed, provenance-based germplasm collections were made in order to capture as great a representation of a species' provincial population as possible. Vegetative propagules were gathered for the establishment of a germplasm repository at the University of Guelph Arboretum, in the form of living gene banks. The gene banks at the Arboretum are arranged as seed orchards and serve two main purposes:

(1) To provide ex-situ back up for failure at in-situ conservation

This pumpkin ash (*Fraxinus profunda*) accession (1994-0010.001) in the World of Trees collection at the University of Guelph Arboretum was cultivated from seed collected in Essex County, Ontario, very shortly after the discovery of the species in Canada in 1992.

Here, the blue ash (*Fraxinus quadrangulata*) gene bank at the University of Guelph Arboretum provides a secure site for a faculty research project.

Table 2. Accessions of known, wild, Ontario-based provenance for selected rare woody taxa under cultivation at the University of Guelph Arboretum.

Taxon	Risk Ranking*	Total Number of Accessions	Total Number of Individuals
Aesculus glabra	G5, S1	5	20
Asimina triloba	G5, S3	8	12
Betula lenta	G5, S1	9	44
Campsis radicans	G5, S2	3	4
Carya laciniosa	G5, S3	6	25
Carya glabra	G5, S3	3	7
Castanea dentata	G4, S3	2	3
Celtis tenuifolia	G5, S2	5	13
Cornus drummondii	G5, S4	5	26
Cornus florida	G5, S2	8	17
Euonymus atropurpurea	G5, S3	6	16
Fraxinus profunda	G4, S2	1	3
Fraxinus quadrangulata	G5, S3	20	26
Gleditsia triacanthos	G5, S2	7	38
Gymnocladus dioicus	G5, S2	26	87
Hibiscus moscheutos	G5, S3	1	2
Juglans cinerea	G4, S3	12	32
Liriodendron tulipifera	G5, S4	11	15
Magnolia acuminata	G5, S2	16	37
Morus rubra	G5, S2	5	21
Morella pensylvanica	G5, S1	3	3
Pinus rigida	G5, S2	4	5
Platanus occidentalis	G5, S4	10	18
Ptelea trifoliata	G5, S3	22	43
Quercus ellipsoidalis	G5, S3	2	2
Quercus muehlenbergii	G5, S4	16	64
Quercus prinoides	G5, S2	2	9
Quercus shumardii	G5, S3	4	9
Rosa setigera	G5, S3	6	8

* G-global, S-provincial
G1-extremely rare, G2-very rare, G3-rare to uncommon, G4-common, G5-very common
S1-critically imperiled, S2-imperiled, S3-vulnerable, S4-apparently secure, S5-secure

efforts related to habitat loss and natural calamities. This is especially critical for many hardwood species that possess recalcitrant seeds that are difficult to store under conventional seed banking practices.

(2) To produce enough seed, through open or controlled pollination, to take the seed collecting pressure off of natural populations in Ontario. Seed produced will provide a valuable and readily accessible resource for restoration efforts, in addition to supplying material with promising horticultural attributes with respect to cold hardiness.

The first crop, in 2006, from the shellbark hickory (*Carya laciniosa*) gene bank at the University of Guelph Arboretum.

Pawpaw (*Asimina triloba*) seedlings growing in the nursery at the University of Guelph Arboretum.

Today, a number of species that are at risk in Ontario have their germplasm archived within the Arboretum's gene banks and plant collections (see table 2). Much of the research conducted to develop germination and cultivation requirements for these rare species was published in 2008 in the book *Growing Trees from Seed* by Henry Kock, late University of Guelph Arboretum horticulturist. The accessions established at the Arboretum represent a significant portion of the genetic diversity for these very rare species at the northern extreme of their geographic range. Several of these accessions are from provenances that have already been lost in the wild.

In addition, many of the early provenance-based seed collections were distributed internationally to botanical organizations for more broad-based ex-situ archiving. A look through the plant inventories of many botanical gardens and arboreta will display cultivated material of species from these Ontario provenances.

PLANTING SEEDS FOR THE FUTURE

The Rare Woody Plants of Ontario Program was first initiated at the University of Guelph Arboretum over 30 years ago, and conservation efforts focusing on Ontario's native woody flora continue to this day. In addition to the endeavors already discussed, the Arboretum is currently engaged in several activities to build upon our conservation programs.

In 2006, after the early passing of our beloved horticulturist, Henry Kock, an endowment was established to help provide long-term, sustainable funding for our conservation programs. Henry's mission—to archive naturally-occurring Dutch elm disease-tolerant Ameri-

Kentucky Coffeetree (*Gymnocladus dioicus*): Distribution within the University of Guelph Arboretum

A view from within the Kentucky coffeetree (*Gymnocladus dioicus*) gene bank at the University of Guelph Arboretum.

WHILE gene banking various accessions within seed orchards makes archiving and maintaining plant material simpler, a strong effort has also been made to establish accessions in suitable botanical and horticultural collections throughout the Arboretum. Distributing our conservation collections in this fashion serves several purposes:

- Accessions throughout our 165 hectare (408 acre) site provide insurance measures against localized disturbances (e.g., weather events, vandalism).
- The incorporation of rare native flora into various formal collections increases the value of our interpretive programs and provides visitors with the opportunity to see important species that are unlikely to be spotted in the wild.
- At-risk species planted throughout the site provide strategic long-term protection for the Arboretum property itself against any potential outside development activities in the future.

A well-established Kentucky coffeetree seed orchard is now starting to bear fruit, but you can also find accessions of known, wild provenance in other locations within the Arboretum.

Table 3. Accessions of *Gymnocladus dioicus* under cultivation at the University of Guelph Arboretum of known, wild, Ontario-based provenance.

Collection or Area	Number of Represented Accessions	Number of Represented Individuals
Gene Bank Seed Orchard	26	65
World of Trees Collection	1	7
Leguminosae Family Collection	6	6
Native Trees of Ontario Collection	1	5
Gosling Wildlife Gardens: Native Plant Garden	1	1
RJ Hilton Center Accent Planting	1	1
Arboretum Nursery Archival Plantings	2	2

ANNE HANSEN

Late University of Guelph Arboretum horticulturist Henry Kock standing next to Canada's largest eastern flowering dogwood (*Cornus florida*).

HENRY KOCK

The accessioned plants in the cucumbertree (*Magnolia acuminata*) gene bank at the University of Guelph Arboretum bear mature fruit on an annual basis.

Over the past ten years, several bumper crops have been produced in the sweet birch (*Betula lenta*) gene bank at the University of Guelph Arboretum.

can elm (*Ulmus americana*) germplasm at the Arboretum—provided the incentive to refer to this as the Henry Kock Tree Recovery Endowment. This endowment provides the opportunity to work with not only elm, but also with any other woody species in Ontario that are in need of recovery efforts in the future.

Ontario's Elm Recovery Project is currently operated out of the University of Guelph Arboretum with an archival germplasm repository in the beginning stages of development. The provincial Butternut Recovery Program was initiated several years ago by the Forest Gene Conservation Association (FGCA) with the Arboretum serving as one of their archival planting sites. The Royal Botanical Gardens (RBG Ontario) is currently undertaking a program to breed pure, non-hybridized red mulberry (*Morus rubra*), a species endangered in Ontario because of white mulberry (*Morus alba*) invasion. The University of Guelph Arboretum serves as a partner and site for a future ex-situ conservation collection.

Provincial field studies and seed collection trips are ongoing for species at risk in Ontario, with a particular emphasis on recently discovered species such as *Quercus ellipsoidalis* (1978), *Fraxinus profunda* (1992), *Quercus ilicifolia* (1994) and *Populus heterophylla* (2002). These are important species that we hope to further incorporate into our ex-situ collections at the Arboretum.

As our existing seed orchards continue to produce increasingly sound crops, we are now in the position to better distribute this seed to nurseries and local conservation authorities to aid in their restoration activities. Large crops of seed will also be archived at the National Tree Seed Center in Fredericton, New Brunswick, and the Ontario Tree Seed Plant in Angus, Ontario. Seed will continue to be available to other botanical institutions for conservation and research purposes.

In this modern era, and with an unstable economy, most botanical gardens and arboreta are facing tough challenges with budget and staff cuts. As the years have progressed at the University of Guelph Arboretum, we've also had to make difficult decisions regarding the activities that we have the capacity to engage in successfully. While we've had to scale back several of our display-based horticultural collections, we've found that our conservation programs have helped to provide a niche that further defines the mission of our organization.

It must always be remembered that ex-situ conservation programs, as valid and critical as they are, don't hold a candle to ecosystem conservation, expansion, and linkage. These in-situ conservation activities must be represented in our highest aspirations as citizens and nations. However, the important role that botanical gardens and arboreta can play must not be underestimated either. Whether it is the education, outreach, research, stewardship, or conservation hat that is being worn, public gardens are in a unique position to be meaningfully engaged in rare flora programs both locally and globally.

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Land Bridge Travelers of the Tertiary: The Eastern Asian–Eastern North American Floristic Disjunction

David Yih

The eastern Asian–eastern North American floristic disjunction is a curious phenomenon that has fascinated botanists for over 200 years: the existence of an entire catalog of species and genera shared by two vastly separated regions and found nowhere else. It has inspired generations of researchers and given impetus to such fields as biogeography and paleobotany. Scientists now recognize many different disjunct patterns around the world, but the eastern Asian–eastern North American was the first to be discovered, and remains the classic disjunction. It continues to stimulate new scientific papers, with each successive generation applying new research tools to its mysteries.

Recognition of the disjunction began in the 1750s with botanists making lists of species found in both regions. By the mid-1800s botanists had collected enough materials to lead them to the astounding conclusion that the flora of eastern North America (ENA) had more in common with eastern Asia (EA) than it did with western North America. Most of

PETER DEL TREDICI

ENA meets EA: A garden path separates the eastern North American species Allegheny spurge (*Pachysandra procumbens*, left) from the eastern Asian species Japanese spurge (*Pachysandra terminalis*).

what were once thought to be identical species are now considered congeners (distinct species belonging to the same genus), so the disjunction is more about shared genera than shared species, and it is now clear that eastern North America has more in common with western North America than with eastern Asia. However, it is also clear that eastern Asia and eastern North America have more in common than eastern Asia and western North America and that a remarkable disjunction phenomenon exists. Today, the list of EA-ENA botanical "disjuncts" (shared taxa peculiar to the two regions) includes about 65 genera, a handful of closely related genera, and a few species (Wen 1999).

Most of the genera are temperate; only a few come from subtropical or tropical zones. And most disjuncts are woody plants. Many of the herbaceous ones are early-leafing species adapted to thrive on the forest floor. Some EA-ENA disjunct genera that have familiar representative species in the Northeast are listed in Table 1 (Li 1952), along with generalized common names for the species.

DISJUNCT REGIONS

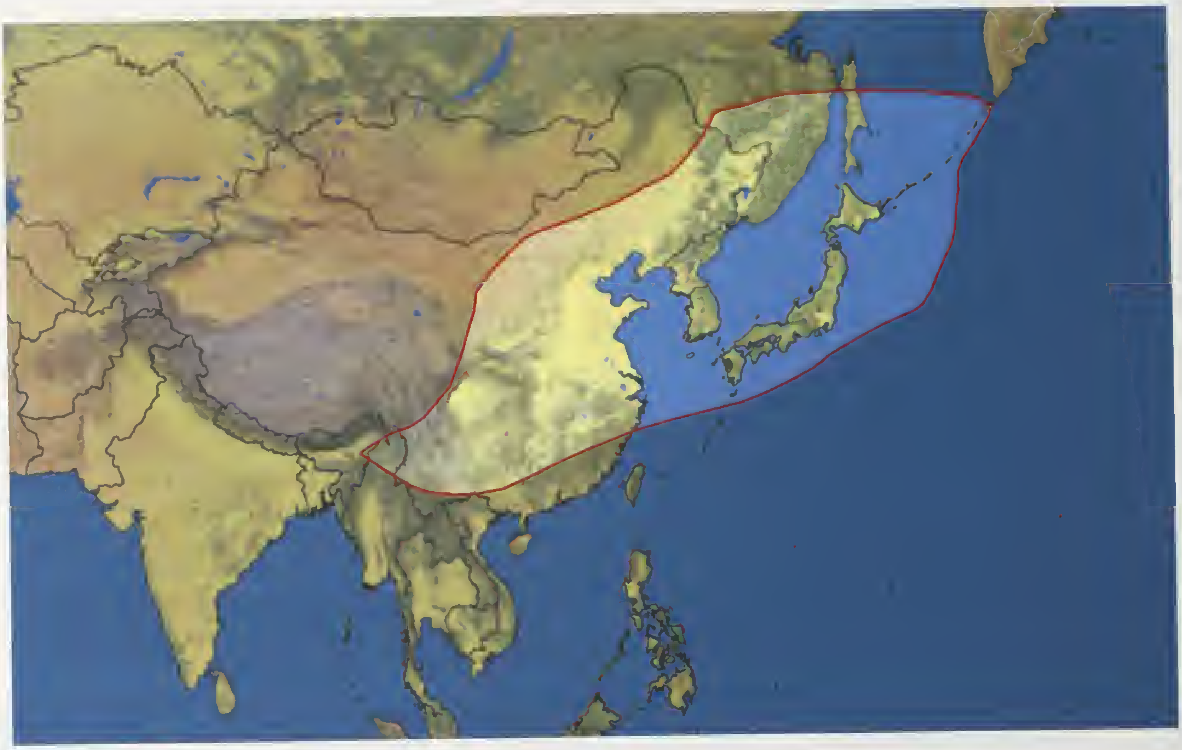
The majority of eastern Asian disjuncts grow in the Sino-Japanese Floristic Region, which extends from China's western Yunnan and Sichuan provinces through central, eastern, and most of southern China to Korea and Japan. The richest association of disjunct genera occurs in central China, along the longest river in Asia: the Yangtze (Li 1952). On the American side, the richest disjunct area is along the Appalachian Mountains. The two areas are the only instances globally of the mixed mesophytic forest, one of the most biodiverse temperate forest types in the world.

Western botanists have reported experiencing a sense of déjà vu in the forests of China. Add to the disjuncts the more wide-ranging species that also occur in both regions, and the level of similarity becomes quite high. A recent study found that 67% of the seed plant genera in Maine occur on Japan's Honshu Island (Qian 2002). The similarity was even greater in ages past. Several genera that are now endemic to eastern Asia occur in fossil form in North America, e.g., the familiar *Ginkgo* and *Metasequoia* (dawn redwood), while fossil remains of *Sequoia* (redwood) and *Taxodium* (baldcypress), genera now confined to North America, have been found in eastern Asia.

At present, the similarity is limited by pronounced differences in biodiversity. Disjunct genera tend to have more species in Asia than in America. The extreme example is *Lindera*, with 80 species in eastern Asia but only 2 in North America. Indeed, eastern Asia, with its 2,753 genera of seed plants, has a biodiversity far greater than that of eastern North America, which has only 1,230. According to one explanation, the Paleocene forests of both regions were equally rich in species until severe climatic fluctuations in North America resulted in many extinctions. Another possibility is that the complex topography of eastern Asia promoted a greater rate of speciation there due to

Table 1

WOODY	
Campsis	Trumpet vine
Carya	Hickory
Catalpa	Catalpa
Cornus	Dogwood
Gleditsia	Honey locust
Hamamelis	Witchhazel
Liquidambar	Sweetgum
Liriodendron	Tuliptree
Lyonia	Maleberry
Mitchella	Partridgeberry
Nyssa	Tupelo
Pachysandra	Pachysandra
Parthenocissus	Virginia creeper
Sassafras	Sassafras
HERBACEOUS	
Panax	Ginseng
Phryma	Lopseed
Podophyllum	Mayapple
Saururus	Lizard's tail
Symplocarpus	Skunk cabbage



The Sino-Japanese Floristic Region.

