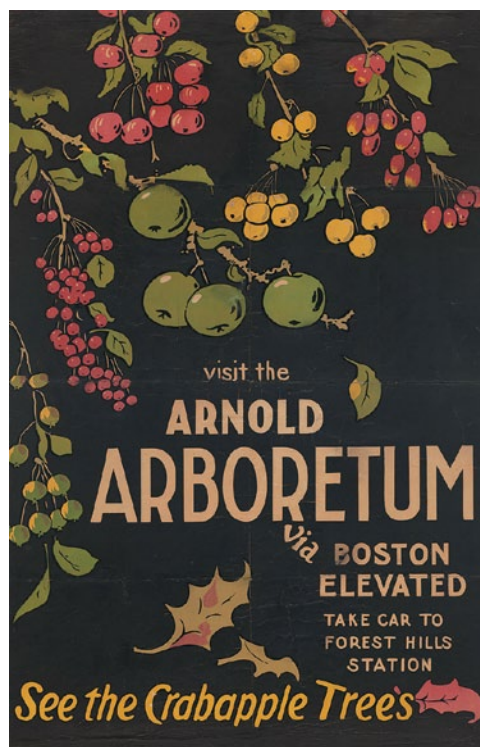


A Year With the Apples of the Arnold Arboretum

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.

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)

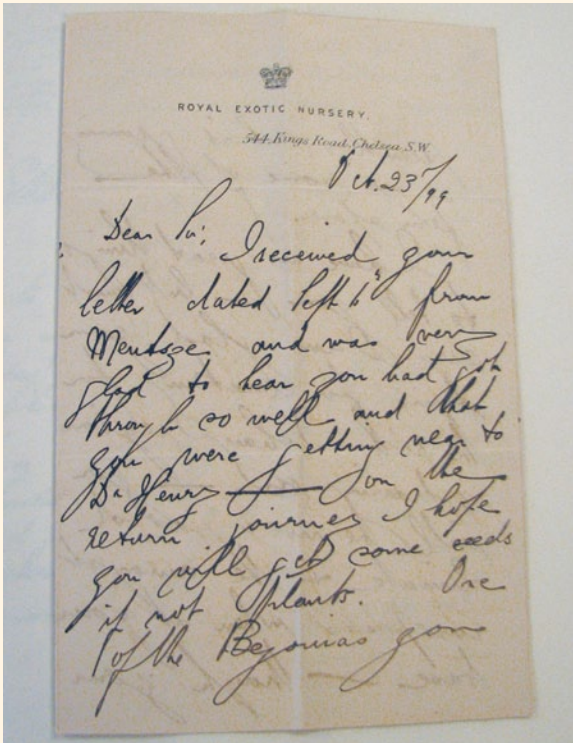


The crabapple cultivar *M. x purpurea* 'Aldenhamensis' (accession 303-50-B seen here) originated in England and was introduced to the United States by the Arnold Arboretum in 1923.

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.



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).

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.

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.

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:

Malus 'Mary Potter'

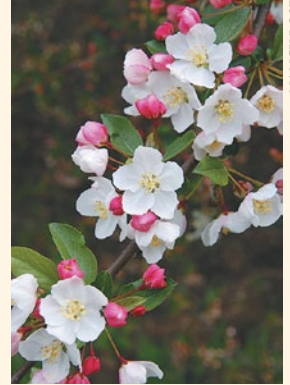
FEATURES: A medium height, wide-spreading tree with high disease resistance, offering abundant white flowers and small (0.4 inches [1 centimeter] diameter) red fruits.

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



NANCY ROSE



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

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



NANCY ROSE



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 nema-

todes 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 orna-

mental 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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