

# arnoldia

*The Magazine of the Arnold Arboretum*

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Postmaster: Send address changes to

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

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

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## CONTENTS

### 2 The History of Minimum Temperatures at the Arnold Arboretum: Variation in Time and Space

*Michael S. Dosmann*

### 12 2014 Weather Summary

*Sue A. Pfeiffer*

### 20 Hamamelidaceae, Part 2: Exploring the Witch-hazel Relatives of the Arnold Arboretum

*Andrew Gapinski*

### 36 *Pterostyrax hispidus*, the Fragrant Epaulette Tree

*Pamela J. Thompson*

*Front and back covers:* After a stunningly cold and snowy winter in Boston, spring's colorful flowers and fresh foliage will be especially welcome. The *Malus* collection on Peters Hill (with Hemlock Hill, the summit of Bussey Hill, and the Boston skyline in the background) is seen in this image from early May, 2008. Photo by Nancy Rose.

*Inside front cover:* The fragrant flowers of *Magnolia* 'Judy Zuk' (accession 183-2011) were in bloom last year on May 19. This hybrid cultivar has *M. acuminata*, *M. liliiflora*, and *M. stellata* in its parentage. Photo by Kyle Port.

*Inside back cover:* The pendent panicles of fringed flowers on *Pterostyrax hispidus* lead to its common name, fragrant epaulette tree. Photo by Pamela J. Thompson.

# The History of Minimum Temperatures at the Arnold Arboretum: Variation in Time and Space

Michael S. Dosmann

Given the original charge to cultivate “all the trees, shrubs, and herbaceous plants, either indigenous or exotic, which can be raised in the open air,” it’s not surprising that the Arnold Arboretum has long been interested in documenting local climate and weather, particularly as they relate to plant hardiness. Early publications such as *Garden and Forest* and *Arnoldia*’s predecessor, the *Bulletin of Popular Information*, are replete with notes of what did and did not survive New England’s climate. *Arnoldia* continues that theme with annual summaries of the previous year’s weather (see page 12 in this issue), often with notes on plant performance.

One of the most innovative projects linking plants and climate was Alfred Rehder’s creation of the first Arnold Arboretum Hardiness Zone Map, which was published in the first edition of his *Manual of Cultivated Trees and Shrubs Hardy in North America* (Rehder 1927). On this map, Rehder divided the United States into eight different zones based on the average minimum temperature of the coldest month. Then, using information about what survived the winters in Boston and other regions, he assigned plants in his *Manual* to particular Arnold Arboretum zones of maximum hardiness. This novel application was further updated and improved by the Arnold Arboretum, and later inspired and gave rise to the hardiness zone map (see page 9) created and now perpetuated by the United States Department of Agriculture (USDA). (See Del Tredici 1990 for a broader review, as well as Dosmann and Aiello 2013 for a brief discussion on the 2012 version of the map and its application to plant acquisition and collections planning.) It is important to bear in mind that the zone parameters in the Arnold Arboretum scheme

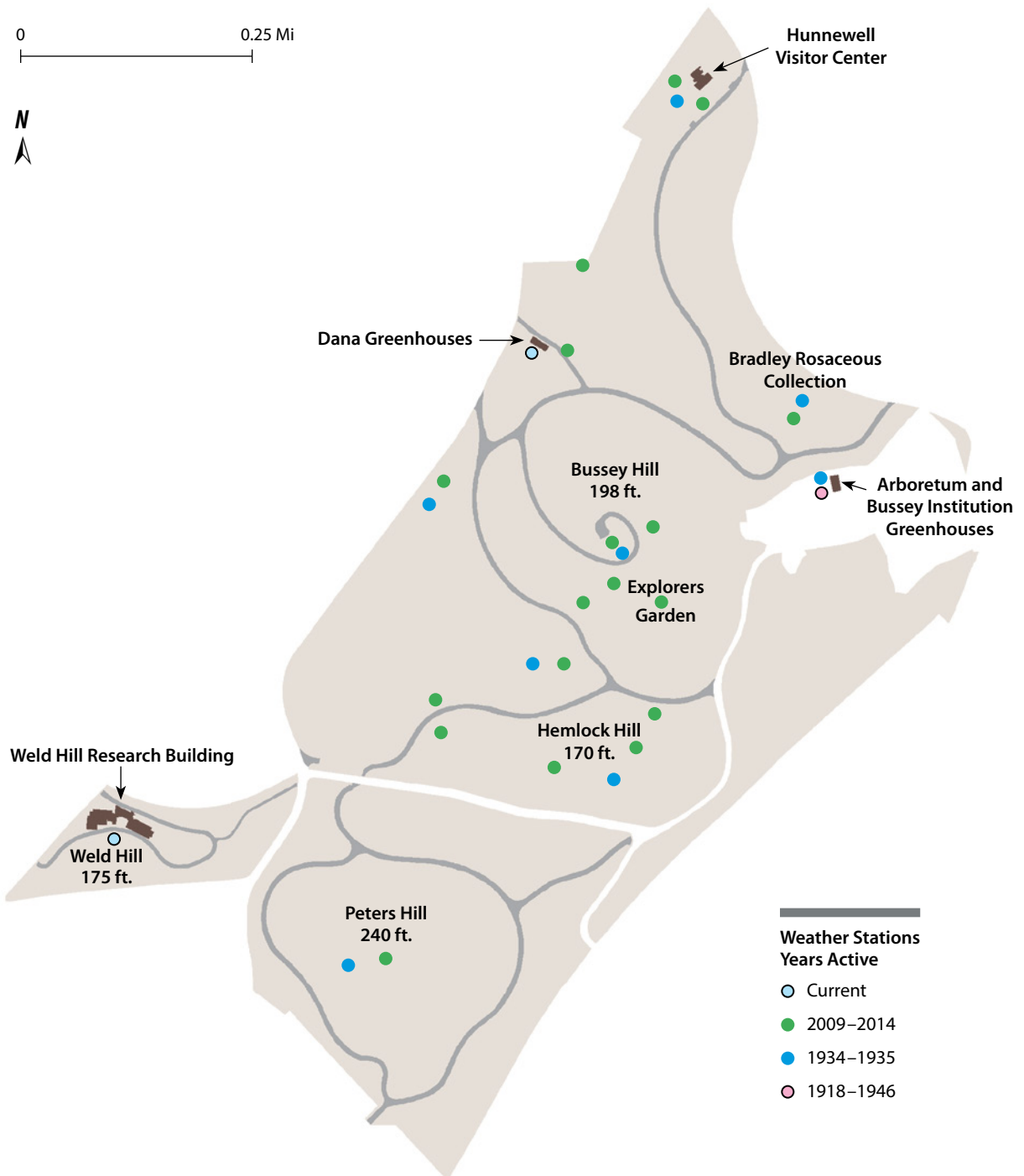
were different from those in the USDA’s, thus giving rise to confusion about a species’ cold tolerance, particularly when a species was simply said to be “hardy to Zone 6” without further clarification—was it the Arnold’s Zone 6 (average annual minimum temperature -5 to 5°F [-20.6 to -15°C]) or the USDA’s Zone 6 (-10 to 0°F [-23.3 to -17.8°C])?

The Arnold Arboretum map was last updated in 1971, and the now accepted industry standard, the USDA Plant Hardiness Zone Map, is based on the principle of average annual minimum temperature. Although other climatic factors (e.g., heat, rainfall, wind) certainly affect a plant’s ability to survive in a given location, it is the minimum temperature in winter that is a primary driver of plant survival. The Arboretum lies within USDA Hardiness Zone 6. This means that in most winters we can expect a minimum temperature between -10 and 0°F, but it does not mean that temperatures lower than -10°F do not occur.

Just as the Arboretum has been curating plant data for almost 150 years, it has also been gathering and archiving weather data for nearly a century. Starting in 1918, William Judd, Arboretum propagator at the time, began to collect and record weather statistics on a daily basis. He collected these data near the greenhouse, which at the time was located near the former Bussey Institution and what is now the Massachusetts State Laboratory near the Forest Hills train station. Judd diligently recorded the data until his death in 1946, leaving us with a wonderful resource. In 1963, a new weather station was installed at the Dana Greenhouses (which had been constructed the previous year) and the Arboretum began to collect data again in earnest (Fordham 1970). In 2011, a new state-of-the-art weather station was erected at



# Location of Weather Stations at the Arnold Arboretum of Harvard University

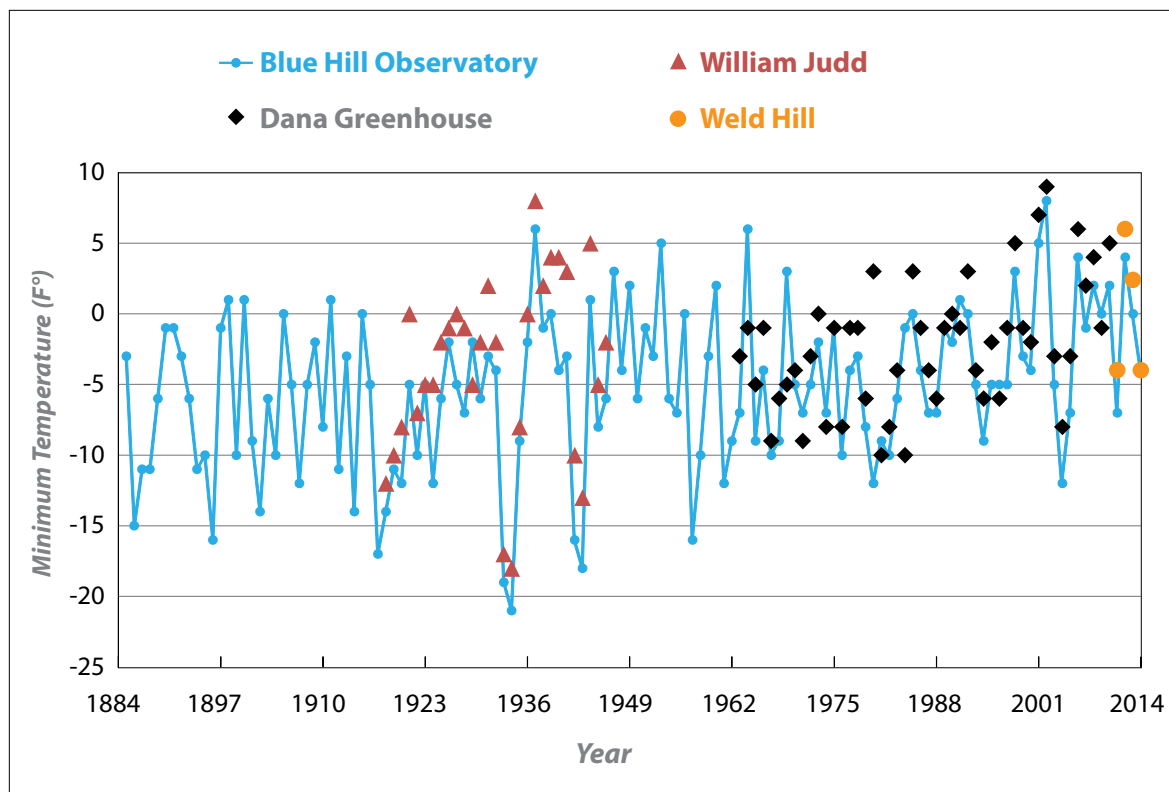


Over almost a century the Arboretum has acquired temperature data from three permanent stations (William Judd's measurements at the former Arboretum greenhouse [1918–1946]; the Dana Greenhouses; and the Weld Hill Research Building) as well as temporary stations set up by Hugh Raup (1934–1935) and, most recently, data loggers located throughout the grounds (2009–2014).

the Weld Hill Research Building, which, among other attributes, allows digital archiving of data and access via the web.

