



FALL 2019

Forests & Gardens



HOLDEN
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Forests & Gardens

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Forests & Gardens is the member magazine for Holden Forests & Gardens, which includes the Holden Arboretum in Kirtland and the Cleveland Botanical Garden in Cleveland.

Our Mission: Advance and inspire a deeper understanding of plants to enhance life.

Our Vision: Vibrant green communities and diverse native forests of the Great Lakes region will flourish and sustain life.

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ON THE COVER: *Asclepias* (milkweed)
by Mike Dougherty



Visitors to the Kalberer Family Emergent Tower discover how a plant's stomata work.

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Greetings!

PRESIDENT'S COLUMN

Dear Friends of Holden Forests & Gardens,

In this issue of *Forests & Gardens* magazine, there is a common thread of persistence in pursuit of celebrating the natural world around us. Nature requires us to be patient, and the rewards are worth the wait as you'll see in multiple stories.

The Western Reserve Herb Society and Cleveland Botanical Garden celebrate the 50th anniversary of the Herb Garden this year. The Herb Society's approach to the garden is as relevant today as it was at its founding 50 years ago. It is community-based, with society members tending to the plants in the garden and creating a place of beauty and calm. It is a teaching garden, engaging visitors through informal conversations, informative signage and publications about herbs, history and horticulture. It is a sustainable garden that is cared for with a commitment to following the lead of nature with earth-friendly practices. It is a giving garden that creates products to share and support continued garden investment. Most of all, though, I am humbled by the passion and joy of the society members in relation to the Botanical Garden and with one another that have persisted over time.

Roger Gettig, director of collections, tells the story of trees that persist in some of the most challenging conditions. In these trees, we witness adaptation that makes one pause and be inspired by the wonder of the natural world. Steve Krebs tells of his work as Station

Director at the David G. Leach Research Station and a patent awarded to a rhododendron hybrid developed for southern climates. From start to finish the development of the new hybrid took more than 10 years of persistence. We are privileged to be in a position at Holden Forests & Gardens to make long-term investments to advance the mission through our plant collections, science and research programs, and all aspects of the organization entrusted to our care.

Working with our dedicated Board of Directors, we are developing a new strategic plan for Holden Forests & Gardens. The planning process has included outreach and engagement of community leaders, members, staff and volunteers. We are building on a rich legacy, and we are dedicated to creating a sustainable future that benefits the people and communities of Northeast Ohio and beyond. We look forward to sharing the strategic framework for our future with you early next year.

You make a difference through your support. Thank you for your part in shaping and enabling our work!

With gratitude,

JILL KOSKI
President and CEO

Heat Tolerant Rhododendron Receives Patent and Hits the Consumer Market

By Stephen Krebs, Director of the Leach Research Station, and Jing Wang, Field Station Specialist

A U.S. plant patent was recently awarded to a rhododendron hybrid that was developed at the Holden Arboretum. Patent No. 30,235 describes the ornamental attributes and novel adaptive traits of the cultivar R. 'Holden52', which was selected for its beauty, heat tolerance, and disease resistance.

This new breed of rhododendron is a product of research and development at the Holden Arboretum that began in the late 1980s with the acquisition of the David G. Leach Research Station. The station, a 30-acre facility in Madison, Ohio, originally belonged to David Leach, a renowned hybridizer of beautiful rhododendrons and azaleas suitable for our northern climate (USDA hardiness zone 5). His dual focus on form (ornamental value) and function (performance in challenging conditions) continues to be a central feature of the station's breeding program.

In 2005, the research station staff started a project to develop rhododendron hybrids with resistance to a common and fatal disease called root rot. The disease is caused by *Phytophthora cinnamomi*, a fungus-like soil pathogen that affects more than 3,000 plant species worldwide. Most Rhododendron species and cultivars are susceptible to root rot. To mitigate the disease threat, a source of genetically based host resistance was identified in a wild Asian species and transferred to hybrid offspring by cross-pollinating the resistant species with cultivated (and mostly susceptible) rhododendrons. Details of the hybridization process are described in an earlier report in *Forests & Gardens* magazine (Spring 2017).