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Manchurian catalpa (*Catalpa bungei*), left, is native to China, while northern catalpa (*Catalpa speciosa*), right, is native to the central and eastern United States and southern Ontario.

NANCY ROSE

Showy flowers are a feature shared by Chinese trumpet creeper (*Campsis grandiflora*), left, and the familiar trumpet creeper (*Campsis radicans*) of North America, right.

***Lindera obtusiloba* (seen here in fall color at the Arnold Arboretum) is one of the many *Lindera* species native to eastern Asia.**

the abundance of varied habitats and natural barriers that could allow different populations of a species to evolve separately (Sargent 1913; Qian and Ricklefs 2000). The EA–ENA disjunction is now recognized not only among plants, but among taxa of fungi, arachnids, millipedes, insects, and freshwater fish, as well (Wen 1999). But botanists can take credit for being the first to notice and document the phenomenon.

A THEORY BLOOMS

The earliest hint came in the 1750 dissertation of Halenius, a student of Linnaeus. It mentions nine species found both on Siberia's Kamchatka peninsula and in North America, including members of genera familiar to New England botanists: *Asplenium, Lycopodium, Anemone, Heuchera,* and *Spirea*. Commercial exploitation of the phenomenon had already begun. Père Lafitau, a French Jesuit, had discovered American ginseng (*Panax quinquefolius*) growing near Montreal in 1716, and French Canadians were neglecting their farms in the rush to collect wild ginseng for export to China (Kingsford 1888). In 1784, C. P. Thunberg, a Swedish botanist, included in his *Flora Japonica* twenty species first described for North America (Boufford and Spongberg 1983). The following year, the Italian botanist Luigi Castiglioni began a two-year sojourn in the United States. Castiglioni's mission was to bring back useful seeds to Italy, and he is credited with introducing to continental Europe such trees as black locust (later to show invasive tendencies), catalpa, and arborvitae. In 1790 he published his *Viaggio negli Stati Uniti dell' America,* with elegant botanical drawings of such American sights as the franklintree, already rare in the wild and soon to be extinct outside of cultivation. It also contains the first explicit discussion of the floristic similarity of eastern North America to Japan, the only part of eastern Asia for which published floras were then available. Overlooked by nearly all who would later treat the disjunction, he received scant credit for his role in its discovery (Li 1955). Brief comments in the work of Pursh and then Nuttall reveal little beyond an incipient recognition of the disjunction, though Nuttall

MICHAEL DOSMANN

Though their flowers look similar, Chinese witchhazel (*Hamamelis mollis*), left, blooms in late winter or very early spring while common witchhazel (*Hamamelis virginiana*), right, blooms in late fall or early winter in eastern North America.

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Cultivated Chinese ginseng (*Panax ginseng*), left, and a fruiting specimen of American ginseng (*Panax quinquefolius*), right.

undertook to note the geographical distributions of North American genera. It remained for Asa Gray, the preeminent American botanist of the nineteenth century, to focus attention on the disjunction, bringing it to the notice of the wider scientific community in a series of articles beginning in 1840 and spanning nearly 40 years.

Charles Darwin, who began an extensive correspondence with Gray in 1855, encouraged him to study the global distributions of the North American flora. In his second letter to Gray he wrote, "The ranges of plants, to the east and west, viz. whether most are found in Greenland and Western Europe, or in E. Asia appears to me a very interesting point as tending to show whether the migration has been eastward or westward" (Darwin 1855). In 1859, after studying new collections from Japan, Gray published his classic "Diagnostic Characters" paper that included a list of 134 species shared by eastern North America and Japan. On the list were such northeastern plants as blue cohosh (*Caulophyllum thalictroides*), fox grape (*Vitis labrusca*), ditch stonecrop (*Penthorum sedoides*), honewort (*Cryptotaenia canadensis*), hobblebush (*Viburnum lantanoides*), wild ginger (*Asarum canadense*), red trillium (*Trillium erectum*), large twayblade (*Liparis liliifolia*), and rose pogonia (*Pogonia ophioglossoides*). All were later shown to be distinct from their Asian counterparts—belonging to the same disjunct genus, but different species. The two ferns on Gray's list, sensitive fern (*Onoclea sensibilis*) and cinnamon fern (*Osmunda cinnamomea*), turned out to be too widespread globally to qualify as disjunct species (Li 1952). In addition to comparing the flora of Japan to various other regions, Gray's "Diagnostic Characters" contains an extended discussion of the EA-ENA disjunction. "It will be almost impossible to avoid the conclusion," he writes, "that there has been a peculiar intermingling of the eastern American and eastern Asian floras which demands explanation" (Gray 1859). It was the eve of the appearance of Darwin's *Origin of Species*, during a ferment of interest in the natural world, and there was no shortage of theories on such topics. "Schouw's hypothesis" held that there had been multiple geographic origins of many species. At a time when naturalists were strug-

COURTESY OF TOM BARNES, UNIVERSITY OF KENTUCKY

Rose pogonia (*Pogonia ophioglossoides*), seen here, is native to bogs in much of eastern North America. *Pogonia japonica* (formerly listed as *P. ophioglossoides* var. *japonica*) is a very similar-looking species native to Japan and parts of China.

gling to reconcile scientific rigor with cherished beliefs, Gray was also conversant with such hybrid approaches as Maupertius's "principle of least action," according to which it was "inconsistent with our idea of Divine wisdom that the Creator should use more power than was necessary to accomplish a given end" (quoted in Gray 1859). By applying this principle, one could argue (without sacrificing piety) that once created, the far-flung species had migrated on their own, rather than requiring further divine intervention. With characteristic grace, Gray gave dispassionate consideration to all points of view. J. D. Hooker, the prominent British botanist and a close friend of Darwin, had recently proposed, in relation to southern-hemisphere taxa, "the hypothesis of all being members of a once more extensive flora, which has broken up by geological and climatic causes" (quoted in

Boufford and Spongberg 1983). In the end, Gray applied a similar hypothesis to the Asian and American floras. With various refinements, it remains in effect to this day.

THE ONGOING PUZZLE

With the general adoption of cladistics in the latter part of the twentieth century and rapid advances in molecular genetics, new tools have emerged for studying the disjunction. Most scientific papers from the last twenty years use molecular data and focus on a single disjunct genus. There are several sorts of molecular-level data to choose from (the most popular has been ITS—short for sequences of internal transcribed spacer regions of nuclear ribosomal DNA). Though their relative merits are still being assessed, the information they yield pertains not only to phylogeny (how disjuncts are related in terms of evolutionary descent), but also to dating divergence times and inferring pathways and directions of migration.

Often the genetic analyses match nicely with the prior work of traditional taxonomists. The genus *Sassafras*, for example, is monophyletic. That is, its three species constitute a clade. The eastern North American *S. albidum* is "sister" to the smaller clade made up of its two eastern Asian counterparts. Molecular data subjected to statistical methods put their intercontinental divergence time at around 15 million years ago (Nie et al. 2007). *Sassafras* also illustrates several frequent patterns; diversification in one or both continents following the time of separation is common, and disjunct genera tend to have more eastern Asian than American representatives.

The upshot of all the investigations into geology, the fossil record, climate studies, taxonomy, and the molecular clocks and phylogenetic analysis of modern genetics is still a necessarily tentative picture of the disjunction's history. But there is agreement on the broad outlines. Most scientists do not consider

NANCY ROSE

Asa Gray listed sensitive fern (*Onoclea sensibilis*) as a disjunct species, but it was later determined simply to be a very globally widespread species.

Native ranges of *Sassafras* species in eastern North America and eastern Asia.

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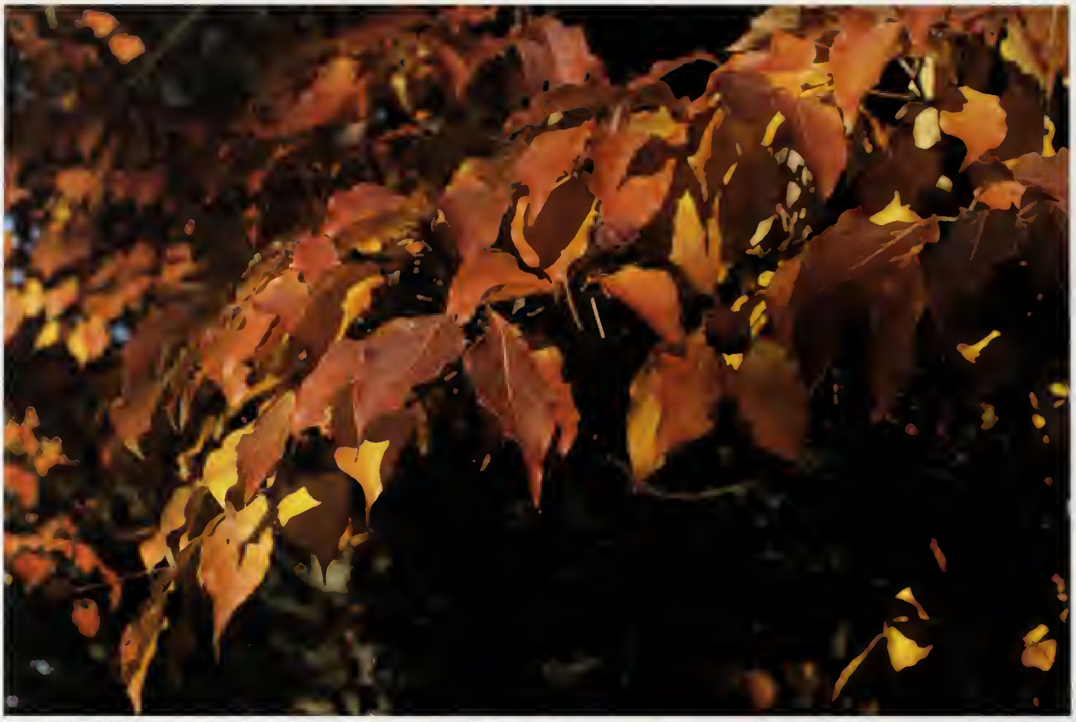
Foliage of *Sassafras albidum* (left), a familiar native tree in much of the eastern United States, and of *S. tzumu* (right), native to China.

The entire genus *Sassafras*, which constitutes a clade. The eastern North American *S. albidum* is "sister" to the smaller clade made up of its two eastern Asian counterparts, *S. tzumu* and *S. randaiense*.



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Autumn foliage of kousa dogwood (*Cornus kousa*), top, from Asia, and flowering dogwood (*Cornus florida*), bottom, from North America.

long-distance dispersal to have played much of a role. The prevailing view is that most disjuncts are remnants of genera that were once widely distributed in the northern temperate zone during the Tertiary period. These broad distributions in the northern hemisphere were made possible by recurring land bridges. Bering land bridges connecting Asia to North America were present at several times since the Mesozoic era. North Atlantic land bridges connected North America to Europe via Greenland beginning in the early Tertiary, and by the mid-Tertiary, Europe and Asia were connected by a land bridge along the Tethys Seaway. After the establishment of the northern Tertiary flora, the formation of the Rocky Mountains brought profound changes in climate and rainfall patterns, causing the genera to disappear from western North America during the late Tertiary and Quaternary. During the Quaternary glaciations, they were also extirpated from Western Europe.

Drawing on fossil, geologic, and climatic evidence, B. H. Tiffney proposed five different time periods during which migrations over the land bridges may have occurred between the two regions (pre-Tertiary, early Eocene, late Eocene-Oligocene, Miocene, and late Tertiary to Quaternary), with different types of plants featured in each migration (Tiffney 1985). A multiple-origins view is also supported by molecular evidence. Molecular clock data from *Cornus, Boykinia,* and *Calycanthus* suggest that the disjunction could have involved multiple events at different geological times in different genera (Xiang et al. 1998).

Ultimately, the EA-ENA disjunction is part of a broader picture that will occupy biogeographers for years to come. Studies of northern hemisphere intercontinental disjuncts point to complex biogeographical relationships among taxa in five major regions, including not only eastern Asia, eastern North America, and western North America, but western Asia and southeastern Europe as well. Darwin's desire to determine whether migration happened "eastward or westward" has grown into a multifaceted field of study.

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A Rare Find: Yellow-Fruited Spicebush (*Lindera benzoin* forma *xanthocarpum*)

Richard Lynch

There are as many different harbingers of spring as there are fond memories in the minds of the people who look for them. For some, the last of the snow melting off a northern slope fits the bill. For others, the first chorusing of spring peepers (*Hyla crucifer*) in the still-cold ponds of late March provides hope for the warmer seasons to come. For those with a more botanical bent, and especially for lovers of the deep woods across the eastern United States, the opening of the tiny yellow flowers of spicebush (*Lindera benzoin*) clearly marks the tipping point from winter to spring. In many parts of the Northeast, spicebush is the first shrub to flower and is often timed with the arrival of mourning cloaks (*Nymphalis antiopa*) and spring azure butterflies (*Celastrina ladon*).


NANCY ROSE

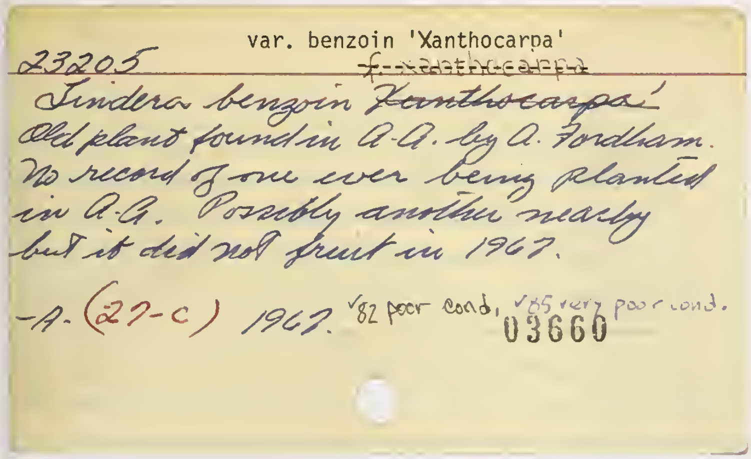
The typical bright red fruit of spicebush (*Lindera benzoin*).


ALL PHOTOS BY THE AUTHOR UNLESS OTHERWISE INDICATED

Lindera benzoin forma *xanthocarpum* bears golden-yellow fruit.

Spicebush also plays a role in alerting nature lovers that the fall season approaches. By the middle of September, female plants begin to display some of the brightest red fruit found in nature. Plants growing in deep woods will be a bit sparse in fruit, but those growing along the forest edge or near wetlands can produce a great profusion of colorful fruit. There are a great number of resident and migrating bird species that take full advantage of the bounty, and often within a week or two the

A view across the lowland sweetgum–red maple forest in the Staten Island Greenbelt.



23205 var. benzoin 'Xanthocarpa'
~~f. xanthocarpa~~
Lindera benzoin ~~Xanthocarpa~~
Old plant found in A.A. by A. Fordham.
No record of one ever being planted
in A.A. Possibly another nearby
but it did not fruit in 1967.
-A- (27-C) 1967. '82 poor cond, '85 very poor cond.
03660

fruit have been harvested and carried off by wildlife.