Although there is a 17-year gap between the end of the Judd period and the beginning of data collection at the Dana Greenhouses, the long-term collection has yielded volumes of information. One notable finding is the dramatic variability over time in the extreme minimum temperature events. The figure below depicts the temperatures from three Arboretum weather stations; I also included the annual minimum temperatures recorded at the Blue Hill Observatory (elevation 635 feet [194 meters]) in Milton, Massachusetts, some 8 miles south of the Arboretum. (Blue Hill Observatory has been collecting weather data since 1885 and is the oldest continuously operating weather observatory in the United States.) At the Arboretum, annual minimum temperatures have, by and large, stayed within

the USDA Zone 6 range. However, there have been notable exceptions, including the bitter winters of 1933 and 1934 when Judd noted the thermometer hitting  $-17$  and  $-18^{\circ}\text{F}$  ( $-27.2$  and  $-27.8^{\circ}\text{C}$ ), respectively. These were clearly Zone 5 ( $-20$  to  $-10^{\circ}\text{F}$  [ $-28.9$  to  $-23.3^{\circ}\text{C}$ ]) winters, and the Arboretum documented the death of plants that could not tolerate that extreme. It has been thirty years since the Arboretum experienced a Zone 5 winter, and it was borderline (the Dana Greenhouse thermometer measured  $-10^{\circ}\text{F}$ ). Since then, annual minimum temperatures have remained in the Zone 6 range, with a number of years experiencing even warmer minimums. Are these due to climate change, or urban heat island effect? Perhaps a combination of both. Do these trends place the Arboretum in a new hardiness zone? I do not believe so. Even if 9 out of 10, or even 19 out of 20 winters never creep below  $0^{\circ}\text{F}$  (i.e., are in the Zone 7 range), all it takes is one Zone 6 winter to elimi-



Annual minimum temperatures from the three permanent stations at the Arboretum, plus the annual minimum temperatures recorded since 1885 at the Blue Hill Observatory for comparison.



nate those plants unable to survive at those temperatures. It pays to be conservative when playing the hardiness game.

### Location, Location, Location

In examining nearly a century of annual variation in minimum temperature at the Arboretum, one must bear in mind that those data were obtained from three separate and distinct locations, each with its own elevation and proximity to buffering buildings or canopies, as well as differences in aspect. And although we know

that the present Weld Hill and Dana Greenhouse stations are sufficiently far away from buildings not to be influenced by them, we are not exactly sure where Judd's station was—it may have been somewhat protected. The Arboretum landscape comprises some 281 acres, with elevations that range from 44 feet (13.4 meters) above sea level in the Meadow by the Hunnewell Building to 240 feet (73.2 meters) on the summit of Peters Hill. Peters, Hemlock, and Bussey Hills each have their own character and microclimates distinct from surrounding areas.

mean for Jan 29.66				mean for Feb. 17.62			
1934	max	min		1934	max	min	
	56°	-2°	30		49°	-18°	22°
Jan 8.	par cloudy fair.	36.	47.	Jan 29.	very cold wind par cloudy	0	7.
9.	" " "	34	45.	30	" " "	-2	13.
10	" " " "	34	44.	31	par cloudy warmer	0	30
11	clear fair	32	42	Feb 1	cloud. snow for 8 1/2"	24.	38
12	par cloudy.	29	46	2.	clear cold.	26	31.
13	cloudy rain	34	40	3	" "	4.	23.
off 14	fair cloudy	30	42	on s 4	cloudy snow.	5	28
15.	par cloudy. cold.	18	28.	5	par cloudy cold.	7	22
16.	" " fair.	19	45.	6	clear	3	16.
17	" " cold	21	28	7.	par cloudy. fair.	-2	27.
18.	clear	6	20.	8	clear cold.	0	12
19.	par cloudy	12	40	9	" " "	-18.	4.
20.	cloudy.	18	34	10	" " warmer	-3.	28
on s 21	par cloudy.	17	29	off s 11	par cloudy " "	13	38
22	" "	12	38.	12	clear. fair.	21	45
23	cloudy. rain.	32	49.	13.	snow on par cloudy cold for	29	39.
24	par cloudy.	25	35.	14	clear all day	-4	20
25.	" " warm.	28	56.	15.	par cloudy clear warm	14	44
26.	" " fair.	28	34	16	" " cold.	2	18
27	cloudy. light rains	22	39	17.	snow light early clearing.	10	25.
off 28	" " " "	39	52	on s 18	clear. fair.	9	38

William Judd recorded daily weather notes, including maximum and minimum temperatures, from 1918 through 1946. The entry for February 9, 1934, (about half way down on the right) shows an extremely cold reading of -18°F.

ARCHIVES OF THE ARNOLD ARBORETUM



(Above) William Judd, longtime plant propagator at the Arboretum, working on cuttings in the former greenhouse (undated photo, probably from the 1930s).

HARVARD FOREST, HARVARD UNIVERSITY



(Left) Plant ecologist Hugh Raup had a long career at Harvard University, including serving as a research associate at the Arboretum and later as director of Harvard Forest.

These microclimates have been studied in the past, and also more recently. During the winter of 1934–1935, plant ecologist Hugh Raup conducted a study to document variation in minimum temperature, no doubt inspired by the bitter winters in the previous two years. As summarized by Al Fordham (1970), Raup set up eight stations across the Arboretum, with each station comprising a minimum-maximum thermometer. He then visited each station twice a day to record the maximum and minimum temperature that occurred for each site (one station on Peters Hill was stolen a month into the study, leaving us with data from just seven stations).

Even though this experiment lasted for only one winter and did not examine all of the undulations in topography, it confirmed the presence of a range of microclimates. According to Raup's measurements, the coldest temperatures for the winter occurred on January 28, 1935, a calm evening with no cloud cover that led to radiational cooling. During radiational



cooling, warm air is lost to the atmosphere and cools. This forms a temperature inversion, where the denser, colder air then settles into the exposed areas at the lower elevations, creating what are often referred to as frost pockets. On this evening, the average minimum temperature of Raup's seven stations was  $-18.6^{\circ}\text{F}$  ( $-28.1^{\circ}\text{C}$ ), yet the range extended from a high of  $-7.5^{\circ}\text{F}$  ( $-21.9^{\circ}\text{C}$ ) near the former greenhouse located at the Bussey Institution (now the site of the Massachusetts State Lab) to a low of  $-26^{\circ}\text{F}$  ( $-32.2^{\circ}\text{C}$ ) in the shrub collection (now the home of the Bradley Rosaceous Collection). The flat area south of the Bussey Hill summit (now called the Explorers Garden) experienced a minimum temperature of  $-16.9^{\circ}\text{F}$  ( $-27.2^{\circ}\text{C}$ ).

### Finding Frost Pockets

Not long after I rejoined the Arboretum staff as Curator of Living Collections in 2007, I decided to repeat Raup's experiment using more modern technology and a greater number of stations. The goal was to again identify and confirm frost pockets as well as protected spots that the Arboretum might not be aware of. For instance, the Explorers Garden has long been exploited as a protected site, particularly the area along Chinese Path on the southwestern side where most of the plants in that collection have been grown. During radiational cooling, the dense cold air settles into the valley between Bussey and Hemlock Hills, leaving this area warmer. I was curious to know to what extent other areas of Bussey Hill—perhaps the eastern side—have the same moderating characteristics. This was particularly important to document because the Arboretum is running out of planting space in the crowded Explorers Garden. It would be wonderful to exploit other regions of Bussey Hill as well as other areas of the Arboretum for their moderating characteristics.

To achieve this task, I purchased some data loggers (Hobo U23 - Pro V2), small micro-meteorological stations that were programmed to record the temperature at 15-minute intervals. Each logger was enclosed in a plastic solar radiation shield, which ensured that the loggers would accurately record the air temperature and not heat up artificially on bright sunny days. The shields also kept out precipitation. The

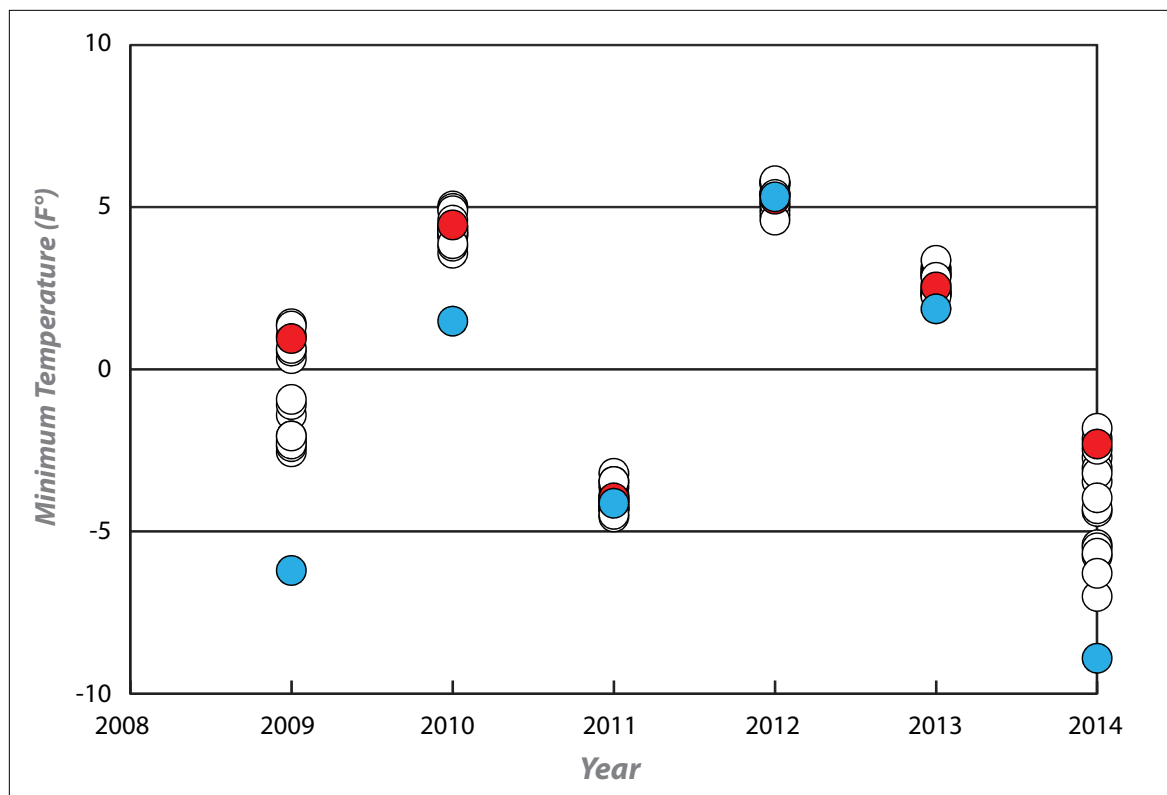


MICHAEL S. DOSMANN

Curatorial assistant Jonathan Damery checks one of the data loggers that collect weather information throughout the Arboretum.