An intriguing aspect of this project was the prospect of developing plants that were heat tolerant as well as root rot resistant. The source of resistance, the Taiwanese species *R. hyperythrum*, is known to be one of the few large-leafed rhododendrons capable of growing in the Gulf South (USDA hardiness zone 9). The two traits may have a functional relationship, because resistance is a necessary adaptation for plants growing in a warm, wet climate where *Phytophthora* disease pressure is higher than in cooler, northern climates. Consequently, the project was geographically expanded to include field trials in both Northeast Ohio and southern Louisiana. A commercial collaborator based in Alabama, Plant Development Services Inc. (PDSI), assisted with the southern field trials due to their interest in expanding the traditional northern market for rhododendrons to include the South. From these evaluations, we discovered that the best-performing rhododendrons in the warm climate test were also the most root rot disease resistant.

The first outcome of this collaboration is the patented cultivar R. 'Holden52', which is being marketed and distributed by PDSI under the tradename Splendor™. The plant blooms during mid-May in Ohio (late March in Louisiana) and has rose-pink flowers with attractive patterning – a purple flare (nectar guide) on the upper petal lobe and white petal midribs contrasting with the pink. The backs of the petals are more deeply pigmented than the faces, resulting in a bicolor appearance. The plant has dark, glossy foliage and a mounded growth habit, which is wider than tall. The patent description notes its resistance to *Phytophthora* root rot as well as its broad climatic range, from USDA hardiness zones 5 to 9.

A patent serves to prevent an invention from being copied or used without agreement from the patent owner(s) over a set period – 20 years for most plant patents. The Holden Arboretum has a licensing agreement with PDSI to produce, market, distribute and assess a royalty fee on this plant. Rhododendron Splendor™ is included in the Southern Living Plant Collection™, a well-known brand in the South.

Plant innovations like Splendor™ can improve consumer success with rhododendrons, decrease the use of chemical (fungicide) control of root rot disease in production nurseries, and expand the traditional geographic market to include the South. Breeding work at the Leach

A U.S. plant patent was recently awarded to a rhododendron hybrid that was developed at the Holden Arboretum. Patent No. 30,235, describes the ornamental attributes and novel adaptive traits of the cultivar R. 'Holden52', which was selected for its beauty, heat tolerance, and disease resistance.



The newly patented Splendor rhododendron. The patent lists Stephen Krebs, director of the Leach Research Station, as the plant's inventor, and ownership (assignment) of the patent is shared equally by the Holden Arboretum and PDSI, which functioned as a co-developer during the southern field trial phase.

Station reflects Holden Forests & Gardens' commitment to sustainable horticulture and research aimed at finding solutions to the threats facing a variety of plant species. With its proven field performance under abiotic (sterile) and biotic stress conditions, Splendor™ may inspire a new group of southern gardeners and

increase the success of rhododendrons in all regions affected by this invasive soil pathogen. We hope that the gardening public feels as excited about Splendor™ as we do.



The new rhododendron is available through the Southern Living Plant Collection and carried by many garden stores.



The flowers of rhododendron Splendor.

Fifty Seasons of Growing: Celebrating the 50th Anniversary of the Western Reserve Herb Society Herb Garden

Cait Anastis, Editor

There is something comforting about an herb garden. Perhaps because herbs evoke warm memories of meals prepared in family kitchens. Or perhaps because herbs are so closely tied to our history, reminding us that in the past, herbal remedies eased people's suffering and natural dyes colored their world.

For 50 years, the Western Reserve Herb Society (WRHS) has welcomed visitors into that comforting world filled with the scents, textures, colors and history of herbs, carefully tending the Herb Garden on the Botanical Garden's campus. That garden, which officially opened on Sept. 5, 1969, represents a long-term partnership between the WRHS and the Botanical Garden, which continues to flourish today with Holden Forests & Gardens.