Though bright red is the typical fruit color, there is also a yellow-fruited spicebush (*Lindera benzoin* forma *xanthocarpum*). The story of this unusual variant begins in Shrewsbury, Massachusetts, in 1913, where it was discovered by Mrs. Frank E. Lowe. A description of the plant written by G. S. Torrey was published the following year in *Rhodora* (note that the species name was then *Benzoin aestivale* rather than the current *Lindera benzoin*):

> "On October 4, 1913, Mrs. Frank E. Lowe collected in Shrewsbury, Mass., specimens of the Spice Bush, *Benzoin aestivale* Nees., which differed from the common form in having the drupes orange-yellow, instead of bright red. Several bushes were found, some growing with the typical form in low, damp places; some alone, in drier ground in a rocky pasture. They all bore yellow fruit, which were ripe and falling. The material was sent by Mrs. Lowe to Mrs. E. L. Horr of the Worcester Natural History Museum, by whom it was referred to the Gray herbarium. The plant may be characterized as follows: BENZOIN AESTIVALE (L.) Nees., forma xanthocarpum, forma nova, fructus flavis."

There seems to be no record of the progress of the plant after its first find in Shrewsbury, at least until the discovery by propagator Alfred Fordham of a plant at the Arnold Arboretum in 1967. It was recorded as spontaneous

The old hand-written accession card for the yellow-fruited spicebush found at the Arnold Arboretum reads: "Old plant found in A.A. by A. Fordham. No record of one ever being planted in A.A. Possibly another nearby but it did not fruit in 1967." The plant's nomenclature had been changed several times over the years. The last note from 1985 indicated that the plant was in "very poor condition" and it presumably died sometime after that.

Thousands of native plant seedlings growing in the propagation range at the Greenbelt Native Plant Center.

(not purposely planted), but given how rare the plant seems to be in nature, one could conjecture whether the Arboretum plant might not have had its genesis from the seeds that were collected from the Shrewsbury population in 1913 or perhaps sometime later. Sadly, the plant that was known at the Arboretum went missing itself sometime after 1967.

The story of the yellow-fruited spicebush continues in New York City (of all places!) where, in 2007, seeds were collected in the Staten Island Greenbelt—an 1,800-acre nature reserve that is part of the New York City Department of Parks and Recreation. The Greenbelt Native Plant Center (begun in 1986) employs 22 full-time staff in the production of hundreds of thousands of native plants that supply native plant restoration projects throughout the region, and they had asked me about good sites for collecting spicebush seeds. I recommended an area in the Greenbelt that I knew contained many thousands of spicebushes and brought some of the staff (including nursery manager Tim Chambers and woody plant propagator Sam Pattison) on a collecting trip to the site. While having a conversation with Tim about the status of endangered native plants of the region (my favorite topic of conversation), Sam returned with a collecting bag full of bright red fruit. Scattered among the red fruit were a number of yellow ones. Before Sam had a chance to add his to a much larger container filled with many hundreds of fruit, I asked to see his yellow fruit and began to marvel at what he had discovered.

We retraced the steps he had taken in collecting the fruit and found a single small shrub growing in a thick lowland grove of red maples (*Acer*

Spicebush grows in full sun in this successional meadow in the Staten Island Greenbelt.

Green milkweed (*Asclepias viridiflora*), left, and globose flatsedge (*Cyperus echinatus*), right, are two of the rare (in New York) plants found growing in a sunny meadow within the Staten Island Greenbelt.

rubrum), where a few of the golden-yellow fruit still remained. After the discovery of the first specimen, we made a greater effort to look for the yellow-fruited plants in the vicinity of the first one, but found none. Further up the trail and into a sunny meadow, we discovered two more plants heavily laden with yellow fruit. The meadow is part of a successional grassland growing over serpentine-derived soils and contains other New York State rare plants such as green milkweed (*Asclepias viridiflora*), purple milkweed (*A. purpurea*), and globose flatsedge (*Cyperus echinatus*). We collected these additional yellow fruit and added the fruit from the first collection; these became a separate cohort of seed from which we could propagate.

It turns out that the yellow-fruited spicebush is a rarer taxon than first believed. According to Charles Sheviak, the state botanist for New York, the plant had not previously been recorded as growing in the state. In Massachusetts, state botanist Brian Connelly has no records for any extant populations in the state. Although it is likely that other populations for the plant do exist, there are no other confirmed populations known in these two states.

The question then arises as to what conservation efforts, if any, need to be taken to ensure the continued existence of the plant in the wild. In using the term "forma" in describing the plant, G. S. Torrey seems to convey the belief that the plant is a random mutation, not sustainable over time, occurring within a larger population. In general, the term "variety" would be used to describe a plant that is self-sustaining or represents a variant that covers a portion of the range of a larger species description.

Given that we don't know either the genetic differences that separate the yellow-fruited spicebush from the more common red-fruited plant, or the potential adaptive differences of the two plants in nature, there remains the outstanding question as to the true taxonomic status of the plant. The first yellow-fruited spicebush seedlings grown from the seeds we collected are reaching flowering size, so we may know within a year or two if the fruit color is inherited from one generation to another (though this might be complicated by the obligate out-crossing nature of spicebush in the wild, as the yellow-fruited plants grow within a colony of several thousand red-fruited plants). We may also consider undertaking experiments to determine if yellow-fruited plants are as attractive as red-fruited plants to wildlife that act as dispersers of the seeds in the wild (though, in general, it is believed that red-fruited plants are favored over other colored fruit by many migrating bird species). It may take some time to unravel the true nature of this elusive plant.

At the very least, we can feel fortunate that the rediscovery of the yellow-fruited spicebush allows a much broader horticultural audience to grow and appreciate the plant. Like the beloved Franklin tree (*Franklinia alatamaha*), the yellow-fruited spicebush might not be the best "fit" for Nature, but at least generations of nature-lovers can enjoy the plant in a more horticultural setting.

Richard Lynch is a botanist and president of the Sweetbay Magnolia Conservancy, a not-for-profit organization dedicated to the study and preservation of rare plants in the vicinity of New York City.

The author with a three-year-old seedling of yellow-fruited spicebush growing at the Greenbelt Native Plant Center on Staten Island.

Book Review:

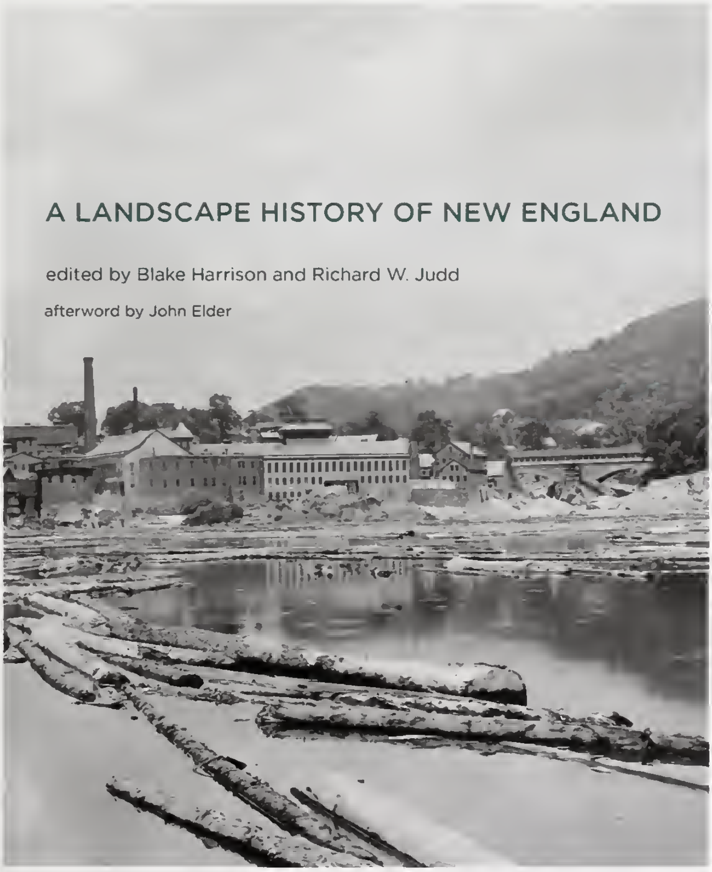
Phyllis Andersen

A Landscape History of New England
Edited by Blake Harrison and Richard W. Judd.
Cambridge: MIT Press, 2011. 413 pages.
ISBN 978-0-262-01640-7

Coeditors Blake Harrison and Richard W. Judd challenged a group of senior and young scholars to produce essays that capture myriad aspects of the New England landscape: the material landscape of forests, upland farms, stone walls, inland rivers, and rocky coast lines, and the symbolic landscape of picturesque villages, bucolic pastures, and the stock pieties of hard-working farmers with backs to the plow and eyes on the horizon. Methodologies deployed by the authors vary from the new disciplines of environmental and ecological history to literary narrative and to the politics of gender, ethnicity, and environmental change. The twenty essays are bookended by the editors' introduction and conclusion—dissimilar threads skillfully woven to form comprehensive case studies of landscape and cultural changes over three centuries. The essays engage both the essence of regional character and the theatrical promotion of magnetic scenery created for the seduction of tourists to visit New England and support local economies.

Old England was a refuge for New England's early settlers, so newly settled places were often named after mother-country places (the Berkshires, Portsmouth, Worcester, New London) and topographic terms (brook, pond, marsh, fens) coincidental to mother country terms. This offered familiarity amidst what some early settlers called the emptiness of the place and others called the howling wilderness. The fact that the "emptiness" contained areas of cultivation by Native Americans was ignored in the jeremiads of early Puritan ministers who needed a transformative narrative to motivate their flocks to both stay and spread out. As waves of settlers came to understand the intrinsic capacities of the landscape, the wilderness became a land of cultivation and harvesting: pastures, orchards, and gardens; forests for fuel and building material; rocky and sandy coastal waters offering access to a rich diversity of fish and crustaceans.

Joseph Conforti opens the roster of essays by setting a theme for the entire volume: regional identity as both historically grounded and culturally invented. Conforti projects New England identity as flowing from Native American



"Fishermen and weir, Passamaquoddy Bay region near Eastport, Maine, circa 1880. This photograph was part of broader study by the U.S. Fish Commission for the 1880 U.S. Census. It shows fishermen using a traditional brush weir to take herring for the burgeoning canning industry."

tribes such as the Algonquians, with their seasonal settlements and cultivation of crops, to the formation of isolated towns and villages distributed across farmland and along the seacoast, a land-planning method still visible today.

The New England landscape was physically reconstituted in the nineteenth century with a surge of industry, especially shoe manufacturing, textile mills, and ship building. The current evolutionary stage of development includes a topology of leisure and recreation: heritage sites, boutique-lined waterfronts, ski slopes, athletic fields, and the indigenous clothier of fishers and hunters, L. L. Bean. Conforti quotes Dona Brown, a historian at the University of Vermont, to describe that tourist landscape as "a commodity peddled and consumed like the notions of an itinerant Yankee trader."

In his essay, Kent Ryden finds the well-worn argument of nature vs. culture a useless bit of rhetoric in understanding the New England landscape. Everything we see is the result of land use, he insists, recorded in the ways that human minds and hands worked in tandem with natural opportunities and constraints. He cites a little-known essay by Thoreau, "The Succession of Forest Trees," first delivered as a lecture in 1860. From years of observing

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"Tourists in Franconia Notch, 1920s. Franconia Notch was one of the most popular sites in New Hampshire's White Mountains. Here, tourists by the shores of Profile Lake gaze upward at the Old Man of the Mountain." Source: From *Automobile Blue Book.*

"Robert Havell, 'View of the City of Boston from Dorchester Heights,' circa 1841. Views of Boston Harbor like this one provide an incomplete picture, because they show only the landscape visible to the human eye. Some of the harbor's most indispenable features, such as its ship channel and anchorage, were part of an underwater landscape that lay out of sight beneath the waves."

the transformation of abandoned farm fields back to forests, Thoreau became aware that the species mix of the New England forest in the mid-nineteenth century was as much a result of human interventions as natural succession. Ryden adds to Thoreau's observation that New England's famous fall foliage is as much determined by human intervention as by natural process. His evidence is that when first-growth forests were cleared for timber and farmland by the middle of the nineteenth century, three-quarters of the region had been deforested and the fields derocked. With the diminishing of agricultural use, the forests returned as old fields were taken over by white pine (*Pinus strobus*), which thrives in sunlight and can survive in poor soils. As the pine forests matured, an understory of deciduous species, mainly oaks and maples, established themselves below the evergreen canopy. At the turn of the twentieth century, pines were cut for wood products and the young deciduous species could then dominate, producing colorful autumn foliage that was of little value to farmers but was essential to establishing the ritual of autumn visitors (leaf-peepers) to New England.

Despite the difficulty of subsistence farming in New England, by the early twentieth century the farm complex of pasture, cultivated fields, orchards, and picturesque barns and outbuildings offered symbolic value to visiting urbanites fatigued by lives over which they had little control. Attracted to a life of self-sufficiency, writers in particular were drawn to the back country of New England where they documented their survival tactics in numerous publications. Dona Brown describes a little known back-to-the-land movement of the 1930s; she notes that an "imaginative reconfiguration" of New England was underway as the image of a region full of "dour puritans and antiquated blue laws" was refigured.

In a 1932 editorial in *Harper's Monthly,* the noted writer and historian Bernard DeVoto observed that the Great Depression was not as severe in New England because long years of trials and tribulations had given the people great moral strength: "By the granite they have lived for three centuries, tightening their belts and hanging on." Brown uses as an example the writer Elliott Merrick and his wife who gave up urban life for a back country farm in Vermont where Merrick wrote *From This Hill Look Down* (1934). He stressed self-reliance and hard work in taming nature as a way to revitalize the urbanized mind and body. The couple was followed by another pair of writers, Helen and Scott Nearing, who relocated first to rural Vermont and then Maine. Their book, *Living the Good Life* (1954), became a manual for disaffected youth of the 1960s and 1970s.

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"Henry Red Eagle on the shores of Moosehead Lake, circa 1940. Red Eagle often drew inspiration from the Moosehead Lake region, incorporating its recreational and its working spaces into his writing." Source: From Bangor & Aroostock Railroad, *In the Maine Woods* (1941).

Elizabeth Pillsbury investigates Long Island Sound on New England's southerly shore, valued first for its oysters and later for boating recreation. The Sound became a waste depository and ended up as a dead ecosystem. Moving up the coast line, Robert Gee brings his reader to Maine's "drowned coast" created by the rising and then receding sea level revealing land features: dramatic inlets of eroded tide pools and island clusters accommodating a rich variety of sea and shorebird life. Gee tracks the development of Maine's fish canning and blueberry industries in tandem with its growing popularity for tourists and summer homes. Moving back down to Boston, Michael Rawson traces the concern for the environmental health of Boston Harbor today back into the nineteenth century, when extensive filling of brackish tidal flats dramatically altered the shore line.

The topic of alternative ways of writing about the New England landscape is covered by two essays on lesser known individuals, each dealing with the ambiguity between documentary and fantasy writings. Under the pen name Henry Red Eagle, the Native American writer and wilderness guide, Henry Perley, wrote numerous stories about Maine's north woods. Written for a popular audience, his tales of adventure and romance highlighted his Native culture. Perley also participated in tourist activities, and like many other Natives took roles in national performing troupes such as P. T. Barnum's, cooperating with displays of stereotypical Indian behavior demanded as entertainment by "white man" audiences. Similarly, the Maine travel writer George H. Haynes, who, in the words of contributing author David L. Richards, specialized in the two social dimensions of landscape in general: timeless antiquity and rushing modernity; he blended literary romanticism with journalistic realism that he referred to as "a bit of realistic fairy-land" writing. Haynes prodigious output included books, articles, historic treatment of scenic areas, and promotional brochures.

Across New England, tourism filled the gap when the utility of lumber and crop-producing landscapes moved on. The landscape that had made agriculture so difficult on rocky upland pastures changed in people's minds to a topography of gentle mountains and valleys cut through by rivers and streams—romantic scenery documented by artists, photographers, and souvenir postcards. Tourism also responded to picturesque scenes of villages with white painted houses, church spires, and town greens.