entire apparatus would normally be mounted to a post or a building just a few feet off the ground. However, I was a bit concerned that the loggers might suffer vandalism, like Raup's Peters Hill thermometer, particularly after many years. Thus we hung the loggers from tree branches about 10 feet (3 meters) from the ground using herbarium press straps and pieces of PVC pipe, effectively keeping the units out of the reach of curious passersby.

The loggers were deployed at 18 separate stations across the landscape (see map on page 3). Most of Raup's station descriptions were sufficient to identify the general area where they were located. New loggers were placed in the general vicinity for seven of Raup's sites; the one at the former Bussey Institution was not used because it is no longer part of the Harvard University enterprise. The remaining 11 stations were chosen for comparative purposes. For example, the station to the south of



Annual minimum temperatures recorded for the winters of 2008–2009 through 2013–2014 at 18 monitoring stations across the Arboretum landscape. For readability, the individual stations are unlabeled; however, based on the 6-year average, the coldest (Bradley Rosaceous Collection) is shown in blue, and warmest (middle of Hemlock Hill) is shown in red. Cold-weather events of 2009, 2010, and 2014 are indicative of radiational cooling and the development of frost pockets, which led to great variation among stations.

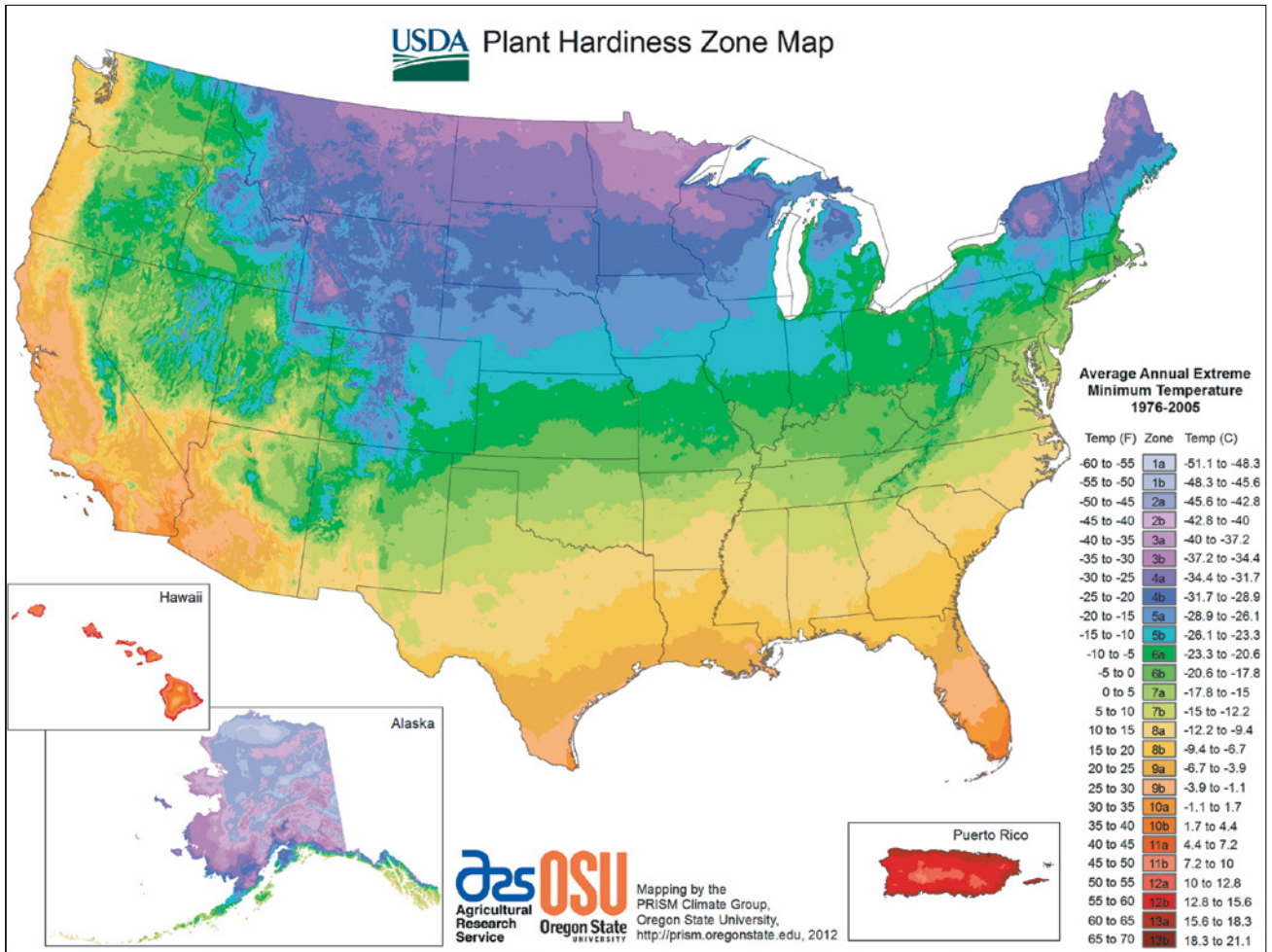
the Hunnewell Visitor Center was paired with one behind the building, to assess the degree to which this site was protected. Raup had only one station on Hemlock Hill, at mid-elevation; we added stations at the summit and the bottom of the hill, in an east-west transect, as well as one in Rhododendron Dell, which lies in the valley between Hemlock and Bussey Hills. And to capture the possible variations in different exposures on Bussey Hill, loggers were placed on its summit and the edges of the Explorers Garden.

Curatorial staff visited each logger in spring to download the data from the previous winter and to provide some routine maintenance. The loggers performed quite well, with just a few anomalies. We are missing data for three separate loggers (one for one year, and two for another) when they stopped recording midway through winter. And on occasion there would be an aberrant spike or drop in temperature, much

different from the readings 15 minutes before and after, so each logger's data were reviewed for consistency and the outliers tossed out. What I report upon here is just the minimum temperature recorded for each logger each year.

Although these data only refer to the previous six years and should be interpreted with caution, a few notable and fascinating trends cropped up (see figure above). To begin with, not just is there year-to-year variation in minimum temperature (which is obvious to anyone who has lived in New England!), but notice the variation among stations within a given year. In years 2009 and 2014, the absolute differences between the warmest and coldest stations were respectively 7.6 and 7.1°F (4.2 and 3.9°C)—a considerable spread, one that even spans multiple hardiness zones in 2009. In these events, the Arboretum experienced radiational cooling; the stations at higher elevations and in protected sites were warmer while those in the bottoms





of bowls—the frost pockets—had cold, dense air. Yet in other years, such as 2011–2013, the station minimum temperatures were all clustered together with only minor variation. Those years' coldest events occurred at times with ample cloud cover that prevented heat from escaping to the atmosphere, and perhaps windy conditions that ensured mixing of the air.

And, just where are these microclimates? Consistently, as it was in Raup's time, the Bradley Rosaceous Collection is the dependable frost pocket (note blue dots on page 8 figure). Cold air sinks down from the surrounding hills into this flat, low area. Across all years, the average warmest station was again the one sited on the middle of Hemlock Hill (note red dots on page 8 figure). However, numerous other stations in the Arboretum experienced rather similar temperatures year-in and year-out, and

there was always another station warmer than the Hemlock Hill spot, so it is difficult to identify the most buffered microclimate. Other sites with moderated minimum temperatures are those clustered around the Bussey Hill summit and Explorers Garden (demonstrating that there is plenty of space to grow tender material), the area behind the Hunnewell Visitor Center (where we have already started to site a few tender plants), the summit of Peters Hill, the Centre Street beds, and the remaining two Hemlock Hill stations. It is worth noting that even if these stations have average minimum temperatures that place them within Zone 7, *all* stations in the Arboretum experienced Zone 6 minimum temperatures in 2011, as well as in 2014. Besides the Bradley Rosaceous Collection, what other frost pockets exist? The Juniper Collection, Rhododendron Dell, and the

open area southwest of the Hunnewell Visitor Center all have average annual minimum temperatures that place them in Zone 6.

### Continuing Weather Data Collection

While it is tempting to draw major conclusions on six years of data, I'm not ready to create a new hardiness zone map of the Arboretum

landscape just yet! The current USDA Hardiness Zone map relies on 30 years of thorough documentation; its 1990 predecessor used only 13 years of data and was deemed unreliable. So, perhaps after another 20 years of recording temperatures in the landscape, I'll feel more confident in creating such a map. Speaking of the future, we are looking into better technology

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## Right Plant, Right Place

The interplay between plant hardiness and microclimates has been well documented at the Arboretum. For example, many of the young cedars-of-Lebanon (*Cedrus libani*) grown from seeds collected in Turkey at the turn of the previous century were sited in a grove on Bussey Hill. Because the plants' hardiness was unknown, planting in this protected site provided some insurance in case the trees failed to survive elsewhere on the grounds. They grew with vigor, and this provenance proved to be fully hardy throughout the Arboretum and even in colder regions of North America. Other successes, like that of *Franklinia alatamaha*, were attributable to both site selection and keen horticultural practice (Del Tredici 2005). Not only was Bussey Hill the sweet spot for cultivation of this rarity, but the Franklin trees were also covered in mulch during the initial winters to ensure survival. Among recent accomplishments, the Arboretum has been able to successfully cultivate wintersweet (*Chimonanthus praecox*), generally known as a solid Zone 7 plant. In 2007, accession 236-98-A was finally planted in the Explorers Garden, and in March of 2010 it produced over a dozen cheerful yellow flowers. In 2012, a milder year, the fragrant flowers started to bloom in the middle of January and lasted for well over a month (for more see Yih 2014).