The garden was designed by WRHS Garden Chair Elsetta Gilchrist Barnes, ASLA, and construction on the new garden started in March 1969. When the \$5,000 allotted by the WRHS members proved to be too small to complete the project, its members moved forward with determination. The group incorporated as a non-profit entity, and

Katherine Patch utilized her fundraising skills to secure \$32,000 in donations for the project. Barnes scoured the countryside searching for stones that could be donated to create garden features, including dozens of millstones that helped form the central knot garden beds and other garden features.

To mark the 50th anniversary of the garden, the WRHS planned a year-long celebration, which kicked off in January with an event honoring past Herb Garden chairs who have overseen the planning and planting of the garden each season. In May, the annual meeting included a celebration of the entire garden and other months have been dedicated to the nine sections of the garden.

"The grand plan was for every month to honor one of the sections of the garden, including the terrace, trail and cutting, culinary, medicinal, fragrance, dye, edible flowers, the historic rose gardens and the iconic knot garden," said Bobbi Henkel, who is one of three chairs of the garden this year.



Kristi Webster and Helen Webster work on the beds in the cutting garden that are designed to resemble a quilt. The time and resources the organization puts into the garden is just one aspect of their support of Holden Forests & Gardens.

Top of Page: Sara Fenderbosch, one of the section leaders for the Trail and Cutting section of the Herb Garden.

The group will wrap up its year-long celebration with a Holiday Tea in December, where the Trowel and Clipper awards will be presented to members who have made special contributions to the Herb Garden in 2019.

The passionate commitment to the garden is displayed by the 105 active members of the Herb Society who spend about 2,000 hours a year working in the gardens on Tuesdays and Thursdays. In total, the group dedicates about 10,000 hours a year to the study and promotion of the growing of herbs and their uses.

"We're bound by a love of herbs," said Beth Schreiber Gehring, the WRHS public relations and education chairperson. "We're all herbalists in our own way. There are women in this group who paint herbs or who are culinary masters. We have crafters. Every single person who works in that garden is there because they love that garden."

"This is a working group, and it all revolves around education," Gehring said. "Our mission is really to teach people about the uses of herbs. We spend a lot of time together and have become a huge family. We spend a lot of time teaching each other."

The primary beneficiaries of this labor of love are visitors to the Botanical Garden. Anyone strolling into the garden while the WRHS members are at work will find willing teachers, eager to answer questions about the herbs, or share information on the plants, growing practices and the history encompassed within the garden's beds.

"The Herb Garden is a community-connected teaching garden following the lead of nature and founded in the relationship of gardens to people and people to one another", said Jill Koski, president and CEO of Holden Forests & Gardens. "Ultimately, it is a giving garden. I am humbled by the passion and joy that the society members so generously give year after year."



The iconic knot bed in early spring.

The group also enjoys the long-term partnership with the Cleveland Botanical Garden, which has evolved from the Garden Center of Greater Cleveland into the Cleveland Botanical Garden, and most recently becoming a part of Holden Forests & Gardens in 2014. Horticulturist Robin Johansen and a volunteer, Richard Behrens, have provided the group with horticulture support and keep an eye on the garden when members aren't on site to tend it.

"HF&G provides us with magnificent assistance," Henkel said. "We raise the money, we purchase the plants, we plan where things are going to go, but we do not underestimate how much Robin and Richard do – it's a collaboration."

They were also thrilled to find that Holden Forests & Gardens President and CEO Jill Koski understood both the value of the garden and the values of the WRHS, Henkel said.

"She got that we are not just nurturing plants, we're nurturing each other," she said. "Beyond caring about each other, we care about the community and every little microbe in the soil that is doing its part to make this world a better place."

Learn more about the Western Reserve Herb Society Herb Garden and herbs at the 74th Herb Fair on Oct. 12 from 10am – 3pm, featuring interactive herb talks and tours by WRHS members, and a wide selection of handcrafted items for sale, including tussie mussies, herbal teas, jams & jellies, culinary seasonings, wreaths & dried arrangements, potpourri, delicious baked goods & confections.