John Cumbler describes how the landscape of Cape Cod, described by Thoreau as the "bared and bended arm of Massachusetts," evolved from the productive but fragile landscape of fisheries, salt works, and grain fields to pleasure grounds for summer visitors. The sandy and nutrient- poor soil and overgrazing by sheep and cattle led to depopulation of the area by the turn of the century, while tourism grew from early guest houses and cottage communities to golf courses and seaside hotels on manicured lawns.

The editors admit that more work needs to be done on the urban landscape of New England. Two useful articles in this volume take up the urban story in the late nineteenth century. Phil Birge-Liberman reveals that the Boston park system was created as much by the values of the reigning Yankee upper class as it was to satisfy a genuine need for leisure spaces on behalf of the city's burgeoning population. The annexation of neighboring towns to the city of Boston and the growing number of immigrants compelled the Yankee leaders to do a bit of social engineering by developing a park system that could control behavior and ease social tensions. Birge also treats real estate speculation and its link to park development—an area that needs much more investigation not only in Boston but other American cities. James O'Connell examines the Boston metropolitan landscape in the twentieth century: the linkage of suburbs, highway development, and a regenerative way of life in expanded urban areas.

European academics use the idea of *terroir,* a French term based on *terre* (land as place), referring to an area where soil and microclimate conditions produce distinctive qualities in food products, especially wine. An expanded definition of terroir includes the customs and traditions of a people. A closer reading of the New England landscape that integrates the work of earth scientists is in the future of environmental history. It would serve to deepen and enrich the current discourse that continues to take much for granted. This book offers a distinctive base for this dialogue to continue.

Additional Reading
(books by some of the essay authors)

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Phyllis Andersen is a landscape historian and former director of the Institute for Cultural Landscape Studies of the Arnold Arboretum.

Remember last winter?

This image of Meadow Road and the Fabaceae (legume family) collection was made on January 13, 2011, after yet another heavy snowfall. Read a summary of 2011 weather events at the Arboretum in the next issue of *Arnoldia*.

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Plainly Unique: *Schisandra chinensis*

Sam Schmerler

The plants of the Arnold Arboretum display incredible floral diversity. *Magnolia macrophylla*'s huge waxy blooms open twice, partly closing in between for an overnight sex change. *Helwingia japonica* sprouts tiny green umbels in the center of otherwise unremarkable leaves. *Davidia involucrata* forgoes petals entirely, but shelters its reproductive organs with massive white bracts. Even wild *Viola sororia*, flagging down bees with its iconic violets, surreptitiously sends out discrete, self-pollinating flowers underground.

With all this bizarre and beautiful reproduction going on, most of us overlook the most evolutionarily distinctive flowering plant in the collection: *Schisandra chinensis*. An unassuming woody vine, it represents a unique and ancient lineage that parted ways with most other flowering plants at least as far back as the early Cretaceous, before even "living fossils" like *Magnolia*. This ancient group, the Austrobaileyales, is now recognized as the third-oldest remaining branch on the phylogenetic tree of flowering plants, diverging after only *Amborella* (a strange New Caledonian shrub) and the Nymphaeales (a group of herbaceous aquatics that includes water lilies). This means that all the other flowering plants in our collection—from creeping crowberries to towering tuliptrees—are more genetically similar to each other than any of them are to *Schisandra*.

We can't grow the other Austrobaileyales here, since they hail from warmer forests in North America, Asia, and Oceania, but *Schisandra chinensis*, from temperate northeastern Asia (China, Korea, northern Japan, eastern Russia), can reliably survive Boston winters. This dioecious vine doesn't *appear* particularly primitive. Visually, it doesn't stand out much at all. Our two specimens (343-97-B, a male plant from Changbaishan, China, and 409-97-B, a female from Chiaksan, South Korea) twine unobtrusively up his-and-hers trellises in the Levintritt Shrub and Vine Garden and tend to blend in with their neighbors. Their simple, medium-green leaves are perfectly innocuous, eventually turning a bland butter yellow. In late spring, small, white, sweet-smelling flowers droop on thin pedicels in a passable impersonation of nearby *Actinidia* (kiwi). The female's flowers develop into elongated fruits with numerous bright red, berrylike fruitlets. Winter will reveal exfoliating bark resembling that of climbing hydrangea.

Evolutionary biologists (including Arboretum director Ned Friedman) have discovered that *Schisandra* and the other Austrobaileyales can offer insight into many key events in the history of flowering plants. Aspects of *Schisandra*'s vascular system may represent an early step in the development of vessels, the structures that allow most flowering plants to rapidly transport water and ecologically dominate hot and dry habitats. *Schisandra* also retains a relatively simple anatomy during its haploid stage, with only four nuclei and one developmental module in each female gametophyte (almost all flowering plants have eight nuclei and two modules). The endosperm of *Schisandra* seeds consequently contains only one complement of genes from each of its parents, while most flowering plants acquire an additional copy of their moms' genes. *Schisandra* likely shares these characteristics with the extinct ancestors of all flowering plants, a living link to the distant past.

But while it retains many archaic anatomical features that are long lost in most flowering plants, *Schisandra* has evolved a unique and medically promising biochemistry. Traditional Chinese herbalism prescribes *S. chinensis* for a whole host of ailments and as a general tonic and adaptogen. Recent science has isolated several new types of lignans (a class of polyphenols) from the fruits; these have anti-oxidant and anti-inflammatory properties. *Schisandra* lignans have been shown to protect brain cells from glutamate and liver cells from a variety of toxins; they may also inhibit platelet aggregation, tumor proliferation, and possibly even HIV replication. As chemists in the food and medical industries increasingly explore these lignans, it's likely that demand for *S. chinensis* as a pharmaceutical precursor and "functional food" will increase.

Even though *Schisandra* may not dazzle, this vine's exciting chemistry and singular evolutionary history prove it truly stands alone. Next time you visit the Arboretum be sure to check out *Schisandra chinensis*—it tends to reward closer inspection.

Sam Schmerler recently completed his appointment as a Curatorial Fellow at the Arnold Arboretum.

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The Magazine of the Arnold Arboretum
VOLUME 69 • NUMBER 4


1
About
½ natural size.
1. Prunus pen a.
2. Prunus -cerasus
"Sekizan" or "Seki-no-Yama."
3. Prunus Mume.
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About ½ natural size
Natural size.

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Front cover: Japanese flowering cherries have been popular with American gardeners for a century. Photo of *Prunus sargentii* 'Dr. S. Edwin Muller' by Anthony S. Aiello.

Inside front cover: A page from the Yokohama Nursery Company's 1901 catalog shows some of the flowering cherries that were offered for sale. Archives of the Arnold Arboretum.

Inside back cover: Arboretum Manager of Horticulture Stephen Schneider extols the inner and outer beauty of Wilson's pearlbush (*Exochorda giraldii* var. *wilsonii*) in this issue's plant profile. Photos by (clockwise from upper left) Nancy Rose, Robert Mayer, and Michael Dosmann.

Back cover: Starting on page 30, read all about the weather events recorded at the Arboretum in 2011. Photo of damage sustained in Tropical Storm Irene by the centenarian silver maple (*Acer saccharinum*, accession 12560-C) along Meadow Road by Nancy Rose.

Japanese Flowering Cherries —A 100-Year-Long Love Affair

Anthony S. Aiello

This year marks the 100th anniversary of the 1912 planting of the famous flowering cherries surrounding the Tidal Basin in Washington, D.C. The story of how they came to be planted is worth exploring, given the centennial anniversary, the lasting impact of the planting efforts, and the continued public fascination with flowering cherries. Although the Tidal Basin plantings seem like a singular event, the interest in flowering cherries was widespread in the early 1900s, and these plants came into the United States through a number of different sources. Around this time both the USDA's Office of Foreign Seed and Plant Introduction (under David Fairchild) and the Arnold Arboretum were instrumental in bringing many cultivated varieties into the United States as part of a broad interest in flowering cherries. Based largely on the efforts of Fairchild, Charles S. Sargent, and E. H. Wilson, there was a surge in the number of varieties available in the first quarter of the twentieth century.

The flowering cherries, or *sakura,* have been an integral part of Japanese culture for centuries. "Japanese flowering cherries" is a general term for a taxonomically complex group of plants that includes several well-known taxa such as *Prunus subhirtella* (Higan cherry),

PETER DEL TREDICI

The famous flowering cherry trees around the Tidal Basin in Washington, D.C.

Prunus × *yedoensis* (Yoshino cherry), *Prunus serrulata* (also known as the Sato-zakura group) with its numerous cultivars, plus a number of other species. Despite their historic popularity in Japan, only a few types of flowering cherries had entered the United States during the latter part of the nineteenth century. The most commonly available flowering cherry at this time was probably the weeping Higan cherry (*Prunus subhirtella* 'Pendula'), listed in nursery catalogues starting in the mid-1800s (Russell 1934). The earliest record of the weeping Higan cherry at the Arnold Arboretum dates from January 16, 1880, when a plant was received from Mr. A. M. McLaren of Forest Hills, Massachusetts. In 1916, Wilson wrote that weeping Higan cherry "is now a fairly familiar tree in the parks and gardens of Europe and North America" (Wilson 1916).

***Prunus* x *yedoensis* 'Shidare Yoshino' in full bloom at the Morris Arboretum.**

***Prunus serrulata* 'Kwanzan' bears an abundance of double pink flowers.**

JAPANESE CHERRIES COME TO AMERICA

In the late 1800s, the Arnold Arboretum was responsible for some of the first introductions of flowering cherries into North America. *Prunus sargentii* (previously described as *Prunus serrulata* var. *sachalinensis*) was first introduced to the Arboretum in 1890 by Dr. William S. Bigelow, who sent seeds from Japan, and again in 1892 by Charles S. Sargent on his Japanese expedition (Wilson 1916). In 1894, seeds of Higan cherry (*Prunus subhirtella*) were received from the Imperial Botanic Garden in Tokyo (Wilson 1916). In 1934, describing trees grown from this collection, Paul Russell of the USDA's Division of Plant Exploration and Introduction wrote that "two excellent specimens which stand near the Forest Hills gate of the Arnold Arboretum are nearly 40 years old; the tips of their widespreading branches nearly touch the ground. These apparently are the oldest trees in cultivation outside of Japan and it was from the Arnold Arboretum that this variety found its way into England" (Russell 1934).

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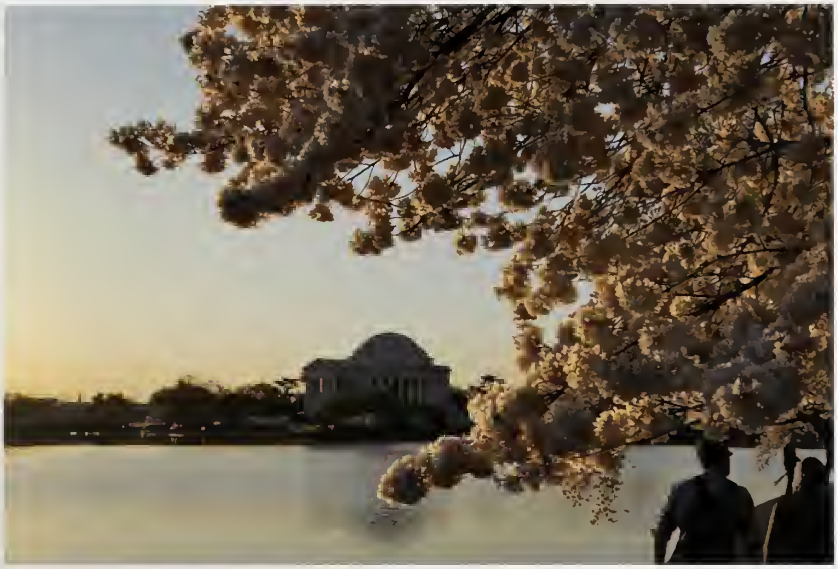
This mid-1800s woodcut print, *Koganeibashi no sekishō* (translation: Evening glow at Koganei Bridge), is by Hiroshige Andō and shows flowering cherry trees along a canal bank with a view of Mount Fuji in the background.

Despite these first introductions, the diversity of flowering cherries available in the early 1900s was limited. Fairchild described the situation at this time, writing, "I do not mean to give the impression that there were no flowering cherry trees in this country before the Office of Plant Introduction began to bring them in. There were individual trees brought in by naval officers and others who had learned to love them in the East, and several nursery firms handled them, but there were no mass plantings and only a few varieties were known" (Fairchild, undated manuscript).

Leading up to the 1912 planting in Washington, David Fairchild and Eliza Scidmore were perhaps the greatest proponents of planting flowering cherries. Scidmore was a remarkable woman who spent a significant amount of time in Japan, China, Java, and the Philippines as a journalist at the turn of the nineteenth century (Jefferson and Fusonie 1977). She became enamored with Japanese culture, flowering cherries in particular, and had long promoted the idea of planting these throughout Washington. Likewise, Fairchild became enthralled with flowering cherries on his 1902 visit to Japan. As a result of this trip, Fairchild, with help from philanthropist Barbour Lathrop, first imported 30 varieties of flowering cherries into the USDA system in 1903. The following year a collection of 50 varieties was imported into the Plant Introduction Station in Chico, California, although Fairchild wrote that the shipment into Chico did not grow particularly well and many of them had died (Fairchild, undated manuscript).

In 1906, Fairchild and his wife, Marian Bell Fairchild, imported 25 varieties directly from the Yokohama Nursery Company of Japan for their property, "In the Woods," located in Chevy Chase, Maryland. One of his goals was to test these varieties for cold hardiness, which to this point was virtually unknown. This experiment was so successful that in 1908 Fairchild helped to organize an Arbor Day planting with schoolboys from every school in Washington,

MATTHEW JONES



Yoshino cherry blossoms frame the Jefferson Memorial in Washington, D.C.

ARCHIVES OF THE ARNOLD ARBORETUM

This striking image of a man seated beneath a large *Prunus subhirtella* 'Pendula' in a village near Tokyo was made on April 1, 1914, by E. H. Wilson during his plant collecting trip to Japan.

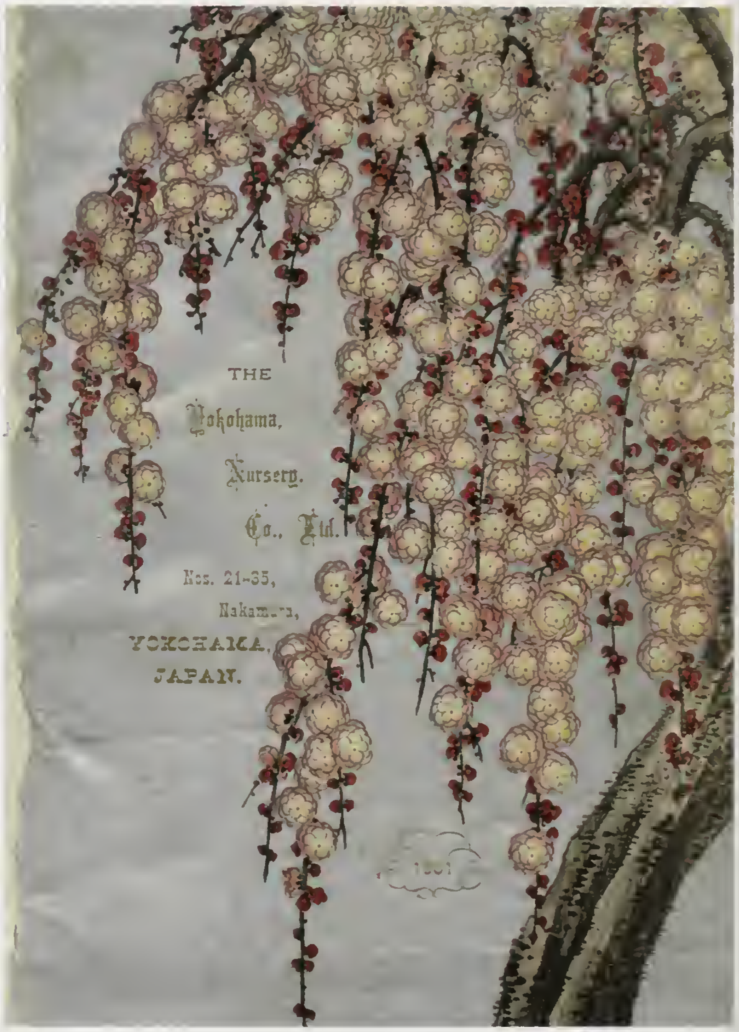
with each of them receiving a flowering cherry to plant in schoolyards across the city (Jefferson and Fusonie 1977).