One thing to note is the difference between a plant's survival and actual performance. The ideal at the Arboretum is not just to grow plants that survive but that are healthy enough to reach mature size, or at least sexual maturity to produce flowers and fruits for study and enjoyment. A great example of this is *Stachyurus praecox*, which requires a favorable microclimate to perform best in New England. Although the species is able to survive—with occasional dieback—throughout the Arboretum, the flowers, which appear in very early spring, are particularly susceptible to low temperature damage. Thus, the plants growing in the Explorers Garden not only survive but consistently produce their unique pendent racemes of flowers.

LEFT TO RIGHT: KYLE PORT, MICHAEL S. DOSMANN, NANCY ROSE



*Stachyurus praecox*



*Chimonanthus praecox*



*Franklinia alatamaha*

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The weather station at the Dana Greenhouses, photographed by Arboretum plant propagator Al Fordham in the summer of 1969 (left), and the current state-of-the-art weather station located at the Weld Hill Research Building (right).



for data collection. This season we are experimenting with a new set of loggers. The originals, while excellent in some respects, were nearing the end of their lifespan and required too much additional care; we have retired them. As part of her research, Arboretum Putnam Fellow Ailene Ettinger deployed a new set of loggers across an even wider swath of the landscape. These pendent loggers (Hobo 8K-UA-002-08) are less intrusive in the landscape, easier to access and maintain, and are collecting temperature data at similar intervals.

As I hope this article has demonstrated, a single landscape like the Arboretum's is marvelously variable. The year-to-year variation in elements such as temperature can be quite significant, particularly when compared across the Arboretum's unique nooks and crannies. I not only find this fascinating as a scientist, but as a dedicated horticulturist I am excited that ongoing data collection and analysis will allow us to best match the plants curated in the Arboretum with their optimum locations.

#### Acknowledgements

The deployment and maintenance of the data loggers and subsequent data wrangling have been no small task, and I wish to call attention to the many who have assisted in

the venture over the years. Erik Youngerman, Sue Pfeiffer, Abby Hird, Jonathan Damery, Sam Schmerler, Stephanie Stuber, Joyce Chery, and Kyle Port did a lot of the heavy lifting out in the landscape with the loggers and data. Jordan Wood created the wonderful map integrating the old and new stations. Will Buchanan spent countless hours in the library putting the Raup and Judd data into spreadsheet form. Lastly, Mike Iacono not only provided data from the Blue Hill Observatory but also gave valuable comments on an earlier draft of this article.

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

# 2014 Weather Summary

*Sue A. Pfeiffer*

KYLE FORT



Horticultural Technologist Dennis Harris worked on clearing Meadow Road while intrepid visitors enjoyed the snowfall on February 5th.

**JANUARY** started out cold and quite snowy. The first winter storm on the 2nd and 3rd delivered 15 inches of fluffy snow while the temperature dipped to -4°F, which turned out to be the coldest reading for the entire year. Temperatures rose thereafter, melting the snow within days. A front moved in on the 11th, bringing downpours and unseasonably warm temperatures in the 50s that lasted for three days—a welcome surprise. Temperatures remained above freezing over the following week; three additional storms passed through over this period but because of the warm temperatures all precipitation fell as rain. A small storm on the 21st and 22nd left 5 inches of snow on the ground which, despite the mostly cold temperatures, had melted away by the end of the month. Wind speeds reached 16 mph with gusts as high as 38 mph on the 25th; fortunately there was no significant damage to Arboretum plants. Overall, January was cooler than normal and total precipitation was slightly above average.

**FEBRUARY** began with sunny and warm conditions. A storm passed through on the 4th and 5th dropping a foot of snow, which remained on the ground until mid-March. A cold front arrived following the storm, bringing a week of cold tem-

peratures with highs in the 20s and lows in the teens and single digits. Seasonal temperatures returned on the 13th, and in the following week an additional foot of snow fell. Frigid temperatures returned and we finished out the month with lows in the single digits once again. The cold trend continued and the average high for the month fell four degrees below the historical average.

**MARCH** brought a continuation of the cold pattern with lows in the single digits during the first week. The first signs of spring were evident on the 8th as temperatures warmed to the mid 50s, greatly melting the snow cover and reducing the icy, hard-crusted remnants of plowed snow. As the snow cover retreated, rabbit damage was visible on many shrubs. Precipitation during the month was scarce; we received two rainfall events on the 12th and 13th and on the 20th, amounting to less than an inch cumulatively. As temperatures warmed, the snow and ice continued to melt; by the 23rd, three days after the spring equinox, bare ground was visible as the snow cover had completely melted. A couple of cold and windy fronts moved in on the 22nd and 26th, both with average wind speeds of 16 mph and gusts reaching 36 mph, making it feel even colder. A storm arrived on the 29th bringing two days of consistent rain followed by a combination of rain, sleet, and hail as the storm lingered into the 31st. Over three inches of rain fell, making up for the lack of precipitation earlier in the month. It felt as if spring was right around the corner as spring ephemerals popped up from the warming soil. Despite rising temperatures, the month as a whole turned out to be colder than the historical average; both the average high and average low temperatures were 5°F colder.

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**GROWING DEGREE DAYS (GDD) measure heat accumulation and are calculated by subtracting a base temperature (50°F is the standard we use) from the day's average temperature (maximum temperature + minimum temperature, divided by 2). For example, if the day's high temperature was 70°F and the low was 50°F, the average temperature was 60°F, and subtracting the base (50°F) from the average results in 10 GDD. Growing degree days are cumulative (if a day's average temperature is 50°F or below, no GDD accrue). Keeping track of GDD is an important tool for determining the expected emergence of insect pests (for example, gypsy moth eggs hatch when 90 to 100 GDD have accumulated), which allows for well-timed control efforts when needed.**

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**APRIL** saw seasonal temperatures with lower than average precipitation. We started the month with temperatures in the high 40s and 50s. A storm arrived and dropped half an inch of rain during the 4th and 5th. Temperatures continued to warm slowly to the high 50s and mid 60s as a second storm passed through on the 8th and 9th, delivering over an inch of rain. Rising temperatures associated with the storm lead to our first accumulation of growing degree days on the 8th. Temperatures continued to rise into the 70s as the third storm of the month arrived. As the storm passed over on the 14th and 15th, strong wind gusts were recorded; a 43.6 mph gust on the 15th proved to be the highest of the year. Rain was followed by sleet and a dusting of snow on the 16th, accumulating over an inch of precipitation. Despite the high winds, there was only minor storm damage to the collection. The latter half of the month saw typical temperature fluctuations and an additional six small storms, accumulating over 3/4 of an inch. The last frost





Ninety-six days later: the Lilac Collection on February 7th and May 14th.

date was recorded on April 21st, marking the beginning of the growing season. The month ended with five days of below seasonal temperatures, with highs mostly in the 40s, resulting in frost damage to some early flowering magnolias.

**MAY** was an average month for both precipitation and temperature. The first storm on May 1st dropped over an inch of rain and was followed by a week of temperatures in the 60s; spring had finally arrived. These temperatures were welcome and necessary for plant development; the effects of the harsh winter were becoming more evident as we waited for buds to break and leaves to emerge. We experienced summer-like conditions over Mother's Day weekend when temperatures soared into the high 80s. Despite these warm conditions, only the early lilacs had started to bloom by Lilac Sunday (May 11th), while the common lilacs were still in bud. Half way through the month, some plants had yet to break bud despite the recent favorable conditions. A second storm passed through on the 16th and 17th, providing nearly an inch of rain. The remainder of the month saw cooler temperatures and typical spring weather fluctuations along with regular precipitation—rain fell on 10 out of the 15 days. A storm on the 27th brought torrential downpours in the evening, depositing 0.41 inches of rain within half an hour. We finished the month with cooler temperatures—May 28th and 29th were so cold that we did not accumulate any growing degree days.

**JUNE** was somewhat cooler and drier than average. The month started with temperatures in the 80s before a couple of storms passed through on the 4th and 5th, delivering close to an inch of rain combined as temperatures dropped into the 60s. Temperatures warmed again into the 80s until the next storm passed through on the evening of the 10th, again dropping temperatures into the 60s for three days. Warm weather returned through the end of the month with only an additional 2/3 inch of rain. Warm, sunny conditions prevailed through much of the month. The extent of fire blight infection became evident as damage became visible throughout the collection.

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## Ups and Downs

Significant temperature fluctuations can affect many natural processes, and we saw several examples in May 2014. This was an explosive year for fire blight (*Erwinia amylovora*), a bacterial disease that affects apples (*Malus*), pears (*Pyrus*), and a number of other rose family genera including mountain ash (*Sorbus*), hawthorn (*Crataegus*), firethorn (*Pyracantha*), and flowering quince (*Chaenomeles*). The warmer temperatures experienced early in the month followed by cooler conditions with regular rain provided ideal conditions for fire blight bacteria to spread throughout the collection. We also witnessed a substantial fish kill in Dawson Pond (the largest of our three ponds) over the Memorial Day weekend. This common natural event, observed across the region, was attributed to low oxygen levels in the water caused by temperature fluctuations.

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**JULY** was characterized by heat, humidity, and torrential downpours. We experienced several consecutive days of hot and humid weather, with the hottest day of the year (94°F) on the 3rd. Summer had arrived! This heat was quelled by a downpour on the 3rd that resulted in a few downed tree limbs. Hurricane Arthur arrived on the 4th, delivering a day filled with blowing rain (a total of 2.6 inches fell) and consistent wind. Fortunately there was minimal damage to the collection. A windy system passed through overnight on the 7th, leaving behind some fallen limbs. Temperatures remained seasonal for the remainder of the month. A couple of storms arrived on the 14th and 16th bringing soaking rains; rainfall rates of approximately half an inch of rain over 30-minute periods were recorded during each storm. Thunderstorms returned on the 27th and 28th, the latter pummeling



KYLE FORT

Goldsmith Brook overflowed its banks and flooded the north end of Willow Path during heavy downpours on July 28th.



the earth with over an inch of rain in a 20-minute period and leaving gravel and dirt roads completely washed out and mulch rivers emanating from planting beds. By the end of the month, despite four torrential downpours, two windstorms, and Hurricane Arthur, the Arboretum collection was relatively unscathed, a testament to the resilience of the well-maintained collection.