Marjorie Fow, section leader of the Terrace beds and Ellie's Overlook, and Sandy Melsop, the section leader of the garden's central Knot Garden.

Golden-crowned Kinglet

Regulus satrapa

By Rebecca Thompson, Manager of Academic Programs



Barely larger than a hummingbird, golden-crowned kinglets have a remarkable ability to endure cold climates, surviving extreme temperatures of 40 degrees below zero. During nesting season, they can be seen high in the trees in boreal spruce-fir forests. In Ohio, they are more frequently seen later in the fall and early in the spring on lower level branches of trees and shrubs.

Golden-crowned kinglets feed on small invertebrates, including insects, spiders and their eggs. During the breeding season, they glean for prey from branches, under bark and in-between conifer needles. In addition to gleaning, golden-crown kinglets have an amazing ability to hover underneath a branch to capture insects off the undersides of the vegetation. In fall, winter and early spring, they search twigs, stems and vines for dormant invertebrates and eggs. They will eat a small number of seeds when insects are sparse.

Golden-crowned kinglets build their nest 6 - 60 feet high in evergreens such as balsam fir, white spruce and black spruce. Both sexes spend 4 - 6 days building a deep hanging cup-shaped nest, usually close to the tree trunk. The nest is generally protected from the elements by overhanging needles. Nests are primarily made of strips of bark but can include mosses, spiderwebs, parts of insect cocoons, lichens and other downy plant material. Nests are lined with finer material, including deer hair and feathers.

Females lay 8 - 9, sometimes 5 - 11, elliptical creamy white to pale buff eggs, with brown and gray spots. Eggs are often arranged in two layers in the nest. Females incubate the eggs for about 14 - 15 days. Males may feed females during incubation. Both parents feed nestlings. Young leave the nest about 14 - 19 days after hatching. Females feed their first brood only one day after leaving the nest. Despite primarily nesting in the Boreal forest, golden-crowned kinglets surprisingly raise two large sets of young per season. Females start laying the second set of eggs while the male takes care of the first set of fledglings.

Golden-crowned kinglets are numerous. Partners in Flight estimates a global breeding population of 100 million. They have been expanding breeding southward towards Pennsylvania, Illinois, Indiana and Ohio. However, according to the North American Breeding Bird Survey, populations overall have declined between 1966 and 2014 due to habitat loss.

BIRD FACTS

SIZE: 3.1 - 4.3 inches

WINGSPAN: 5.5 - 7.1 inches

DESCRIPTION: Pale olive above and gray below; black-and-white striped face, bright yellow-orange crown; thin white wing bar with yellow edges to their black flight feathers; black and yellow feet

RANGE: Across the United States and Canada; resident to medium-distance migrants; migrates in the late fall and early spring; Northern Pacific Coast permanent residents

VOICE/SONG: Song: high pitch tsee-tsee-tsee-tsee varies in number Call: thin tsee note

BEST LOCATION TO VIEW: At the Arboretum, look for golden-crowned kinglets along the Woodland and Old Valley Trails. At the Botanical Garden, watch for them in the Woodland Garden.

Pawpaw

Asimina triloba

By Ethan Johnson, Plant Records Curator

In 2009, the fruit of the pawpaw tree became Ohio's official native fruit, joining the scarlet carnation, the state's flower; the white trillium, the state wildflower; and tomatoes, the state fruit as symbols of the Buckeye State.

The North American native, which can be found growing from New Jersey to Nebraska, was growing in Ohio long before humans arrived on the continent. The northernmost member of the custard apple family, the pawpaw was named by members of the Hernando de Soto expedition in the 1500s and provided sustenance for members of the Lewis and Clark expedition in 1806.

The native pawpaw patch in the Myrtle S. Holden Wildflower Garden at the Holden Arboretum is worth a visit. During the last two decades, new wild-collected pawpaws from other populations in Ohio were planted alongside them in the floodplain meadow. The largest tree measured 44 feet tall with a trunk diameter (DBH) of 10.4 inches in 2016.