In the often told story (Jefferson and Fusonie 1977; McClellan 2005), the first donation of flowering cherries sent to Washington from the City of Tokyo was found to be heavily infested with insects and diseases. All 2,000 trees were burned and, as can be imagined, this created a great deal of diplomatic consternation. Fortunately this was all overcome and a second shipment of 6,000 insect- and disease-free trees reached the United States in 1912. One half of these were sent to New York City, where some of the original Yoshino cherries grow near the reservoir in Central Park. The better known half of this shipment were the 3,020 trees that were sent to Washington and were planted around the Tidal Basin, on the White House grounds, and in other areas in the city, where they quickly made the capital famous for its cherry blossom displays. These original trees were made up of 11 varieties of *Prunus serrulata* (1,220 plants) and 1,800 plants of Yoshino cherry (*Prunus × yedoensis*) (Jefferson 1995). Today, of the 3,750 total trees counted by the National Park Service, Yoshino and Kwanzan (*Prunus serrulata* 'Kwanzan') cherries predominate (http://www.nps.gov/cherry/index.htm).

Soon after these plantings, E. H. Wilson conducted his 1914 plant collecting expedition to Japan. This expedition focused on cultivated plants and, because it was to be a less rigorous trip, Wilson was accompanied by his wife and daughter (Howard 1980). This trip is often overshadowed by Wilson's more famous expeditions but it is remarkable for his investigation and importation of Japanese flowering cherries. One of the main purposes of this expedition was to assemble a collection of authentic, named Japanese flowering cherries, backed up by herbarium specimens and published taxonomic descriptions. One of the lasting results of the expedition was the publication of Wilson's seminal work on the subject, *Cherries of Japan*. Wilson's nomenclature can be confounding at times, but the book marked the first publication in English of a thorough review of these plants.

A FLOOD OF FLOWERS

In early 1915, a large shipment of over 60 varieties arrived at the Arnold Arboretum directly from the Yokohama Nursery Company. Additionally, scion wood of 63 varieties was sent for propagation directly to the USDA in January 1915, under a cooperative agreement between the USDA and the Arnold Arboretum. Unfortunately many of these were not successfully propagated, so in February 1916 a duplicate set of 54 varieties was "presented by the municipality of Tokyo to the American Government. These scions were cut from authentic trees growing in the famous Arakawa flowering-cherry collection maintained by the Tokyo municipality, which collection ... contains some of the loveliest forms of these remarkable flowering trees" (Fairchild 1916). Another famous plant explorer, Frank N. Meyer, along with Mr. H. Suzuki of the Yokohama Nursery Company, was instrumental in arranging this second shipment. Fairchild wrote that "so much and such genuine interest has been aroused in the Japanese flowering cherry trees, through the gift to the City of Washington by the Mayor of Tokyo of a collection of them, and through the satisfactory growth which specimen trees have made in Maryland, Massachusetts, and California, that a demand for them has grown up which nurserymen find it difficult to meet. It is of interest, therefore, to point out that 54 varieties from the municipal collection of Tokyo near Arakawa, which represent the loveliest of the hundreds of varieties known to the Japanese, have been secured through the Mayor's courtesy, and these will be propagated and distributed under the same varietal names as they bear in the Arakawan collection" (Fairchild 1917).



This 1901 Yokohama Nursery Company catalogue features an elegant image of a weeping flowering cherry on a silver background.

It may seem heretical to us today, given current concerns over invasive plants and pests, but at the time it was possible to purchase a wide range of plants directly from overseas. Yokohama Nursery Company catalogues from this era list a large assortment of single, double, and semi-double flowering cherry varieties. It is possible to gain insight into this trade from institutional and private records. For example, our records at the Morris Arboretum indicate that co-founder John Morris purchased weeping Higan cherries from the Yokohama Nursery Company in 1910 and Yoshino and Mt. Fuji (*Prunus* *serrulata* 'Shirotae') cherries from the same source in 1912.

Flowering cherries continued to be very popular between the World Wars. One of the leading proponents and sources of flowering cherries was Anton Emile Wohlert, the proprietor of the Garden Nurseries in suburban Philadelphia (Wister 1955–56). Information about Wohlert is scarce and comes indirectly through his nursery catalogues and the plant records of Philadelphia arboreta. Wohlert promoted all forms of *Prunus,* including his own introductions named after family members. As far as I can tell, all of these cultivars are extinct from cultivation so we will never know if they were as exemplary as Wohlert claimed.

During the pre-World War II period the USDA continued their great interest in flowering cherries, with the mantle passed on to Paul Russell, whose 1934 publication *The Oriental Flowering Cherries* remains one of the most useful works on this group of plants. In the late 1920s and 1930s Russell continued the tradition of importing cherries into the germplasm system, most significantly plants he propagated from the Fairchild estate in Chevy Chase. Russell had the advantage of examining thirty years of growth and establishment of *Prunus,* and his work provides an invaluable insight into the state of development in the early 1930s. In this booklet Russell mentions the most important cherry collections, including those at the Plant Introduction Gardens in Glenn Dale, Maryland, and Chico, California, along with those at the Arnold Arboretum and the city parks of Rochester, New York.

No article on flowering cherries is complete without mention of Captain Collingwood "Cherry" Ingram, a British horticulturist who was one of the most well-known plantsmen of his time. Among many diverse interests, Ingram dedicated himself to importing, growing, and hybridizing flowering cherries (Buchan 2011). His 1948 book, *Ornamental Cherries,* was responsible for spreading the gospel of growing cherries both in the United Kingdom as well as on the Continent (Ingram 1948). If you happen to visit the Philadelphia Flower Show or tour the city in mid-March, you will unwittingly owe a great debt to Captain Ingram because one of the most dominant trees at the show and on the streets at that time of year is *Prunus* 'Okame', an Ingram

A specimen of *Prunus* 'Okame' in bloom at the New York Botanical Garden.

Cherries in Print

AN INDICATION of the popularity of flowering cherries can be gained by reviewing the Arnold Arboretum's *Bulletin of Popular Information* and its successor, *Arnoldia* (Del Tredici 2011). Flowering cherries were mentioned as early as 1911, and their virtues were extolled regularly from the 19-teens through the 1930s (for examples, see *Bulletin of Popular Information*: New Series, Vol. III (3) May 14, 1917: pp. 9–12; Series Three, Vol. II (4) May 3, 1928: pp. 13–16; and Series Four, Vol. VI (6) May 20, 1938: 27–30). Interest in Japanese flowering cherries continued after World War II but slowly waned as the century progressed. Donald Wyman's article, *The Better Flowering Cherries*, is the last holistic view of the group (Wyman 1950), after which most of what is written is restricted to only a few species and their varieties (Arnold Arboretum 1970; Arnold Arboretum 2000).

ARCHIVES OF THE ARNOLD ARBORETUM

E. H. Wilson (left) and C. S. Sargent (right) pose in front of a flowering *Prunus subhirtella* at the Arboretum in this 1915 lantern slide image.

E. H. Wilson in the *Bulletin of Popular Information*, May 3, 1928:

> **The Rosebud Cherry (*Prunus subhirtella pendula* [*P. s.* 'Pendula']) is another sport and this, on account of its pleasing habit of growth, was one of the first trees brought to this country from Japan. Another Cherry belonging to this group is *Prunus subhirtella autumnalis* [*P. s.* 'Autumnalis'], a small tree with many twiggy branches and more or less vase-shaped when young. It is a precocious plant with semi-double pink blossoms, which sometimes appear in the autumn but in other years sparsely in autumn and abundantly the next spring as is the case this year. Owing to this peculiarity, it is known when it flowers in the autumn as the Jugatsu-zakura or October-flowering Cherry and in the spring as the Yaye-higan or Double-flowered Spring Cherry.**

hybrid cherry with early-blooming light pink flowers. It was imported into the United States through the Morris Arboretum by Henry F. Skinner. This plant grew in relative obscurity here until the early 1980s, when propagation and distribution made it a popular nursery choice (Meyer and Lewandowski 1985).

REJUVENATING FLOWERING CHERRIES AT THE MORRIS ARBORETUM

Like many arboretum collections, the *Prunus* collection at the Morris Arboretum reflects changes in horticultural trends. Our cherry collection is comprised of venerable old specimens, young trees growing vigorously, and newly added plants. In addition to trees dating to the Morris Estate era, there were continual waves of cherry varieties accessioned from the 1940s through the 1980s. In the 1940s we received a large consignment of trees from the Scott Arboretum, including a few that remain today. These were followed by a group of plants from Kingsville Nursery in the late 1950s, from Princeton Nurseries in the mid-1960s, and more cultivars from the U.S. National Arboretum in 1983.

One often reads that cherries are short-lived, surviving for not more than 50 or 60 years, so it may be surprising to learn that we have cherry trees that were planted by John and Lydia Morris prior to the establishment of the Morris Arboretum in 1932. Our collection has individuals up to 100 years old because we use specific management practices for veteran trees. We work with the natural life cycles of these trees, managing them for longevity and safety and rethinking our approach to arboricultural practices.

By implementing the practices of veteran tree care, we have been able to prolong the lives of our old flowering cherries almost indefinitely (Fay 2002). I could say that we began this process through careful literature research and a prescient understanding of veteran tree biology, but the reality is more serendipitous than that. In the early 1980s, then Morris Arboretum curator Paul Meyer (now our director) began to rejuvenate our *Prunus* collection by removing older trees and replanting with newly propagated plants that we had received from the National Arboretum. A 1940s accession of *Prunus* × *yedoensis* 'Daybreak', thought to be nearing the end of its life, was pruned hard to make way for some of these youngsters. This Yoshino cherry cultivar responded remarkably well, with vigorous new growth where it had been pruned. This practice of hard pruning was then tried on more of our mature cherry trees, with very similar results.

What began as trial-and-error attempts has evolved into a regular retrenchment or restoration pruning program, based on the ideas established in Europe for veteran tree management (Fay 2002). We begin the process of targeted pruning by reducing the end-weight of declining and decaying older branches. Major portions of these branches are removed, lessening the end-load on these branches and reducing the risk of failure along with hazards to the public and

New shoots grow from the trunk of this venerable Yoshino cherry at the Morris Arboretum, where a veteran tree management program keeps old cherries alive and blooming.

ANTHONY S. AIELLO

This 1912 Yoshino cherry accession at the Morris Arboretum has been pruned to reduce the old crown and encourage interior growth.

staff. Simultaneously, we selectively encourage young shoots from along the interior portions of the trunk, working with the natural growth patterns of these veteran trees. Through this process of phased reduction, we continue to reduce the major structural branches, leaving the young interior branches to develop and mature into the new architecture of the tree (Fay 2002). This is an ongoing process, and we rotate through the cherry collection on a five to seven year cycle. In essence we are coppicing the trees, maintaining them in a state of juvenility and not allowing them to reach the ultimate stage of maturity and decline (Del Tredici 1999). It is illustrative to look at Japanese books on flowering cherries to learn that propping and pruning of ancient trees is a long-established cultural practice resulting in the long-lived cultural icons so revered in that country (Sano 1990).

A remarkable example of this process is one of the Yoshino cherries purchased by John Morris from the Yokohama Nursery Company in 1912. This tree grows in relative obscurity in the English Park section of the Arboretum, and it was not until recently that we pieced together historical documents and realized its origin as one of the 1912 plants. This tree has also been sustained through our veteran tree management techniques, with crown reduction and encouraging of interior growth. In addition to its massive old trunk, there are numerous basal and trunk sprouts—rather than thinking of these as detriments, we work with the tree biology, thinning and selecting this new growth with the intention of making those shoots the future crown of the tree.

On some specimens we will encourage these basal sprouts into new trees, but only if we know that the plant is on its own roots. A prime

Management of the vigorous new sprouts around this old *Prunus subhirtella* 'Pendula' allows the specimen to be rejuvenated.

example of this is an old specimen of *Prunus subhirtella* 'Pendula' that was planted prior to 1932. This tree has a highly decayed trunk with a band of healthy bark and one large remaining branch. For the past few years we have removed all but about five of these sprouts and are encouraging the basal rejuvenation of these to form a new tree (Fay 2002). Eventually we will remove all but one or two of these and then allow the original trunk to decay completely.

Cherries have an especially interesting biology because of their tendency for endocaulous rooting, a process of forming roots from portions of stem tissue; these roots result in a successional trunk as they grow down through the decaying parent trunk (Fay 2002; Liu and Wang 1992). As the inner trunks of older plants decay, often there is a shell of living tissue surrounding a core of rich decomposed organic matter from the old wood. The tree often initiates roots into this rich medium, and as root tissue grows down through the core of the tree, it provides added structural support to the tree's upper portions (Jenik 1994). This process is especially apparent in old flowering cherries, and an extreme example occurred with another of our old *Prunus subhirtella* 'Pendula' plants, in this case a plant that is shown on our 1909 Atlas of Compton (the Morris Estate). In the mid 1990s this tree was in significant decline, with a severely decayed old trunk supporting a few feeble branches. For a number of years we observed a major root growing within a cavity in the trunk and leafy shoots arising from the top of this root with increasing vigor. With each passing year the root became more trunklike as the old trunk further deteriorated until it was a standing hollow shell. In the fall of 1997, the old rotting trunk simply fell to the ground under its own weight. We were delighted to see that the "new tree" that had formed inside of this shell was strong enough to stand on its own, but with about four feet of above-ground root tissue forming the new trunk. Since then this tree has continued to prosper, a Lazarus of a plant having returned from the brink. It now grows vigorously across from our visitor center, providing a fabulous spring display.

FUTURE EFFORTS WITH FLOWERING CHERRIES

A few years ago I began to expand the Morris Arboretum's cherry collection by propagating early- and late-flowering varieties to extend the period of flowering interest. Before this project began I was intimidated by *Prunus* propagation, believing that, like many other rosaceous plants, they had to be grafted or budded to be reproduced. Fortunately our propagator, Shel-

PHOTOS BY PAUL W. MEYER

(clockwise from top left) In the mid 1990s it appeared little was left of this *Prunus subhirtella* 'Pendula', but a root growing within the decaying trunk developed into a new trunk, fully revealed when the old trunk fell away. By 2005 the rejuvenated plant was a fine flowering specimen.

ley Dillard, disabused me of this notion and we regularly root cuttings of a number of *Prunus* species and varieties (see page 14).

This project has evolved, and in recent years I have begun to survey public gardens in the northeastern United States to determine the extent of their *Prunus* holdings and to discover where there are unique cultivars. The goal is to propagate these and then redistribute them to a wider audience of public gardens and private collectors. Two notable examples are *Prunus serrulata* 'Gyoiko' and 'Jo-nioi', both represented by single trees, the former at the Morris Arboretum and the latter at the Arnold

Arboretum. Last year we rooted cuttings of these and look forward to growing and distributing them. 'Gyoiko' is an especially interesting plant because it has chartreuse flowers with thin pink and white streaks in the center of the petals. The name translates as "colored court-robes" and refers to the green, white, and purple robes of women in the ancient Japanese imperial court (Kuitert 1999). In the original 1912 Washington planting, all 20 specimens of 'Gyoiko' were planted at the White House. 'Jo-nioi' ("supreme scent" or "first-class fragrance") has single white flowers that bloom in profusion and is known as one of the most fragrant of the flowering cherries (Kuitert 1999). Although once more commonly grown, it has vanished from our landscapes and would make a fine addition to any garden.