**AUGUST** was dry and 2 degrees cooler than average. The first 12 days of the month were quite comfortable with temperatures mostly in the 80s. A system moved through on the 13th, bringing an all-day rain that soaked the ground with 1.35 inches of rain. Temperatures cooled and remained comfortably in the 70s until the 25th. Heat returned for several days as we reached highs in the 90s on the 26th and 27th. Rain continued to be sparse throughout the month and the soil was only moderately moist. A second rainfall was recorded on the 31st, dropping 1/3 inch of rain and adding much-needed moisture to the landscape where plants had begun showing signs of water stress.

**SEPTEMBER** continued as August ended, the feeling of fall was in the air and rain was nowhere to be found. The month started out very warm as temperatures hit the 90s on three occasions over the first five days before returning to seasonal levels. We received small amounts of precipitation on four occasions throughout the month, none totaling more than 0.15 inches. The weather was perfect for vacations but the plants were suffering from lack of moisture. Additional irrigation was provided throughout the entire month; we had received only 0.39 inches



High-volume irrigators were used in the collections during what turned out to be the driest September on record.



of rain, officially making it the driest September since climate records began. These drought conditions, combined with the low rainfall amounts during late August, translated to accumulations of only 0.83 inches over a six-week period. The effects of this drought were apparent throughout the landscape; soils were extremely dry and the air was very dusty. Two of the Arboretum ponds almost dried up completely. Most plants showed some signs

of drought stress and severe stress was obvious on many plants. Leaves were flagging, some turning brown; many plants had already formed their winter buds and appeared to go dormant early. Because of these continued dry conditions, fall planting was postponed until the following spring. Despite all this, fall leaf color on maples (*Acer*), cork trees (*Phellodendron*), and birches (*Betula*) was exceptional throughout the landscape.



KYLE FORT

A garter snake (*Thamnophis sirtalis*), the state reptile of Massachusetts, navigated through fallen leaves in mid-October.

**OCTOBER** was a warm and wet month. We started out with some much-needed precipitation from a storm that passed through on the 1st and 2nd, delivering well over an inch of rain. Sunny skies were prevalent as temperatures remained above average. A warm front moved through mid-month and we hit a high in the 80s on the 15th before temperatures returned to seasonal averages. The first nor'easter of the season arrived on the morning of the 22nd, bringing with it a welcome rain. As the storm intensified overnight, torrential downpours and high winds prevailed; recorded gusts peaked at 41 mph. A microburst (a small but intense downdraft of air) in the Centre Street Gate vicinity resulted in the complete loss of two accessions—a black hickory (*Carya texana*, accession 12892-A) along with a centenarian pin oak (*Quercus palustris*, accession 22896-E) were completely uprooted and broken below the base. Rain continued to fall until the 24th, delivering over three inches of precipitation. Other than the loss of the two large trees and damage to several nearby plants, the impact on the collection was minor with just some smaller branches down. Rain accumulation for the month was more than double that of the months of August and September combined!

**NOVEMBER** began with a nor'easter on the 1st and 2nd; wind gusts reached 35 mph and we recorded an additional 3/4 of an inch of precipitation equivalence which included a few hours of snow flurries on the 2nd. The snow created a beautiful juxtaposition in the landscape, but this did not last long as temperatures quickly warmed into the 60s. The growing season came to an end on November 10th when the first frost was recorded, ending the growing season at 202 days, the

## Arnold Arboretum Weather Station Data • 2014

	Avg. Max. (°F)	Avg. Min. (°F)	Avg. Temp. (°F)	Max. Temp. (°F)	Min. Temp. (°F)	Precipi- tation (inches)	Snow- fall (inches)
JAN	34.5	17.8	26.1	58.8	-4.0	3.98	20.0
FEB	35.5	19.1	27.3	54.4	5.1	3.35	24.0
MAR	41.6	23.3	32.5	58.5	6.9	4.19	
APR	57.0	38.3	47.7	75.2	28.9	3.26	
MAY	68.0	49.0	58.5	85.7	37.8	3.14	
JUN	78.1	56.5	67.3	88.8	44.6	2.51	
JUL	82.6	64.0	73.3	93.5	56.9	6.00	
AUG	79.6	59.1	69.4	90.2	51.0	1.83	
SEP	75.1	54.1	64.6	92.9	37.3	0.39	
OCT	64.0	46.5	55.3	81.4	33.4	5.51	
NOV	49.5	32.2	40.9	66.9	17.6	5.26	1.5
DEC	43.1	30.7	36.9	63.3	12.7	6.97	

Average Maximum Temperature . . . . . 59.1°F

Average Minimum Temperature . . . . . 40.9°F

Average Temperature . . . . . 50.0°F

Total Precipitation . . . . . 46.39 inches

Total Snowfall in 2014 . . . . . 45.5 inches

Snowfall During Winter 2013–2014 . . . . . 57.0 inches

Warmest Temperature . . . . . 93.5°F on July 3

Coldest Temperature . . . . . -4.0°F on January 4

Strongest Wind Gust . . . . . 43.6 mph on April 15

Last Frost Date . . . . . 32.0°F on April 21

First Frost Date . . . . . 32.0°F on November 10

Growing Season . . . . . 202 days

Growing Degree Days . . . . . 2815.0 days



SUE A. PFEIFFER

**Heavy rain in early December resulted in mulch washouts, especially on slopes like this one in the Lilac Collection.**

longest we have seen in over 7 years. Mid-November saw overnight temperatures dip well below freezing; this combined with rain and wind resulted in many trees dropping the remainder of their leaves, bringing an end to fall color. Another significant rainfall was recorded on the 17th, bringing over an inch and a half of rain. The last week of the month was very moist; we received 3 rain/snow events accounting for almost 2 inches of precipitation equivalence. Overall, November was a wet and cool month; average temperatures were 2 degrees below normal and accumulated precipitation exceeded five inches.

**DECEMBER** was a very wet and warm month; temperatures were 4 degrees above average and rainfall was abundant for the third month in a row. High temperatures during the first week fluctuated between the mid 30s and lower 60s with three storms depositing a total of almost two inches of rain. The next storm hit on the 9th, bringing wind gusts of over 40 mph and sustained winds at 18 mph—the highest recorded for the year. An additional three inches of rain fell, bringing the 10-day total to more than 5 inches. All of this rain left eroded gullies in gravel pathways and mulch washouts from planting beds, especially those in the lilacs. The rain subsided temporarily and temperatures remained above seasonal averages, allowing the grounds crew to accomplish much pruning and mulching. We recorded four additional rain events before we hit a high in the 60s on the 25th. These temperatures would not last as we ended the year with highs just below freezing. Little did we know what lay in store for the rest of the winter as we moved into 2015.

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Sue A. Pfeiffer is an Arboretum Horticulturist at the Arnold Arboretum.



# Hamamelidaceae, Part 2: Exploring the Witch-hazel Relatives of the Arnold Arboretum

Andrew Gajowski

In “Hamamelidaceae, Part 1” we looked at just one genus, *Hamamelis*, in the witch-hazel family. In Part 2, we’ll study the other representatives of the family that are present in the Arnold Arboretum. It’s helpful to start by looking at the evolutionary relationships among the genera in Hamamelidaceae. As mentioned in Part 1, witch-hazel (*Hamamelis*) displays showy flowers, each with four straplike petals. Several other genera within the family also have four-petaled flowers but they are found in warmer regions of the world and are not represented in the Arboretum, except for a lone specimen of *Loropetalum* (see page 26). In the past, these four-petaled genera were thought to be closely related on the family tree but recent DNA work is proving otherwise (Li and Bogle 2001). For example, when looking at the

very similar appearing flowers of *Hamamelis* and *Loropetalum* it’s easy to think they must be closely related (at one time both were included in the same genus), but in fact they are distant relatives found on separate branches of the family tree. The closest relatives of *Hamamelis* actually include genera such as *Fothergilla*, *Parrotiopsis*, and *Parrotia* (Li and Bogle 2001). Furthermore, the more advanced genera on each branch of the tree are those that have lost their showy, insect-attracting petals altogether, which is seen as an evolutionary shift from insect to wind pollination (Figure 1) (Li and Del Tredici 2008; Li et al. 1999). Among these aforementioned genera, *Hamamelis* is the oldest in evolutionary terms and is insect pollinated; *Fothergilla* and *Parrotiopsis* appear to represent an intermediate state in the transitional period and likely have both insect and wind pollination; and *Parrotia*, the most advanced, relies mainly on wind for pollination. Similar transitions take place on the other branches of the tree as well. We pick up here with the historical, taxonomic, and horticultural stories of the rest of the witch-hazel family starting with the closest relatives of *Hamamelis*.

## Fothergilla

*Fothergilla Gardenii* was introduced into English gardens one hundred and thirty years ago [1765], and judging by the number of figures that were published of it in Europe toward the end of the last and at the beginning of the present century, it must at that time have been a well-known and favorite inhabitant of gardens from which it has now almost entirely disappeared, in spite of the fact that few shrubs present a more curious and beautiful effect than *Fothergilla* when it is covered with flowers. Its habit is excellent, too, and its foliage is abundant and rich in color.

C. S. Sargent, *Garden and Forest*, 1895



The flowers of *Loropetalum* look very similar to those of *Hamamelis*, but the two genera are not closely related within the witch-hazel family. This is a flower of *L. chinense* on the Arboretum’s sole specimen (see page 26).

Beyond the witch-hazels (*Hamamelis*), the genus *Fothergilla* is perhaps the second most recognizable and utilized member of the witch-hazel family among gardeners. It is also the genus most closely related to *Hamamelis*. An exclusively North American genus, *Fothergilla* consists of two species, *F. gardenii* and *F. major*, both of which grow natively in the southeastern United States. Despite the favorable assessment of its ornamental traits by Sargent and others through the years, *Fothergilla* still remains underutilized, though new cultivar introductions as well as recent mentions in trade and popular publications are helping the cause (Darke 2008; Dirr 2009). Like its Ozarks relative, vernal witch-hazel (*Hamamelis vernalis*), the fothergillas carry with them winter hardiness well beyond their native range. They grow successfully at the Arnold Arboretum (USDA Hardiness Zone 6, -10 to 0°F [-23.3 to -17.8°C]) and even colder areas.

The flowers of *Fothergilla* are apetalous (lack petals) but are far from inconspicuous. The sweetly scented, bottle-brush-like inflorescences—composed of many individual flowers clustered together—appear in May in New England, with full bloom occurring just as the

leaves begin to emerge, *F. gardenii* typically slightly ahead of *F. major*. Lacking petals, the species' insect pollinators are attracted to the creamy white coloration of the flowers' enlarged stamens, tipped with yellow, pollen-bearing anthers. The fall foliage color of the genus is second to none. Typically the plant transitions from its clean, dark green to bluish green summer foliage to an array of yellow, orange, and red shades in autumn. Given these attributes, it's surprising that fothergilla isn't more widely planted, though the lack of a catchy and recognizable common name may have limited the marketability of the plant in the nursery industry. Anderson and Judd (1933) note, "Fortunate, indeed, are those plants whose common names are attractive and imaginative ... Lacking such a name, the Fothergillas have made their way slowly into public favor."