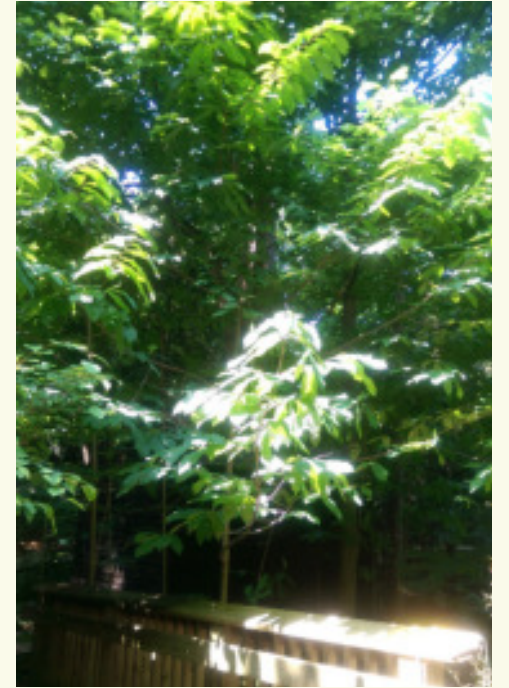
The pawpaw is the only larval host for the zebra swallowtail butterfly. Because of this, 20 young pawpaws are now growing in the Arlene and Arthur S. Holden, Jr. Butterfly Garden, all planted in the last 17 years.

Pawpaw trees are playing a role in forest restoration, helping to restore areas after invasive species have been removed. Fruit from pawpaws growing naturally near Carver's Pond and in south Stebbins Gulch along with pawpaws from the Holden Wildflower Garden have been harvested

and the seed sown at the Long Science Center Nursery. The resulting seedlings have been planted in our natural areas including the south section of Working Woods, along with spicebush (*Lindera benzoin*), shrubby dogwoods (*Cornus racemosa*, *C. sericea*, *C. amomum*), and other understory shrubs important to wildlife in areas where exotic invasives such as buckthorn, multiflora rose, Tatarian honeysuckle, privet and burning bush have been beaten back a bit.

Visitors to the Cleveland Botanical Garden will find pawpaws on the east side of the Hershey Children's Garden where two pawpaw trees planted in 1999 have been producing fruit since at least 2016. Although the tallest one lost its leader, it measures 18 feet in height. The wood of pawpaw is not strong and leaders may be lost when small mammals choose not to wait until the fruit falls to the ground. There is also a small pawpaw patch in the Botanical Garden's Woodland Garden, where the tallest tree is 30 feet with a diameter of 4.2 inches in 2017. There is some fruit on these trees, which are shaded primarily by tuliptrees (*Liriodendron tulipifera*).

Cultivated varieties (cultivars) of pawpaw have been grafted onto seedling understocks and planted in a variety of areas at the Arboretum. 'Mitchell' is north of the Baldwin Research Plot on the downslope of the Nut Tree Collection. 'Estil' and 'Overleese' are at Lantern Court along the southeast tree line. 'Mitchell', 'Prolific', 'Rebecca's Gold', 'Sunflower',



Pawpaw trees near the boardwalk at the Botanical Garden.

and 'Sweet Alice' have been planted and are getting established in the Display Garden along the stream below Lotus Pond.

In home landscapes, pawpaw trees are useful for screening or occasionally as a specimen. They eventually form colonies from root suckers, which should be removed if a single-trunked specimen is desired. Its leaves turn yellow with cinnamon-colored tinting in fall. During summer, the large, 6-15" long droopy leaves are easily distinguished from other native plants. The leaves unfold throughout May along with the beetle- and fly-pollinated fetid, lurid purple flowers.