The flowering cherries at the Morris Arboretum are a prime example of how a living collection can fulfill multiple aspects of our mission, namely, collections preservation, horticultural display, research, and education. The cherry collection is a model for preserving our horticultural heritage while providing a living laboratory to implement the practices of veteran tree care.

Three *Prunus serrulata* cultivars, including the unusual green-flowered 'Gyoiko', are featured on this page from a 1916–1917 Yokohama Nursery Company catalogue. The name listed here, *P. pseudocerasus*, is no longer accepted, but its appearance in the catalogue hints at the confusing nomenclature within Japanese flowering cherries.

Flowering cherries have long been a captivating presence in Japan and—since their widespread introduction 100 years ago—throughout the United States as well. Their continued popularity is seen in the numerous blossom festivals across North America. The ephemerality of their blossoms provides the highlight of spring and, as the famous Japanese poet Kobayashi Issa wrote, "There is no stranger under the cherry tree ...". Plant one in your garden and see what happens.

Propagating *Prunus*

OUR TECHNIQUE involves taking 4- to 6-inch-long terminal cuttings in mid-June when the trees have set terminal buds but the new growth is still somewhat flexible. We wound the cuttings, then dip in 3,000 ppm KIBA in liquid. The cuttings are stuck in a 60:40 mixture of perlite:peat to which RootShield granules (a biological fungicide containing *Trichoderma harzianum*) are added. The cutting trays are placed in a fog and mist greenhouse with bottom heat of 70°F (21°C) and 16-hour extended photoperiod. Although it varies from year to year and by cultivar, with this method we have very good rooting percentages with a number of cultivars. A critical step in succesful propagation is leaving the cuttings in their potting trays for the subsequent winter after they have been rooted, repotting them only when they start to show new growth the following spring.

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Charlie Deam and the Deam Oak (*Quercus* x *deamii*)

George Hibben

A handy reference in the Arnold Arboretum's curatorial office is a paperback reprint of *Trees of Indiana,* originally published by the Indiana State Board of Forestry in 1912. It was written by Charles Clemon Deam (1865–1953), a drugstore owner with a lifetime passion for documenting the flora of Indiana. With the help of a young zoology student and *Gray's Manual of Botany,* he taught himself the basic methodology employed by botanists and taxonomists. Deam mounted his first specimen on a herbarium sheet in 1896. Sixteen years and over ten thousand specimens later, his first edition of *Trees of Indiana* was printed. It was a reference book that: "scientists could use, rich in accurate technical detail, filled with Latin names and botanical terminology. At the same time, it was a useful and understandable manual for the amateur pupil, teacher, or hobbyist, with picture book drawings that mixed hard science with the warm fuzzy feel of the drugstore almanac" (Kriebel 1987). All ten thousand free copies were distributed within three years, and a one-thousand-copy reprint in 1919 was snapped up within a few days. Revised editions of *Trees of Indiana* were printed in 1921, 1931 and 1953. In subsequent years, photo reprints and digital print-on-demand copies have been produced. Deam also wrote and published *Shrubs of Indiana* (1924), *Grasses of Indiana* (1929) and *Flora of Indiana* (1940). One hundred years after its publication, *Trees of Indiana* remains his best known work.

SPURGEON-GREENE PHOTOGRAPHS, ARCHIVES AND SPECIAL COLLECTIONS,

Charlie Deam in May 1938.

INDIANA'S PLANT COLLECTOR

Deam is remembered as: "a rugged individualist who appeared brusque and gruff to those not well acquainted with him, but to those who were closest to him and knew his intellectual integrity and scientific sincerity this outward brusqueness masked a humble, modest, unassuming man who despised sham and pretense and was deadly serious about his scientific work" (Kriebel 1987). Recognized for these characteristics, in 1909 Deam was appointed the first Secretary of the State Board of Forestry and a member of the Indiana Conservation Commission. In 1917 he became the acting State Forester and in 1919 was appointed head of the Forestry Division in the newly formed Department of Conservation. A significant portion of the salaries and travel allowances he earned while serving in these positions paid for his collecting expenses.

In 1915 he purchased and outfitted a Ford Model T touring car which he called the "Weed Wagon." "The advent of this motor car signaled an end of Charlie Deam's first fifty years,

A 1933 Arnold Arboretum herbarium specimen of *Quercus* x *deamii* accession 897-28, which was grown from acorns received from Charlie Deam in 1928.

Accession	Taxon	Grid	Height (meters/feet)	DBH (centimeters/inches)	Year accessioned
7033 E	*Fraxinus tomentosa* Pumpkin ash	27SW	24.1 / 79.1	82.2 / 32.4	1929
7033 F	*Fraxinus tomentosa* Pumpkin ash	27SW	25.1 / 82.3	58.5 / 23.0	1929
21817 A	*Quercus* x *bebbiana* Bebb oak	25SE	17.4 / 57.1	29.5 /11.6	1916
16883 A	*Quercus shumardii* var. *schneckii* Variant of Shumard oak	32NW	21.3 / 69.9	61.7 / 24.3	1916
19804 A	*Tilia americana* American linden	7SE	14.2 /46.6	76.1 / 30.0	1916
21588 A	*Gleditsia triacanthos* Honeylocust	21NE	18.4 / 60.4	56.4 / 22.2	1929

a period of growth and the laying of groundwork. Now began in earnest his tireless, distinguished journey into science . . . In the decade from 1905, when he reorganized and restarted his Indiana herbarium and numbering system, through 1914, his last full year without a car, he averaged collecting about 1,500 specimens a year. But in 1915 alone he added 3,764" (Kriebel 1987).

Deam sent his collections to the Missouri and New York Botanical Gardens and to Charles S. Sargent, director of the Arnold Arboretum. He asked for assistance in identifying his specimens. The Sargent Letter Books, found in the archives of the Arnold Arboretum, contain copies of thirty letters written by Sargent to Deam during the years 1914 through 1919. They reveal that Sargent identified over 600 tree and shrub specimens mounted on Deam's herbarium sheets. Sargent thought highly of Deam's work, writing on two occasions in 1915: "I am very pleased indeed with your collection [*Cornus* and *Salix*] and I think you have done a capital piece of work, and certainly you are adding greatly to the knowledge and distribution of Indiana trees" and "There is nothing in your *Carya* collection which I should not have expected from Indiana. It is a remarkably fine collection and of very great assistance to me."

When Sargent believed one of the trees found by Deam would enrich the Arnold Arboretum's living collection, he requested Deam send seed for propagation. The table above lists some specimens grown from seeds sent by Deam that still survive in the Arboretum's living collection.

THE DEAM OAK

In Wells County, Indiana, about three miles northwest of Bluffton, stands an oak tree which is well into its second century of growth. Specimens from this tree were first collected on October 4, 1904, by Bruce Williamson, a young zoologist, and his father. The specimens were taken to Deam who forwarded them to Professor William Trelease of the Missouri Botanical Garden for identification. Growing in proximity to this tree were many white (*Quercus alba*) and chinquapin (*Q. muehlenbergii*) oaks. Though reminiscent of *Q. alba,* the leaves were not as deeply lobed and its acorns were not as large as those of a white oak.

In the first edition of *Trees of Indiana,* Deam described the tree as follows: "*Quercus alba* x *Mu[e]hlenbergii.* Plate 44. Bark of a white oak type, branchlets in October gray and somewhat pubescent; winter buds ovoid, blunt, reddish-brown, more or less gray pubescent; leaves obovate in outline, 6–12 cm. (2¼ – 4¾ inches) long, wedge-shaped at base, coarsely toothed and irregularly lobed, sinuses wide or narrow, lobes and teeth ascending except the lowest pair, lobes and teeth generally triangular, sometimes oblong, dark green above, paler and densely gray pubescent beneath; petioles 1.5–3 cm. (½ – 1¼ inches) long; acorns on stalks about 0.5 cm. (1/5 inch) long; nut ovoid, about 2 cm. (¾ inch) long, rounded or flat at the base, rounded at the apex, chestnut brown, pubescent near the summit, enclosed for 1/3 or more of its length in the thin saucer-shaped cup; cup rounded at the base, pubescent within; scales blunt, thickened on the back, brown, densely gray pubescent."

In 1915, Deam discovered that this unique hybrid tree had been blazed for cutting by the landowner. When persuasion to save the tree failed, Deam negotiated the purchase of the one-fifth acre of land on which the tree was growing for seventy-five dollars, a princely sum in those days. The land was deeded to the State in order to preserve and protect the tree. The property became known as the Deam Oak Monument Forest, the smallest preserve in Indiana.

In July of 1916, Sargent, who had been assisting Deam in the identification of woody specimens found in Indiana, wrote: "Dear Mr. Deam, I have been hoping for some time to hear from you and I hope you are getting on all right. You remember, no doubt, your peculiar Oak, a supposed hybrid between *alba* and *Muehlenbergii* (14117 and 14131). I should be very glad to get some acorns of this tree to plant in the autumn, and as it grows within a few miles of Bluffton it ought not to be difficult for you to get them. Before sending acorns put them in water and send only those that sink for those that float are worm-eaten and worthless."

Records for Arnold Arboretum accession 7786 list it under the name *Quercus deamii* Trelease and indicate that plants were grown

DOUGLAS SUNDLING BOTH PHOTOS

The original Deam oak in Indiana on May 8, 2011 (left) and July 16, 2011 (right).

The Arboretum's First Deam Oak

IN 1908, the Arnold Arboretum received two plants of *Quercus muehlenbergii* × *Q. alba* (accession 5962) from the Parks Department of Rochester, New York. It is likely that they were grown from seed distributed by Charles Deam. Accession 5962-B has grown over the past century on Peters Hill to become a stately tree 20.1 meters (66 feet) tall and 59 centimeters (23.2 inches) DBH.

GEORGE HIBBEN

This 1908 accession (5962-B) of Deam oak (center) grows on Peters Hill at the Arboretum.

GEORGE HIBBEN

This Deam oak (accession 7786-A) was grown from acorns received by the Arboretum in 1916 from Charlie Deam.

from seed received on September 28, 1916, from C. C. Deam, near Bluffton, Wells County, Indiana. Accession 7786-A, now over ninety years old, stands adjacent to Oak Path and is 21 meters (69 feet) tall and 69.8 centimeters (27.5 inches) DBH. Indeed, after studying specimens taken annually for many years, Professor William Trelease determined the tree discovered in 1904 was a natural hybrid of the two species. In the 1917 *Proceedings of the American Philosophical Society* he named it not for the Williamsons who first found it, but for Deam who had first described the tree and saved it from destruction.

Seventy years later, in 1987, the Deam Oak Monument Forest was described in Robert C. Kriebel's biography, *Plain Ol' Charlie Deam, Pioneer Hoosier Botanist*: "Northwest of Bluffton, off Indiana 116 at County Road 250-N, the traveler encounters a chain link fence around a hundred-foot-square reservation. Inside the enclosure are three picnic tables, a rusted trash barrel, a grill, a back-yard-type swing set for youngsters. And forty feet from the highway pavement, the Deam oak lives on, plain and battered as its namesake. A brown and yellow, state-maintained sign explains its significance to the stranger."

PERPETUATING THE DEAM OAK

Today, very few inhabitants of Bluffton and Wells County recall Charlie Deam's career as a plant collector, forester, and conservationist, or the history of the Deam oak. Among the knowledgeable few are Douglas Sundling, a resident and employee of Bluffton, and Brad Brody, the Wells County District Forester. They are both dedicated to the preservation of this notable oak. Sundling's photographs—made in the spring and summer of 2011—show that the tree, while aging, is in good condition, and a wooden fence encloses the well maintained grounds.

Because of the Deam oak's interesting history and connection to the Arboretum, several staff members became interested in clonally repropagating the original tree. In the spring of 2011, a request was made to Sundling and Brody for scion material. They sent a bundle of 3- to 6-inch-long stem terminals, and Arboretum propagator Jack Alexander grafted these scions onto *Q. macrocarpa* understock. Several of these grafted plants will be grown on for future planting in the Arboretum's Living

WELLS COUNTY GIS

An aerial view of the the Deam Oak Monument Forest (upper left), the smallest preserve in Indiana.

GEORGE HIBBEN

One of the grafted Deam oaks growing at the Arboretum's Dana Greenhouses.

DOUGLAS SUNDLING

The informational sign near the original Deam oak.

Collection. The remaining plants will be returned to Sundling and Brody to be planted in Indiana's Deam Oak Monument Forest and Wells County parks. One hundred years later, Charlie Deam's legacy lives on.

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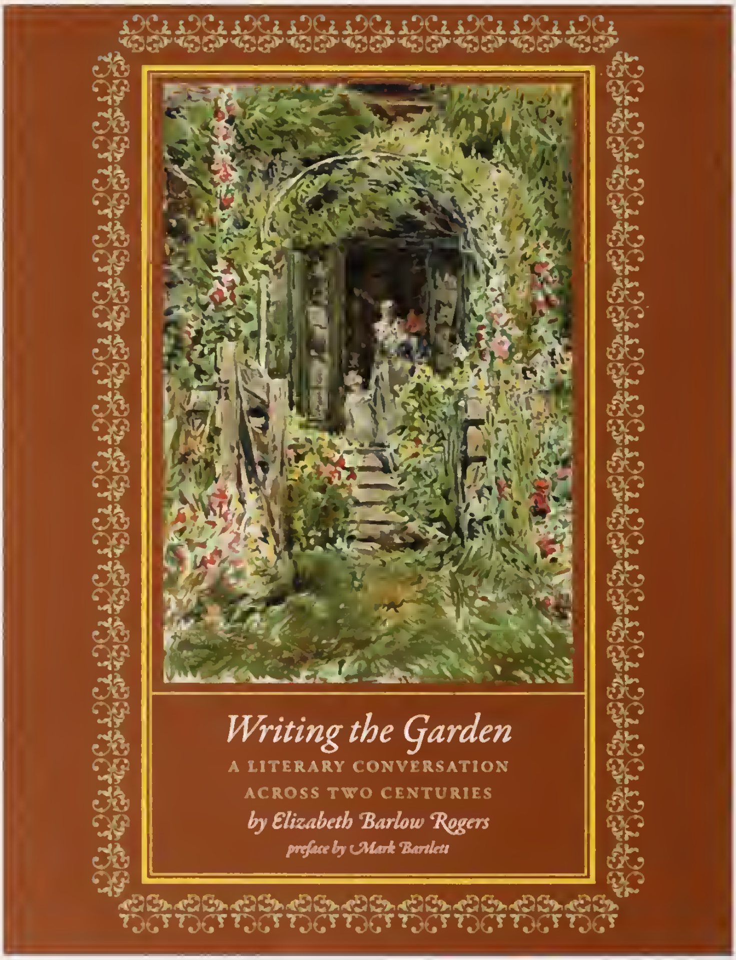
George Hibben began volunteering with the nursery and greenhouse staff at the Arboretum's Case Estates site in 1988. He also accessioned artifacts found at the Arboretum and prepared the monograph *Arnold Arboretum—Prehistoric Indian Artifact Collection* in 1991.

BOOK EXCERPT:

Writing the Garden: A Literary Conversation Across Two Centuries

Elizabeth Barlow Rogers

David R. Godine, Publisher, Jaffrey, New Hampshire, with funding from the Foundation for Landscape Studies and the New York Society Library. 2011. 312 pages. ISBN: 978-1-567902-440-4.