*Fothergilla gardenii*, commonly called dwarf fothergilla, is native to the moist coastal plain from North Carolina to Georgia and also the Florida panhandle along the Gulf Coast. The plant typically grows only 2 to 3 feet (.6 to .9 meters) tall and spreads slowly by underground stems, making it an ideal size for smaller landscapes. Although its native range falls within

(Figure 1) An example of the evolutionary transition from insect pollination (*Hamamelis*) to more advanced wind pollination (*Parrotia*) within the witch-hazel family. The sweetly-scented flowers of Chinese witch-hazel (*Hamamelis mollis*) have showy petals and freely exposed nectaries and stigmas to support insect pollination, while the flowers of Persian parrotia (*Parrotia persica*) are apetalous and have large, elongated anthers common to wind-pollinated species (Endress 1993).



NANCY ROSE



MICHAEL DOSMANN



PIETER B. PELSER, PHYTOIMAGES, SIU EDU



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*Hamamelis* →

*Fothergilla* →

*Parrotiopsis* →

*Parrotia* →

Insect pollination

Secondary-insect pollination

Secondary-insect pollination

Mainly wind pollination

Showy petals

Lacks petals, but other showy flower parts present

Lacks petals, but other showy flower parts present (petal-like bracts appear below the inflorescence)

Apetalous, with large anthers and stigmas and powdery pollen



The bottle-brush-like blooms of large fothergilla (*Fothergilla major*) are sweetly fragrant.

USDA Plant Hardiness Zones 8a to 9a, it can be grown successfully through Zone 5. The Arboretum's most interesting individual of the species, accession 681-88-A, was originally wild collected near Jesup, Georgia, by Harold Epstein, renowned New York plantsman. The specimen was much smaller than typical *F. gardenii*—only 12 to 15 inches tall and with proportionately smaller leaves and flowers. A rooted layer of the plant was sent to the Arboretum for evaluation in 1988, and in 2001, as part of our Plant Introduction, Promotion, and Distribution Program, it was released under the cultivar name *Fothergilla gardenii* 'Harold Epstein' (Bennett 2000). The original diminutive plant we received can still be seen in the Arboretum's Leventritt Shrub and Vine Garden.

Its cousin, *F. major*, commonly called large fothergilla or mountain witch-alder, grows upland from *F. gardenii* in the southern Appalachian Mountains from North Carolina and Tennessee to South Carolina, Georgia, and Alabama. A disjunct population is also found in Arkansas. Growing at higher elevations (and therefore in cooler conditions) and in leaner, drier soils, large fothergilla is hardier (to USDA Zone 4) and less finicky than dwarf fothergilla. Large fothergilla can reach upwards of 10 feet (3 meters) in height, forming a large mass over time. The Arboretum's finest specimen (694-34-A), accessioned in 1934, was found as a seedling growing at the base of the parent plant in the Arboretum. It was ultimately transplanted to a spot near the main gate along the Arborway, where it thrives today for all to enjoy. The 10- by 10-foot plant is consistently engulfed with blooms in the spring and displays magnificent fall color. Wild-collected representatives of the species can be found in the Leventritt Shrub and Vine Garden and on the summit of Bussey Hill and in the Explorers Garden.

Increasing interest in finding reliable native plants for home landscapes has boosted the popularity of fothergilla in recent years (Darke 2008). Another factor in raising fothergilla's profile is the recent introduction of new cultivars, particularly those that we now know are the result of hybridization between *F. major* and *F. gardenii*. In the Arboretum's propagation records, the earliest determination of a hybrid between the species is from 1980, made by Richard Weaver, the Arboretum's horticultural taxonomist and assistant curator at the time. As a graduate student at Duke University, Weaver had helped to settle the long-standing debate over the number of *Fothergilla* taxa (some authors had cited as many as four) by counting chromosome numbers and comparing morphological features of the species (Weaver 1969). Some of the samples he used for comparisons were from the Arboretum, and in his subsequent years working here Weaver continued his interest in *Fothergilla* and the rest of Hamamelidaceae (Weaver 1976; Weaver 1981).

The plants noted in 1980 as "*Fothergilla* hybrid—*F. major* × *F. gardenii*" were seedlings from a 1967 accession (709-67) received as open-





KYLE FORT

This splendid specimen of *Fothergilla major* (694-34-A) grows near the Arboretum's main gate.

pollinated *Fothergilla gardenii* seed from the Botanical Gardens of Villa Taranto in northern Italy. Several individuals appeared distinct from the others, leading to the hybrid notation. Later entries (1983) noted that in fact "Dr. Weaver counted chromosomes" to determine that the plants were hybrids between *gardenii* and *major*. Although no formal publication of the hybrid was made, Michael Dirr, following a year-long fellowship at the Arnold, notes in the 1983 revision of his *Manual of Woody Landscape Plants* that "The Arnold Arboretum has identified a hybrid between the two species which offers intermediate size and other characteristics. This could be a most valuable shrub for modern landscapes." Dirr's manual, well known for its cultivar descriptions, listed no cultivars for *Fothergilla* at the time—a testament to the lack of horticultural attention the genus had received (Dirr 1983).

Around the same time, selections of fothergilla noted for improved ornamental traits and adaptability began to enter the nursery trade, most identified as *F. gardenii* cultivars (Darke 2008). 'Mt. Airy', a 1988 Michael Dirr selection from a plant growing in Cincinnati's Mt. Airy Arboretum, was one of the first named fothergilla cultivars and is still perhaps the best known and most widely planted. The true identity of 'Mt. Airy' and other cultivars as either *gardenii* or *major* was certainly confusing, and in many cases the species names were used interchangeably in the horticulture industry. Research by Ranney and others (2007) finally determined, through cytometry, that the majority of cultivars available today, including 'Mt. Airy', are in fact hybrids between *gardenii* and *major*.

The hybrid was officially described and named *Fothergilla* × *intermedia* (Ranney et al. 2007).



The hybrid fothergilla cultivar 'Mt. Airy' has notable displays of spring flowers and bright fall color.

The increasing success of fothergilla in cultivation can be attributed to the hybrid's adaptability and hardiness—gained from *F. major*—and the landscape-friendly intermediate size, typically 4 to 5 feet (1.2 to 1.5 meters) tall. Within the Arboretum collections, fine specimens of *Fothergilla* × *intermedia* 'Mt. Airy' grow in the Leventritt Shrub and Vine Garden (429-2002- B and -D), along with several accessions near the summit of Bussey Hill.

### Ancestors from the Persian Empire

*Parrotia Jacquemontiana*. – This is now flowering for the first time in the arboretum at Kew. It differs from *Parrotia Persica* in having smaller flowers arranged in a conical head and surrounded by ovate petaloid whitish bracts nearly an inch long. The flowers are developed before the young leaves. When mature, the leaves are orbicular or obovate, distinctly toothed all around the edges, dull green, and they do not assume the bright colors in autumn so characteristic of Persian species. The former is a native of Kashmir at an elevation of from 5,000 to 9,000 feet, where it forms a Hazel-like bush, six to twelve feet high. Dr. Aitchison [Scottish surgeon and botanist known for his plant collecting in India and Afghanistan in the late 1800s] found it in abundance in Afghanistan in the interior

of the hills, forming much of the shrub jungle there. He says the long slender stems and pliant branches are used in wicker-work and for the handles of farm implements. As a garden plant it is not as valuable as *P. Persica*, which at Kew forms a beautiful shrub or small tree, bearing large glossy leaves all summer, which in autumn change to the richest hues of orange, red, brown and yellow.

C. S. Sargent, *Garden and Forest: Foreign Correspondence*. London Letter. 1896

The monotypic genus *Parrotiopsis*, containing only *P. jacquemontiana*, as it is known today, is the topic of Sargent's writing above. Originally named *Fothergilla involucrata* without being formally described, the species would later be reclassified as *Parrotia jacquemontiana*. In 1905, the plant was placed in its very own genus as *Parrotiopsis involucrata* because its floral characteristics were found to be distinct from both *Fothergilla* and *Parrotia*. Alfred Rehder, Arboretum taxonomist, revised the specific epithet to *jacquemontiana* in 1920. Splitting hairs, he justified the name change because *F. involucrata*, as it was originally called, was never published with a description and thus the specific epithet *involucrata* was invalid and "cannot stand" (Rehder 1920).





An illustration of *Parrotiopsis jacquemontiana* (known then as *Parrotia jacquemontiana*) from an issue of *Curtis's Botanical Magazine* published in 1896.





Foliage of a *Parrotiopsis jacquemontiana* specimen (656-75-A) growing at the Arboretum.

The taxonomists of the day were certainly not far off in their placement of *Parrotiopsis* with *Fothergilla* and then *Parrotia*. They are closely related on the family tree, with *Parrotiopsis* serving as the transitional link between the two other genera (Li and Bogle 2001). The most conspicuous difference in *Parrotiopsis* is the white floral bracts (modified leaves) that surround the conical cluster of flowers, which are apetalous but feature enlarged yellowish stamens, as is the case with both *Fothergilla* and *Parrotia*. These bracts are similar in function and appearance to those of flowering dogwood (*Cornus florida*), serving as a device to attract insect pollinators. The species is abundant in the northwestern Himalayan Mountains of India, Pakistan, and Afghanistan at elevations up to 9,000 feet (2,743 meters).

The Arboretum's best specimen of *Parrotiopsis jacquemontiana* (656-75-A) is located under the shade of the hickory (*Carya*) collection just off of Valley Road. Although a fascinating plant with modest horticultural merit as a large multi-stemmed shrub or small tree, it is rare in

cultivation but certainly deserving of a place in any plant collector's garden.

Its cousin, *Parrotia persica*, known as Persian parrotia or Persian ironwood, occurs on the mountain slopes of Iran at the southern end of the Caspian Sea. Unlike *Parrotiopsis*, *Parrotia persica* offers undoubtable ornamental value and environmental adaptability. An upright, often multi-trunked small tree, it is notable for its attractive foliage that develops excellent fall color and its multi-colored, jigsaw-puzzle-like bark (see Nicholson 1989 for more on the species). The oldest and largest specimen of *Parrotia persica* (2230-A) at the Arnold Arboretum

## A Lone *Loropetalum*

Chinese fringe-flower (*Loropetalum chinense*) is a shrub in the witch-hazel family that is commonly featured in southern landscapes (USDA Zones 7 to 9) but is not hardy outdoors at the Arboretum (USDA Zone 6). However, we do have a handsome penjing (the Chinese predecessor of Japanese bonsai) specimen of this species (accession 200-90) that is kept in a cool greenhouse over winter before moving to the dwarf potted plant pavilion for the warmer months.