This species has no significant insect or disease problems and is resistant to deer browse. Because it is tap rooted in the moist, well-drained soils where it grows naturally, container-grown plants are recommended, although at least one Ohio nursery had success by oversizing the root balls on balled and burlapped field grown plants. Seedlings require some shade during their first few years. They are adaptable to a range of soil types, but are sensitive to drought. Pawpaw needs shelter from high winds. The berries are the largest edible fruit produced by any native temperate North American plant. At the Arboretum, they can be as much as 7" long and up to a pound in weight and ripen in late October.



PLANT FACTS

LIGHT: Part shade to full sun, will persist in mostly shaded areas

SOIL TYPE: Seasonally wet to moist, acid to neutral pH

MATURE SIZE: 25-30' or more

BEST LOCATION: USDA Zones 5b-8a

SOURCE: Mail order, via a landscaper, or ask your local garden center if they can order it for you

Cleveland's Fleet Response Helped Make Summer Exhibit a Reality

Special thanks to our Woodland Express presenting sponsor, Fleet Response. Fleet Response provides claims management, accident management, driver safety training, subrogation and other high value services to a variety of clients. They provide flexibility, allowing clients to customize processes, programs and reporting, visibility and accountability. This family-owned company was founded by Ron Mawaka Sr. in Cleveland in 1986. More than 150 employees provide support for accident, maintenance, and safety programs.

Under the leadership of CEO and President, Scott Mawaka, the company has been named a Plain Dealer and Ohio Business Magazine Top Workplace and featured as a growing firm in Crain's Cleveland Business.

If you are interested in sponsoring a Holden Forests & Gardens exhibit or event, contact Samantha Lengel, director of corporate and foundation giving, at 216.707.2805.



Harvest Moon A Benefit Event for Holden Forests & Gardens

Friday, Sept. 20, 2019, 7pm
Cleveland Botanical Garden – Geis Terrace

Make your reservation at cbgarden.org/support/harvest-moon.aspx. Capacity is limited, so make your reservation today.

Enjoy a five-course dinner prepared by Cleveland's top chefs – Ben Bebenroth (Spice Kitchen + Bar), Chris Hodgson (Driftwood Group), Cory Kobrinski (Astoria Café & Market), Chris Hines (Cleveland Botanical Garden's Bon Appétit) and Bridget Thibeault (Luna Bakery & Café) – featuring Green Corps produce. Experience elegant, farm-style seating on the Geis Terrace, with live music and locally brewed beer. A VIP reception will kick off the evening for sponsors and their guests.

Proceeds will support Green Corps, HF&G's urban agricultural work-study program for high school teens, which teaches them leadership and communication skills while helping to bring fresh produce into inner-city neighborhoods where access to produce may be limited.



Celebrating 20 Years in the Hershey Children's Garden with Joan Bania

A volunteer that has been there for almost all of them

By Sarah Hartley, Volunteer Coordinator

This year marks the 20th birthday of Hershey Children's Garden, which opened in 1999. The following year, Joan Bania started volunteering in the garden, helping with the gardening and special events, such as the annual Egg Hunt and Botanical Bash.



Q: What is your favorite feature of the Children's Garden? Why?

A: My favorite feature of the Hershey Children's Garden is the Vegetable Patch, because it educates children about where food comes from. It also encourages them to grow fruits and vegetables that will provide them with food for their healthy diets.

Q: Is there an area or activity in the Children's Garden that you wish more people knew about?

A: I wish more people knew about the Four Seasons Fountain Court with its sundial and how the four seasons in a garden connect to our earth's journey around the sun, and how the phases of the moon affects changes on earth. When I am volunteering, I often explain to our visitors that by standing below the moons, with their feet on the letter of the current month, they can tell the time of day by the shadow cast by their raised right hand.

Q: What has been your most memorable experience in volunteering with us?