EDITOR'S NOTE:

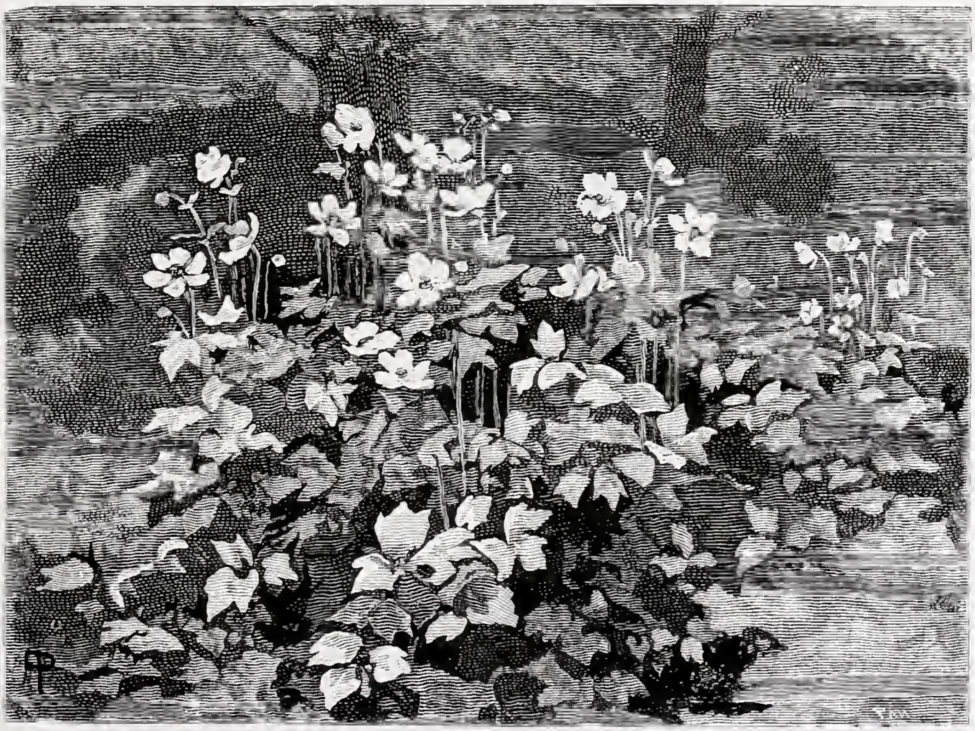
IT'S SPRING, and those of us who love to garden are happily sinking our fingers into the warming soil as we plant seeds, pull early weeds, and ruthlessly hunt down lurking cutworms. But after a hard day in the garden it's time to relax with a good book, and what better than a book about some of the best garden writers (or writing gardeners) of the past couple of centuries. In *Writing the Garden,* author Elizabeth Barlow Rogers presents insightful essays on the works of a diverse group of writers. Some are well known, others less so, but in their writing all present fascinating opinions about the nature of gardening and a deep love for the subject. Rogers groups the authors into sections based on their interests and importance to garden literature, such as "Women in the Garden," "Travelers in the Garden," and the delightful "Humorists in the Garden" (it turns out I'm not the only gardener who goes slug hunting at night with a flashlight). In the following excerpt, "Warriors in the Garden," we are reminded that the seemingly gentle art of gardening is full of highly opinionated practitioners.

"Warriors in the Garden"

Gardening is nothing less than warfare with nature. With no respect for the cabbage or the rose, nature sends in her legions of hungry insects and foraging animals to wreak havoc. But there is another kind of warfare in the garden, one that is waged against fellow gardeners rather than garden pests. In this kind of warfare garden theory is often presented as a polemical diatribe against previous practices or contrary philosophies. For the reader, it is both instructive and amusing to argue or agree with certain opinionated writers and to refight the horticultural battles of yesteryear as they promulgate their passionate beliefs and ideas.

William Robinson

If [Gertrude] Jekyll was the authoritative mother of a more naturalistic English garden style, her friend William Robinson (1838–1935) was its highly influential father. He also serves as the prime exemplar of a didactic and sometimes colorfully caustic genre of garden writing. In Robinson's view, the architect was the enemy of good landscape design, which he held to be the exclusive province of the gardener—that is, the enlightened gardener who agreed with him that mowing be forsaken in some parts of the garden so that cut lawns would transform themselves into wildflower meadows. His further ideal was to allow climbing plants to entwine themselves on trunks and branches, and he dogmatically declared that fallen leaves should be left on the ground as natural mulch in woodlands.



The White Japan Anemone in the Wild Garden.

Anemones in the Riviera. Thrive equally well in any open soil here, only flowering later.

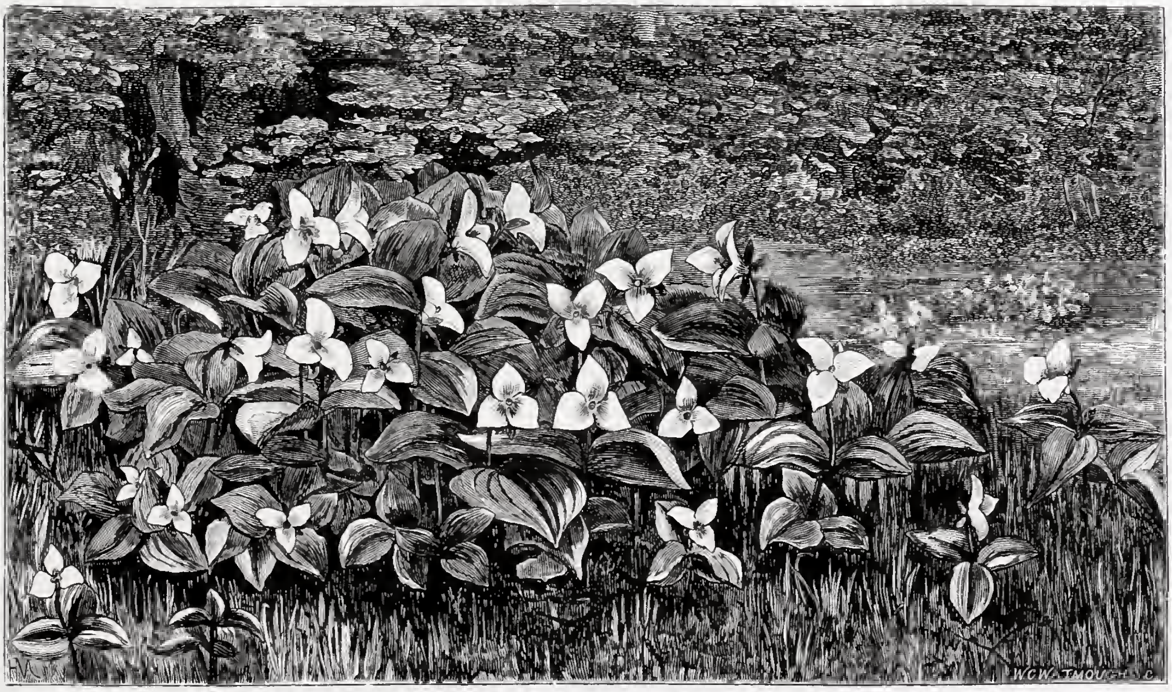
A trained professional gardener, Robinson had a botanist's as well as a horticulturist's thorough knowledge of plant species and their growth habits. He was adamantly opposed to greenhouse-grown annuals planted in regimental rows or showy ornamental beds. He also detested the display of trees and shrubs in Loudon's Gardenesque style as individual specimens, and he vigorously proselytized the overthrow of late Victorian gardening in favor of one in which bulbs were planted in drifts, herbaceous beds were composed of mixed perennials, and horticultural species appeared to merge at the garden's perimeter with the native vegetation of meadows and woodlands. Together he and Jekyll redirected garden design in a way that gave the world what is now thought of as the prototypical English garden—a blending of wild and artificial nature; the grouping of trees and shrubs to form pleasing landscape vistas; the use of hedges to create more intimately scaled garden "rooms"; and the laying out of beds in which casually composed yet sophisticated plant combinations—based on a thorough knowledge of floral and leaf colors, blooming times, and growth characteristics—made gardens interesting throughout the entire year.

Two years after the publication of *The English Flower Garden* (1883)—a volume that eventually ran to fifteen editions and remained in print for fifty years—Robinson purchased the Elizabethan manor of Gravetye in Sussex along with its adjoining two hundred acres. He subsequently acquired additional land so that his property totaled a thousand acres, more than sufficient in size for rural nature and naturalistic garden to be melded into a unified landscape with unobstructed views of the horizon. Here, with occasional advice from his friend Jekyll, he created broad scenic effects as well as herbaceous gardens closer to the manor. The landscape theories he put into practice at Gravetye, however, had been articulated long before in *The Wild Garden* (1870).

It would be a mistake, as Robinson is at pains to point out, to assume that the wild garden is the same thing as the native-plant garden. It should, to the contrary, be considered an opportunity to naturalize the flora of other countries, for as he tells us:

> Naturally our woods and wilds have no little loveliness in spring; we have here and there the Lily of the Valley and the Snowdrop, and everywhere the Primrose and Cowslip; the Bluebell and the Foxglove take possession of whole woods; but, with all our treasures in this way, we have no attractions in or near our gardens compared with what it is within our power to create. There are many countries, with winters colder than our own, that have a rich flora; and by choosing the hardiest exotics and planting them without the garden, we may form garden pictures.

Here it is important to pause a moment and consider again the term "garden pictures," since it is so frequently found in the writing of both Robinson and Gertrude Jekyll. For these writers, garden pictures did not imply the same thing as the Picturesque, the term commonly used to describe the earlier garden style in which designed landscapes were created in accordance with the principles of landscape painting. The garden pictures they had in mind are perhaps better characterized as vignettes, small scenes of beauty that the eye takes in as discrete discoveries rather than as panoramic scenery. Jekyll's carefully positioned camera framed many charming, seasonal vignettes within Munstead Wood, and in *The Wild Garden,* Alfred Parsons's engravings give graphic expression to Robinson's words, which are never themselves lacking in descriptive power. This does not mean, however, that such garden pictures, whether verbal or illustrational, should be considered as so many floral incidents independent



The American White Wood-Lily (Trillium grandiflorum) in Wild Garden, in wood bottom in leaf-mould.

The Giant Scabious (8 feet high). (Cephalaria procera.)

of the overall landscape composition. Rather, the term is intended to imply that gardening is fundamentally an art form in which composition, color, line, and texture are as important as botanical knowlededge and horticultural expertise.

Marshaling his arguments in favor of wild gardening, Robinson points out:

> Hundreds of the finest flowers will thrive much better in rough places than ever they did in the old-fashioned border;... look infinitely better than they ever did in formal beds;... [have] no disagreeable effects resulting from decay;... enable us to grow many plants that have never yet obtained a place in our 'trim gardens'; [and] settle the question of the spring flower garden [since] we may cease the dreadful practice of tearing up the flower-beds and leaving them like new-dug graves twice a year. As a final point in its favor, the wild garden can be seen as a kind of paradisiacal reunion of nature's bounty, for from almost every interesting region the traveler may bring seeds or plants, and establish near his home living souvenirs of the various countries he has visited.

Robinson's luxuriously produced *Gravetye Manor, or Twenty Years' Work Round an Old Manor House* (1911), is both a diary and a narrative of the successive stages of Gravetye's creation from 1885 through 1908. He tells the reader how he went about felling trees to open up views, removing iron trellises and the kitchen garden abutting the house, eliminating "a mass of rock-work (so-called) of ghastly order," and destroying other offensive elements left by the previous owners. The book's beautiful engravings evince the principles put forth in *The Wild Garden* as Robinson demonstrates Gravetye to be the paradigm in which house, garden, fields, and forest are united in a pastoral work of art as quintessentially English as a painting by Constable.

As attractive as all this may sound, there were some who felt that Robinson's garden ideal lacked cohesive structure. His peppery personality made it inevitable that he would be attacked by those who disagreed with him, most notably the architect Reginald Blomfield, whose ideas about what a garden should be were quite different.

Reginald Blomfield

The Formal Garden in England (1892) by the country-house architect Reginald Blomfield (1856–1942), with its attractive engravings by F. Inigo Thomas, is a treatise in the form of an essay on English garden history. In the preface to my second-edition copy Blomfield puts forth a spirited defense against what he considers to be Robinson's fallacious, intemperate, and untenable charges, made after the publication of the first edition. With considerable invective Robinson had taken issue with Blomfield's recommendations for a return to formality, and here it is Blomfield's turn to aim a few angry verbal arrows at Robinson. Heatedly, he rebuts Robinson's sarcastic barbs, accusing him of willful misinterpretation and ignorance of garden making as a form of art:

> Mr. Robinson neither gives us the definition, nor shows us where the art is or what it consists of. The trees are beautiful, and so are the flowers, but where is Mr. Robinson's art? What does it do for us, or for the trees or the flowers? His skill as a tree-planter, or as a flower-grower, is no doubt great, but that does not make him an artist, and by no possible wrestling of the term can he be called so on this ground only.

Blomfield maintained, "The formal treatment of gardens ought, perhaps, to be called the architectural treatment of gardens, for it consists in the extension of the principles of design which govern the house to the grounds which surround it." Discriminating between the two views of gardening—the formal and the naturalistic—he argues:

> The formal school insists upon design; the house and the grounds should be designed together and in relation to each other; no attempt should be made to conceal the design of the garden, there being no reason for doing so, but the bounding lines, whether it is the garden wall or the lines of paths and parterres, should be shown frankly and unreservedly, and the garden treated specifically as an enclosed space to be laid out exactly as the designer pleases.

He strongly refutes the notion that the landscape gardener has a monopoly on nature:

> The clipped yew-tree is as much a part of nature—that is, subject to natural laws—as a forest oak; but the landscapist, by appealing to associations which surround the personification of nature, holds the clipped yew-tree to obloquy as something against nature. Again "nature" is said to prefer a curved line to a straight, and it is thence inferred that all the lines in a garden, and especially paths, should be curved. Now as a matter of fact in nature—that is, in the visible phenomena of the earth's surface—there are no lines at all; "a line" is simply an abstraction which conveniently expresses the direction of a succession of objects which may be either straight or curved. "Nature" has nothing to do with either straight lines or curved; it is simply begging the question to lay it down as an axiom that curved lines are more "natural" than straight.

For Blomfield, it was not the Italian style of formal gardening that was instructive for contemporary gardeners; rather it was the old gardens of England that had not succumbed to the fashion for Baroque ornamentation or,

The tall Ox-eye Daisy (Pyrethrum serotinum).

Valley in Somersetshire, with Narcissi, Marsh Marigolds, and Primroses.

subsequently, the Picturesque. Nor did formality imply a great expanse as in the French garden, for "some of the best examples of [the English garden] are on a comparatively small scale." However, Blomfield does not merely sing the praises of old English formal gardens. With an architect's eye for composition and detail, he criticizes these as well as the later gardens designed in the Picturesque style, his principal objects of censure. He maintains that the white marble statues of Bacchus and Flora at Wilton were a mistake: "To attain its full effect [marble] wants strong sunlight, a clear dry light, and a cloudless sky. In the soft light and nebulous atmosphere of the north marble looks forlorn and out of place." An integrated overall plan is what counts most, so in discussing public parks he comes down hard on "the spasmodic futility" of Battersea Park where, without a dominant idea controlling the general scheme, "merely to introduce so many statues or plaster casts is to begin at the wrong end. These are the accidents of the system, not the system itself."

Blomfield is united with Robinson, however unintentionally, in despising the Gardenesque style and the gardener who would have the specimen dahlia banish the hollyhock and other simple, old-fashioned flowers. He equally hates plants in beds that "make the lawn hideous with patches of brilliant red varied by streaks of purple blue." Taking sarcastic aim at the Victorian head gardener, he asks, "Would he plant them in patterns of stars and lozenges and tadpoles? Would he border them with paths of asphalt? Would he not rather fill his borders with every kind of beautiful flower that he might delight in, and set them off with grass and pleasant green?"