ANDREW CAPINSKI

Views of the multi-trunked form and bark detail of *Parrotia persica* (2230-A), which was received in 1881 as a cutting from the Harvard Botanical Garden in Cambridge, Massachusetts.



MICHAEL DOSMANN

This handsome specimen of Persian parrotia was received as cultivar 'Pendula' (accession 629-87-A), though it has a spreading rather than weeping habit.





This specimen of *Parrotia subaequalis* (accession 304-2004-A) developed outstanding fall color in 2014.

(and possibly all of North America) grows in the Centre Street Beds adjacent to the hickories.

A second species of *Parrotia*, *P. subaequalis*, has recently been uncovered. The plant was originally described in 1960 as *Hamamelis subaequalis*, then in 1992 was placed within a newly proposed genus as *Shaniodendron subaequale*. After DNA analysis showed that *S. subaequale* was actually a sibling species of *Parrotia persica*, the plant was once again renamed in 1998 as *Parrotia subaequalis*. Critically endangered in the wild, only a handful of populations are known to exist in eastern China. The Arboretum has several specimens growing in the collections, the finest of which (304-2004-A) grows in the shade of mature white pines in the Explorers Garden. Although it has yet to show the exfoliating bark for which *Parrotia* are known, last fall the specimen developed outstanding orange, red, and purple foliage coloration, certainly among the most spectacular plants at the Arboretum that season.

## Chinese Wilson

The genus *Sinowilsonia* is named in compliment to Mr. E. H. Wilson, whose excellent collections have thrown light on many doubtful points connected with Chinese plants.

W. Botting Hemsley, *Hooker's Icones Plantarum*, 1906

The genus *Sinowilsonia* consists of a single species, *S. henryi*, named after the plant explorers Augustine Henry and E. H. Wilson who collected the herbarium specimens from which the species was described; Wilson also first introduced the species into cultivation in 1908 as part of his first expedition for the Arnold Arboretum. *Sinowilsonia* specifically refers to Wilson—the term *sino* refers to China, and he was nicknamed “Chinese” Wilson among his peers in the botanical world.

While of botanical and historical interest, *Sinowilsonia* offers little in the way of ornamental value. Apetalous male and female flowers are borne on separate catkin-like structures (similar to birch) and rely on wind for polli-



Flowers of *Sinowilsonia henryi*.





VINCENT SIMEONE

This *Sinowilsonia henryi* growing at Planting Fields Arboretum is linked to the original introduction of the species into cultivation. A sapling propagated from the original tree—intended to take the place of its parent one day—can be seen growing nearby.

KYLE FORT



Foliage of a *Sinowilsonia henryi* specimen (156-99-A) that was propagated from the large tree at Planting Fields Arboretum on Long Island, New York.

nation. Similar in form to witch-hazel, the species is a large shrub or multi-stemmed small tree. From his collection notes, Wilson observed that the species was, "Common in the sheltered valleys and ravines of north-western Hupeh, very rare elsewhere in the province and unreported from western Szech'uan [Sichuan]. It is very partial to the sides of mountain-streams where it forms a large bush or bushy tree, and in general appearance resembles a witch-hazel" (Wilson and Sargent 1913). Today we know the species' range to be throughout central China, but it is threatened, like many species, by habitat degradation.

The Wilson collections of *Sinowilsonia* in 1908 grew in various locations throughout the Arboretum until the dev-

astatingly cold winter of 1933–1934, in which dozens of taxa, including all the *Sinowilsonia*, were outright killed and many more plants died back to the ground (Faull et al. 1934). Fortunately, material from the Wilson collection had been distributed to other gardens, though it is unclear how many plants from this original collection remain in cultivation today. A truly grand specimen of *Sinowilsonia*—possibly the finest in North America—grows at Planting Fields Arboretum State Historic Park, Long Island, New York. It originated from material shared by the Arnold Arboretum and undoubtedly represents the lineage of the original Wilson introduction. Propagules from this now 40- by 50-foot multi-stemmed tree have been obtained on several occasions to reestablish the Wilson pedigree here; one such specimen (156-99-A) currently grows on the edges of the hickory collection. Our best representative of the species (1970-80-A) grew from the only seed to germinate from a seed lot acquired during the 1980 Sino-American Botanical Expedition (Spongberg 1991). Today, it thrives in its permanent location on the edge of a gentle slope adjacent to the east nursery at the Dana Greenhouses.

At the same time of Wilson's expedition to introduce *Sinowilsonia* to the cultivated world, he discovered a plant that Augustine Henry overlooked in his travels in Hubei 20 years prior:

Ichang [Yichang]

June 28, 1907

Dear Professor Sargent,

... I am enclosing a fragment of what is to me perhaps the most interesting plant, together with a similar fragment of *Sinowilsonia* for comparison. The new plant may be any one of these things ... a new genus; a new species of the *Sinowilsonia*; the male form of *S. henryi*, allowing that the latter plant is sexually dioecious ... If I can only secure fruits of both, the point can be easily settled. Unfortunately, the new plant is very rare, occurring only in oak woods ...

Believe me, Dear Professor Sargent

Faithfully and obediently yours,

E. H. Wilson

Returning to the location that autumn to prospect for seeds, Wilson again wrote to Sargent:

Ichang [Yichang]

November 30, 1907

Dear Professor Sargent,

... Some time ago I wrote you about (and forwarded a fragment of) what I thought was either the male form of *Sinowilsonia henryi* or a new species. I have now secured ripe fruits and seeds of both plants and these conclusively prove the latter view to be correct. The species are very distinct in every way, so much so in fact that some doubtless will be inclined to regard them as constituting distinct genera. I am particularly delighted over this find and only hope you succeed in raising plants ...

I am, dear Professor,

Faithfully and obediently yours,

E. H. Wilson

At the conclusion of his first expedition to China for the Arboretum in 1907–1908, Wilson returned to Boston, accepting an offer from Sargent to supervise the investigation in the Arboretum's herbarium of the plant vouchers he had collected. Working alongside Alfred Rehder, the pair described several new species from Wilson's collections. The vouchers Wilson mentioned in his correspondence with Sargent were cited when Wilson and Rehder introduced a new genus, *Fortunearia*, to the botanical world:

This new Chinese genus is named for the late Robert Fortune whose travels in China and Japan, from 1843–1861 resulted in important additions to our knowledge of the far eastern, and particularly the Chinese flora and enriched our garden with a large number of highly ornamental plants ... *Fortunearia* closely resembles in foliage and habit *Sinowilsonia*, which differs chiefly in its tubular calyx-tube several times longer than the ovary and enclosing it, by the absence of petals, the larger spatulate sepals, sessile flowers and the flat cotyledons ...

*Plantae Wilsonianae* Volume 1, 1913

As Wilson noted, *Fortunearia* differs from *Sinowilsonia* in its reproductive structures. The two species are close cousins on the family tree and again the evolutionary transition from



## What About Sweetgum?

The sweetgums (*Liquidambar* spp.) have traditionally been included in Hamamelidaceae, forming the subfamily Altingioideae along with two other genera, *Altingia* and *Semiliquidambar*. However, the members of Altingioideae have enough morphological differences from the rest of Hamamelidaceae that some taxonomists through the years have suggested that the group be elevated to their own separate family, Altingiaceae. Recent research at the molecular level supports this separate family, and some (though not all) taxonomic references now list sweetgums under Altingiaceae rather than Hamamelidaceae. The Arboretum has accessions of three *Liquidambar* species in the collection: *L. styraciflua* from North America, and *L. acalycina* and *L. formosana*, both from China. This large specimen of *L. styraciflua* (135-38-B) grows near the juncture of Bussey Hill Road and Valley Road.



ANDREW CAPINSKI

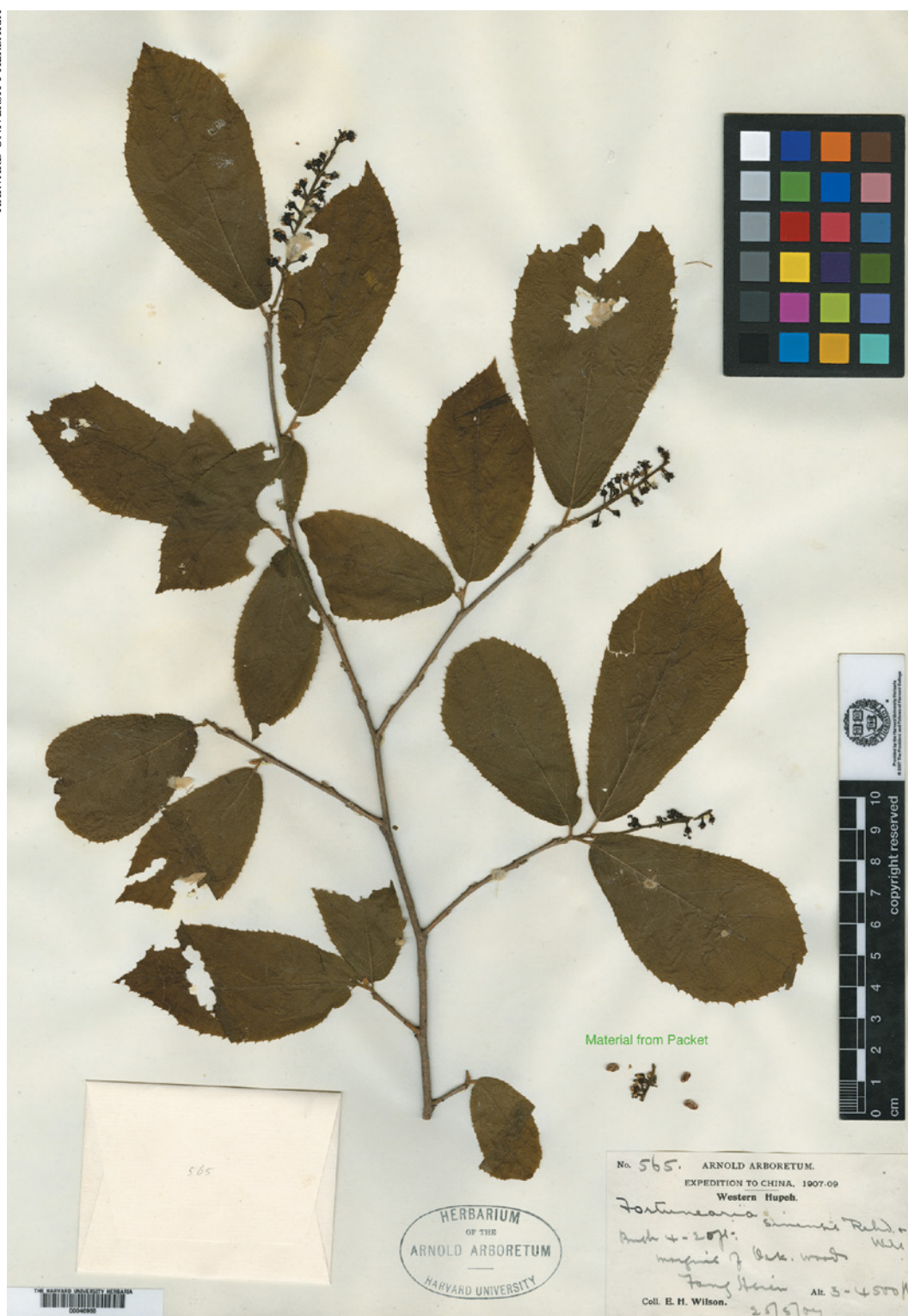
petals to no petals is apparent. A few accessions of *Fortunearia sinensis* do exist in the Arboretum, most notably a pair growing in the Explorers Garden under the shade of a large Canadian hemlock (*Tsuga canadensis*) just up the slope from Oak Path. These specimens were received as wild collected seed in 1980 from the Chinese Academy of Forestry. No plants collected directly through Arboretum expeditions currently exist on the grounds; seedlings from Wilson's original collection survived only a few years in cultivation. Seeds were also collected on the 1994 NACPEC expedition, but no plants resulted. This is another example of an extremely rare plant in cultivation, given its modest ornamental interest.



KYLE PORT

Foliage and warty developing seed capsules of an Arboretum specimen of *Fortunearia sinensis* (580-79-B) grown from seeds received from the Nanjing Botanical Garden.





Herbarium voucher in flower collected May 25, 1907, in Fang Hsien, Hubei, China, by E. H. Wilson, who considered it a possible new species at the time of collection. It would later be named *Fortunearia sinensis* by Wilson and Rehder.

KYLE PORT



(Clockwise from top left) The bonsai specimen of *Corylopsis spicata* was in bloom in mid-April last year.

A raceme of pale yellow flowers dangles from a branch of *Corylopsis sinensis* var. *calvescens* in the Explorers Garden.

A specimen of *Corylopsis glabrescens* 'Longwood Chimes' (159-99) in full bloom in the Leventritt Shrub and Vine Garden.

KYLE PORT



NANCY ROSE



### Winter-hazel

*Corylopsis*. All the species of this genus of shrubs of the Witch Hazel Family cultivated in the Arboretum have survived the winter with little or no loss of wood, but the flower-buds of the Chinese *C. Veitchiana* and *C. Willmottiae*, and of the Japanese *C. pauciflora* and *C. spicata* have been killed by the cold, and the only species which has flowered is *C. Gotoana* of the elevated region of central Japan. This is evidently the hardiest of the plants of this genus, and as it has now flowered in the Arboretum every spring for several years there is good reason to hope that we have here an important shrub for the decoration of northern gardens. The flowers are produced

in drooping spikes and open before the leaves appear, as in the other species, and are of a delicate canary-yellow color and pleasantly fragrant.

Arnold Arboretum, *Bulletin of Popular Information*, May 4, 1918

In the early to mid-1900s, the status of the winter-hazels (*Corylopsis*) was a topic of interest in Arboretum publications each spring. As noted above, the most reliably flower hardy species has been *C. gotoana*, which some taxonomic references now group with another Japanese montane species, *C. glabrescens*, under the latter name. There is still much debate about the most appropriate treatment of the *Corylopsis*





## A Missing Gem

*Disanthus cercidifolius* is a witch-hazel family member that is, unfortunately, missing from the Arboretum collection. This large shrub from China and Japan is noted for its attractive heart-shaped leaves; the specific name *cercidifolius* alludes to their resemblance to the leaves of *Cercis*, the redbuds. Like several of its relatives in Hamamelidaceae, *Disanthus* has excellent fall foliage color featuring rich shades of red and purple.

The Arboretum has accessioned this species a number of times but we currently have no living specimens. Some seed accessions had poor or no germination, and unfavorable climate or site conditions may be responsible for other failures. Arboretum Curator of Living Collections Michael Dosmann reports that *Disanthus cercidifolius* is high on his “wanted” list, and future accessions will be carefully sited to provide the fertile, moist, well-drained soil, partial shade, and wind protection that this plant prefers.

taxa. Some references have listed upwards of 30 taxa, though most research today groups many of these together into around ten species. E. H. Wilson even proclaimed his confusion with the genus in field correspondence with Sargent from China dated August 17, 1907: “*Corylopsis* are exceedingly common shrubs and extremely variable in foliage and degree of hairiness. At present I am undecided as to whether one, two or three species occur ...”

All of the species are similar in appearance, growing as multi-stemmed, broad-spreading shrubs of varying size. Of particular ornamental value are the early spring flowers—fragrant, bell-shaped, pale yellow to greenish yellow, and borne in pendulous racemes. Fall foliage color is a rather muted greenish yellow, unimpressive compared with many other family members. There are reports of better fall color farther south; possibly the leaves fall prematurely in colder northern regions.

*Corylopsis glabrescens* (*C. gotoana*), reportedly the hardiest species and the most well suited for New England gardens, was first introduced into cultivation by Arboretum dendrologist John George Jack. He sent seeds back to the Arboretum from Japan in 1905, the year he spent touring Northern China, Korea, and Japan as only the second Arboretum staff member (after Sargent) to visit Asia. Another Arboretum connection to the genus came when Wilson and Rehder named several new *Corylopsis* taxa from the herbarium vouchers Wilson brought back from his early expeditions for the Arboretum. Although some of these *Corylopsis* have now been lumped together with other taxa, I think Wilson would be pleased to hear that the topic continues to confuse taxonomists even today!

The greatest concentrations of winter-hazel in the Arboretum can be found adjacent to the hickories in the area known as the Centre



Street Beds and in the Explorers Garden near the summit of Bussey Hill—a visit to these areas in early spring is certainly worth the trip. A bonsai specimen of *Corylopsis spicata* can also be seen in the dwarf potted plant pavilion adjacent to the Leventritt Shrub and Vine Garden.

### A Family Worth Knowing

The witch-hazel family contains a relatively small number of species (around 100), yet the group is tremendously diverse. Its members are botanically fascinating and carry with them a remarkable history of exploration and discovery. From witch-hazel to winter-hazel, *Fothergilla* to *Parrotia*, they are among the most charming of garden plants. Although much work has been done to increase the utility of the family members in our landscapes, their presence remains understated. In New England and many other regions, the plants of Hamamelidaceae fill our gardens with beauty, even in the depths of winter. As has been stated before, there is a tree or shrub in bloom every month of the year in the Arnold Arboretum—a phenomenon only possible because of the witch-hazel family.

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Andrew T. Gapinski is Manager of Horticulture at the Arnold Arboretum.

# ***Pterostyrax hispidus*, the Fragrant Epaulette Tree**

*Pamela J. Thompson*

I began my relationship with fragrant epaulette tree (*Pterostyrax hispidus*) when long-time Arboretum supporter and volunteer Elise Sigel brought me a lanky, homely specimen, wondering if I could give it a home. Elise couldn't recall its full botanical name (some sort of styrax?), and I failed to record even this. I planted it in my Milton garden, not knowing what I had, or how it might grow. Though I don't widely recommend this blind-faith landscape design strategy, in this case I've been delighted with the results.

*Pterostyrax hispidus* is a deciduous tree native to Japan, specifically in the forested mountains of Honshu, Shikoku, and Kyushu. A member of the storax family (Styracaceae), it is closely related to the silverbells (*Halesia*). Though it can grow almost as broad as tall, reaching up to 50 feet (15.2 meters) in height and 40 feet (12.2 meters) in width as a tree, it is more often noted as a large multi-stemmed shrub reaching about 25 feet tall. In fact, it was the shrub form that Arboretum Director C. S. Sargent first saw in 1892 growing "... wild in Japan on the banks of a stream among the mountains above Fukushima."

The leaves of fragrant epaulette tree are oblong with a tapered point and have finely-toothed margins. They range from 3 to 7 inches (7.6 to 17.8 centimeters) long and 2 to 4 inches (5.1 to 10.2 centimeters) wide. Handsomely bright green above and gray-green below in spring and summer, the leaves turn yellow-green to yellow in autumn before dropping. A truly remarkable feature of this plant is its profusion of 7- to 9-inch-long panicles of fringed, downward facing, white flowers that appear in mid to late June (in the Boston area). Hanging below the leaves, the flower clusters sway in the breeze, attracting multitudes of pollinators and giving off a delicate sweet scent. The inflorescences, reminiscent of the fringed epaulettes that once adorned the shoulders of military uniforms as a show of rank, give fragrant epaulette tree its common name. Through the summer, long clusters of indehiscent, bristly dry drupes develop, adorning the tree like

bronze-chartreuse ornaments. These are most evident once the leaves have dropped, looking somewhat reminiscent of dangling sections of a DNA helix.

The Arboretum's accession records for *Pterostyrax hispidus* reveal a history of human interest and persistence in growing this plant. The Arboretum acquired its first accession in 1880 from J. Veitch and Son in England. Over the next 130 years, the Arboretum acquired plants and seeds, including the 1892 accession collected by Sargent in Japan. Many of these acquisitions, though, were of garden origin or uncertain provenance. The Arboretum currently has 3 accessions (9 total plants) of *Pterostyrax hispidus*. Accession 218-60 came to the Arboretum as seed from the University of British Columbia, Canada, but with uncertain provenance. Accession 241-2008, received from Chiba University in Japan as seed, was wild collected in 2006 in Gunma Prefecture, Kanto District, about 20 miles northwest of Tokyo. The third accession, 843-76, came from the Academy of Sciences, Vacratot, Hungary, in 1976 and is also of uncertain provenance.

Though it received the Royal Horticultural Society's Award of Garden Merit in 1993, *Pterostyrax hispidus* remains uncommon in the nursery trade. It is often listed as hardy to USDA Zone 4 (average annual minimum temperature -20 to -30°F), but Arboretum observations over the years indicate that this species may be only marginally cold hardy and is also intolerant of drought. Notes about leader dieback and vigorous basal sprouting imply that this species is more likely to grow as a multi-stemmed shrub in the Boston area.

As the snow has melted from around my now 15-foot-tall tree, I can see that several lower lateral branches have snapped off at the trunk union from the weight of this winter's snow. Even so, it is a plant worth trying in southern New England, even if only on blind faith.

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Pamela J. Thompson is Manager of Adult Education at the Arnold Arboretum.