In Blomfield's mind, the desired relationship between the architect and the horticulturist should not end in a standoff, nor would it, if their responsibilities were divided thusly: "The designer, whether professional or amateur, should lay down the main lines and deal with the garden as a whole, but the execution, such as the best method of forming beds, laying turf, planting trees, and pruning hedges, should be left to the gardener, whose proper business it is."

In this regard, it is worth noting that Gertrude Jekyll achieved some of her most notable gardens in collaboration with the architect Edwin Lutyens. Their sympathetic marriage of brick terracing and hedge-enclosed garden spaces created an Arts and Crafts landscape idiom that influenced Vita Sackville-West and Harold Nicolson at Sissinghurst and many other gardeners up to the present day. Providing an architectural frame uniting house and garden and giving structure to seasonal borders of sophisticated horticultural artistry, this type of design might be viewed as a synthesis of Robinson and Blomfield. The harmonizing of their opposing but ultimately complementary theories resulted in a style that made a virtue of formal structure as a foil for loosely composed "garden pictures." In this way these important late-nineteenth-century garden writers can be said to have assisted in the redirection of English garden style at a critical time when vast estate grounds were beginning to become a thing of the past.

Elizabeth Barlow Rogers is a writer on the history of landscape design and the cultural meaning of place. She is the president of the Foundation for Landscape Studies and was the founding president of the Central Park Conservancy. *Writing the Garden* recently won a 2012 Book Award from the American Horticultural Society.

Note: The images that accompany this excerpt are engravings by Alfred Parsons from William Robinson's *The Wild Garden*, 1881 edition.

2011 Weather Summary

Bob Famiglietti

2011 continued the trend of warmer than normal temperatures and above average precipitation that started in 2008. Plentiful moisture plus a long growing season allowed the Arboretum's plants to attain optimum growth. Some of our plants suffered damage from storms during the year.

JANUARY began mild, and Arboretum visitors celebrated New Year's Day at 59°F, the high temperature for the month. Only a week earlier, on December 26th, 2010, the Arboretum had experienced a fierce blizzard that brought high winds and heavy snow, which led to considerable plant damage. This mild early January weather helped reduce the blizzard's snow pack to 6 inches and gave our horticulture crew an opportunity to start cleaning up and repairing our living collections. The spring mood was short lived, however, as temperatures dipped and the snows began. Light snowstorms occurred by the second week and a strong, windy northeaster on the 11th and 12th dropped over 15 inches of snow and inflicted even more damage to our plants. Snowstorms occurred from the 17th through the 22nd, depositing another 10 inches. Now 22 inches of snow lay accumulated on the ground. The snow stopped for a couple of days as an Arctic cold front swept through, dropping the night temperature to -4° on the 24th. This was the first below-zero reading in two years. The month finished cold and very snowy with storms dropping another 10 inches from the 24th through 26th, making January's snow total 35 inches and leaving 31 inches of snow accumulation on the ground.

SUE A. PFEIFFER

The view from an Arboretum plow truck on January 13, 2011, after another heavy snowfall.

Arnold Arboretum Weather Station Data • 2011

	Avg. Max. (°F)	Avg. Min. (°F)	Avg. Temp. (°F)	Max. Temp. (°F)	Min. Temp. (°F)	Precipi-tation (inches)	Snow-fall (inches)
JAN	33.9	16.0	25.0	59	-4	5.01	35.2
FEB	37.9	17.9	27.9	59	5	4.48	13.0
MAR	46.4	28.9	37.7	71	11	2.88	1.0
APR	58.3	40.5	49.4	76	29	4.59	2.5
MAY	68.8	51.5	60.2	90	37	3.69	
JUN	74.6	57.8	66.2	89	43	5.01	
JUL	85.8	64.4	75.1	101	52	1.66	
AUG	81.2	62.7	72.0	93	54	10.45	
SEP	74.4	57.7	66.1	86	41	6.49	
OCT	62.9	45.0	54.4	82	28	10.75	2.0
NOV	57.6	38.3	48.0	69	26	4.64	
DEC	46.3	29.2	37.8	62	13	4.14	

Average Maximum Temperature . . . . 60.7°F

Average Minimum Temperature . . . . 42.5°F

Average Temperature . . . . 51.6°F

Total Precipitation . . . . 63.79 inches

Total Snowfall in 2011 . . . . 53.7 inches

Snowfall During Winter 2010–2011 . . . . 67.8 inches

Warmest Temperature . . . . 101°F on July 22

Coldest Temperature . . . . -4°F on January 24

Last Frost Date . . . . 30°F on April 16

First Frost Date . . . . 30°F on October 28

Growing Season . . . . 194 days

FEBRUARY 1st delivered 7 inches of snow. The snow pack on the ground now measured 38 inches, testing the limits of our snow depth gauge (40 inches maximum). Rain storms occurred on the 2nd and 5th while light snow fell on the 7th and 8th. The snow pack was reduced to 28 inches. A storm-free period occurred from the 9th through the 18th and our low for the month of 5°F occurred on the 10th. Temperatures soared to 59°F on the 17th and 18th, reducing the snow pack to 24 inches. February ended with seasonal temperatures and 3 inches of light snow, leaving the month's total snowfall at 13 inches and the snow pack at 17 inches.

MARCH began with a rainstorm, a rare event for this winter. Temperatures climbed into the low 40s and our accumulated snow from the fading winter season was further reduced to 13 inches. The maximum temperature on the 3rd was well below average at just 28°F and temperatures dipped into the teens and twenties for the first five nights of the month. It felt like winter would never end. Snow and ice were everywhere, making it extremely difficult for anyone to walk in the Arboretum, let alone work on the grounds. Gardeners could hardly wait to walk on bare earth again. Temperatures then jumped to 60°F on the 6th and it remained relatively mild, eventually making it to 71°F on the 18th. This was the high for the winter season and the warmest it had been since October 28th, 2010, nearly five months earlier. A combination of these unseasonably warm temperatures along with the sun's intensity and some rain brought an end, on March 16th, to the continuous snowpack that had started on December 20, 2010—an incredible span of nearly three months. Old Man Winter teased us with a 3 inch snowstorm on the 31st. March ended on the dry side with only 2.88 inches of precipitation, which was 14.56 inches less than March 2010's record-setting 17.44 inches.

APRIL 1st started with remnants of the snowstorm that began on March 31st. The first ten days saw high temperatures rise into the 40s, 50s, and 60s. It dropped to freezing or below on the 6th, 7th, and 8th, the last freezing temperatures for the season. It reached a warm 72°F on the 11th, 76°F on the 24th and 29th, and then hit 81°F on the 27th, the high for the month. Very humid conditions were recorded on the 5th, 26th, and 27th, and wind gusts of over 50 mph from the east occurred during a storm on the 17th. Measurable precipitation occurred on 14 days, totaling 4.59 inches.

MAY had lots of fog and near normal temperatures but its average daily high temperature of 68.8°F was 4.3°F cooler than last May's average daily high of 73.1°F. Rainfall totaled 3.69 inches and precipitation was measured in our rain gauge on ten consecutive days from the 14th through the 23rd. Our highest one day rainfall was only .95 inch on the 18th. A low temperature of 37°F was recorded on the 2nd, the last reading in the 30s for the season. It reached 90°F for the first time this year on May 27th. Last year the first 90°F reading was recorded on April 7th.

JUNE was rather cool. Total rainfall reached 5.01 inches, about 2 inches above normal. There were 14 days with measurable precipitation and thunder was heard on several occasions. High temperatures of 89°F were recorded on the

8th and 9th. It never reached 90°F, very unusual for June but not as cool as June 2009 when the maximum temperature was 83°F and the month turned out to be the third coldest June in Boston's 140 years of weather history (Logan Airport station). A low of 43°F was recorded on the 4th, the last minimum temperature in the 40s.

JULY was very hot and dry. 52°F, our low for the month, occurred on the morning of the 15th. Heat waves (three consecutive days of 90°F or over) were recorded at Boston's weather station (Logan Airport) on several occasions, but the Arboretum's weather station only recorded one. We missed others by just a couple of degrees. Our heat wave occurred from the 20th through the 23rd. July's high temperature was recorded on the 22nd at 101°F, making it the highest temperature reading for the year and our first triple digit reading since July 2002 (104°F). In contrast, our low temperature for the year was -4°F on January 24th, giving an incredible temperature range of 105°F in 2011. We had measurable precipitation on 11 days and the month's total of only 1.66 inches was produced mainly from brief periods of light rain.

AUGUST brought very heavy rainfall, a continuation of July's heat, and Tropical Storm Irene. The month began hot—a reading of 93°F occurred on the 1st, which was the high for the month. Temperatures then moderated to the 70s and 80s and we did not reach 90°F again this year. Some early August rains developed into continuous rainy weather, and by the 10th almost 5 inches had fallen. More rain fell from the 13th through the 21st, leaving another 2.48 inches.

KYLE PORT

Tropical Storm Irene blew through the Arboretum on August 28, 2011. Fortunately, damage was limited, but this shellbark hickory (*Carya laciniosa*, accession 12898-S) lost a large section of its crown.

Tropical Storm Irene arrived in full force on the 28th but (fortunately) didn't live up to expectations. Wind speeds only reached 28 mph at the Arboretum's weather station and rainfall was less than 2 inches. Structural damage to our collection was minimal thanks in large part to the preventive pruning standards used by our arborists and horticulturists. Thunder was heard throughout the month and August ended up with an incredible 10.45 inches of rain, more than making up for July's deficit.

SEPTEMBER was summerlike and continued the trend of warm, wet weather that had been so evident this growing season. Rain, thunder, fog, and mosquitoes were prevalent. A high of 86°F was recorded on the 5th while a low of 41°F occurred on the 19th. It rained for four days from the 5th through the 8th, dropping over 3 inches of precipitation. Rainy conditions continued and the month's total reached 6.49 inches. These warm rains encouraged our plants to remain lush and actively growing, showing no signs of slowing down for the impending fall season.

OCTOBER began as September had ended and the year's trend continued with warm temperatures and more rain. The monthly high temperature of 82°F was reached on the 9th and 10th. Above average temperatures occurred throughout the month and October ended as the 12th warmest in Boston's 140 years of weather records (Logan Airport station). Our first fall freeze finally happened on the morning of the 29th as temperatures dipped to 32°F and a heavy rainstorm was ending, leaving a trace of snow and icy surfaces. This officially ended the Arboretum's long growing season at 194 days. Five heavy rain storms occurred through the month along with lighter periods of rain, leaving 10.75 inches as the month's total. On October 30th, the last storm of the month left 2 inches of wet snow on the ground. Our plant collections suffered some damage since the snow was able to accumulate on the leaves that had not yet fallen, weighing down and breaking branches. The Arboretum was very fortunate to have escaped the devastation that occurred just to the north and west of here where up to 31 inches of snow fell, causing massive damage and statewide power outages that in some cases lasted for weeks

NOVEMBER brought opinions and predictions as to what the imminent winter season would be like as October's snowfall brought back memories of last winter's extremely snowy conditions. Some were sure that the wet, stormy weather pattern that we were in would continue into the winter. Much of Massachusetts now lay under a heavy blanket of snow, but the Arboretum's 2-inch layer melted as temperatures rose into the 60s and the monthly high of 69°F was reached on the 9th. November continued very warm and finished 2nd warmest in 140 years of records at Boston's Logan Airport weather station. Our low for the month was set on the 1st at 26°F. The fall foliage season was somewhat disappointing as the warm temperatures created unfavorable conditions for vivid color. It only dipped below freezing on ten nights in November, and Thanksgiving was a delightful 57°F. At the Dana Greenhouses, as in several recent years, the trend in warm temperatures prevented our containerized plants from going dormant, thus delaying their return to winter cold storage. November ended with 4.64 inches of rain and no snow!

NANCY ROSE

Two inches of heavy, wet snow fell on October 30, 2011. The next day, traces of snow along with fallen leaves remained around this ginkgo (*Ginkgo biloba*, accession 222-97-A).

DECEMBER was very mild, continuing November's warmth. A high of 62°F was recorded on the 5th and it reached 50°F or more on nine occasions. It was the 7th warmest December in Boston's weather record keeping history and the sixth straight month with above average temperatures. December's early warmth brought vivid foliage displays on some individual specimens. A 13°F low for the month—recorded on the morning of the 19th—hastened winter dormancy in our containerized plants, a condition needed for storage. 4.14 inches of precipitation was recorded and no snow fell, an unusual event that marked only the fifth time in Boston's weather records that no snow fell in the November–December period.

Bob Famiglietti is a Horticultural Technologist at the Arnold Arboretum's Dana Greenhouses.

Wilson's Pearlbush (*Exochorda giraldii* var. *wilsonii*): A Gem to the Core

Stephen Schneider

It can be a memorable experience the first time you crack open a geode—pale gray and nondescript on the outside, the colorful crystalline center is anything but. The same can be said for cutting into the wood of the trees and shrubs in the Living Collection at the Arnold Arboretum. There have been many surprises for Arboretum staff who prune and remove trees and are also interested in woodworking; often what is hidden by thick, scaly, neutral-colored bark proves to be a treasure once the inner wood is revealed.

Several species come to mind when considering unique and beautiful wood. Golden raintree (*Koelreuteria paniculata*) and Osage orange (*Maclura pomifera*) yield consistent chocolate brown and bright yellow heartwood, respectively. Boxelder (*Acer negundo*), on the other hand, often displays an erratic, bright red fungal staining in parts of its center. Even the old-growth stems of common lilac (*Syringa vulgaris*) often have a deep purple center that, unfortunately, disappears once the wood is seasoned.

Although there are many other Arboretum plants that possess interesting wood, a large specimen of Wilson's pearlbush (*Exochorda giraldii* var. *wilsonii*, accession 11626-C) merits particular attention. Grown from seeds collected in 1907 by E. H. Wilson in Hubei, China, this centenarian shrub resides just off the road near the top of Bussey Hill. Its racemes of spring flowers start as white, pearl-like buds and open to perfect, five-petaled flowers. The flowers are followed by interesting star-shaped seed capsules. Mature and well established, this multi-stemmed shrub has a commanding spread of about twenty feet and a height to match. Its presence, however, is often overlooked by the many visitors who pass by it each day on their march to the top of the hill. They are unaware of the secret that lies beneath its bark.

I remember well the first time I was introduced to *Exochorda* wood. A rather small piece, about a foot long and four inches in diameter, was tossed to me from across the room. Its weight took me by surprise—it felt as strong and dense as hickory. A first attempt to cut through it failed, since the wood was too hard for the band saw blade to provide a straight cut. It became necessary to use a fine-toothed carbide blade on a table saw. That machine even seemed to struggle a bit, but the results were worth the effort. Hidden beneath the gray, scaly, exfoliating bark was densely grained wood patterned in light and dark browns with orange-red highlights throughout. A single pass of the blade proved to be all that was needed to create a smooth finish, velvety to the touch. Applying a coat or two of Danish oil enhances the beauty of this material since it makes the swirling grain more noticeable.

When put on a lathe and turned, this wood creates a beautiful spindle that displays the variety and complexity of its colors and patterns. Checking (cracking that occurs during the lumber drying process) is nearly impossible to avoid with a wood this dense, so finding stable stock to work with between the cracks can be a challenge. Since discovering the wood of *Exochorda*, I have reserved the use of it for very special projects for very special people. Since Wilson's pearlbush is a relatively easy plant to grow, I'll often give the recipient of the gift a live specimen of it to plant in the backyard as a reminder that, much like a geode, its plain appearance on the outside can harbor profound beauty on the inside.

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