A: If I must choose my most memorable experience, I would have to say that it would be during the season in which we grew purple dragon carrots, bunny tail radishes, chocolate mint and a giant pumpkin that we called, "The Great Pumpkin." It was a joy to grow some things in the Children's Garden that were a little out of the ordinary, and that sparked the interest of young and old alike! The children that visited the Hershey Children's Garden that season were astounded to learn that a carrot could grow and be purple instead of the usual orange color, that a green mint leaf can taste like a piece of chocolate candy, and that a pumpkin can grow to be an enormous size! It is fun and a challenge indeed to see how tall a plant can grow, or how large a fruit or vegetable can develop to be!

Q: Why did you choose to become a Hershey Children's Garden volunteer? Did you have prior experience working with children?

A: I chose to become a Hershey Children's Garden volunteer because I have a great interest in and passion for gardening and being out in the great outdoors, enjoying all that nature has to offer. I love taking care of and watching plants and flowers grow and thrive, and I wanted to bring that love for gardening and nature to children. I thought what better way would there be to do this than to become a Hershey Children's Garden volunteer! When I was a child, I grew a garden of flowers, fruits and vegetables in my own backyard each year. I had prior experience working with children as a teacher at St. Ignatius Elementary School. At the school, I worked to bring a children's vegetable, fruit and flower garden to life! The students grew vegetables, fruits, and flowers to take home to their families.

Q: Do you have any advice for someone who is considering volunteering in the Children's Garden?

A: Someone who is considering volunteering in the Hershey Children's Garden must have a great love for gardening and nature and have a willingness to bring that same love for gardening and nature to the children and to all guests that visit the Hershey Children's Garden.



Overcoming the Odds: 10 Trees That Are Thriving Despite Injuries and Less Than Optimal Conditions

By Roger Gettig, Director of Collections

Trees are resilient; they have to be. Entrenched in one location for life, they have no other option than to deal with whatever challenges come their way. While members of the horticulture staff follow best practices when planting trees, conditions change over time, and trees that start from seeds often sprout in less than optimal conditions. Here are 10 trees at the Holden Arboretum that have defied the odds that you can find growing within easy walking distance of the Corning Visitor Center.



In 1958, a bald cypress (*Taxodium distichum*) was planted on the west side of the island in Corning Lake. That end of the island has eroded away, leaving the tree surrounded by water. Now the bald cypress stands alone, an island unto itself.



A Siberian larch, on the east side of Sperry Road after you enter the Arboretum, was hit by lightning in 1991. Lightning can create an explosive shock wave splitting open the bark, and it can create a steam explosion by super-heating the cambium layer beneath the bark. Death can result when the tree's ability to transport water is compromised. This tree has spent the past 28 years compartmentalizing the damage while it continues to grow.



Osage orange (*Maclura pomifera*) trees used to be used as "living fences" for livestock until the use of barbed wire became common. Sometimes people strung barbed wire between the trees, and we can see reminders of this in a row of Osage orange trees next to the Rhododendron Discovery Garden. The three rows of barbed wire are gone, but the trees' reaction to the wire remains as a trio of persistent grim smiles.



On the path to the Kalberer Emergent Tower, you can see through an old red maple (*Acer rubrum*). It is hollow, yet still alive. We don't know how it happened. We don't know how it persists. But it does.



This red oak (*Quercus rubra*) is on the edge of a cliff in Bole Woods, reaching into a light gap. Leaning trees and trees on slopes often form "reaction wood" to prevent them from breaking under their own weight or blowing over down a slope. This tree has created a massive root up-slope, an anchor in defiance to gravity.



Maybe this falls under the category of sneaky, rather than resilient, but a side branch of the weeping European beech tree (*Fagus sylvatica* 83-560) in our Display Garden has rooted into the ground. It has grown large enough to qualify as its own tree while still taking advantage of the energy it gets from the parent tree. It will not be surprising if it eventually surpasses the growth of the parent tree if it doesn't collapse the wall above the lily pond first, a potential downfall of being too ambitious.



Surrounded by other trees on a narrow strip of land at the base of a hill, competition for resources is fierce for this red elm (*Ulmus rubra*). Somehow it managed to send a root across the stream and found a wide-open area to exploit. Look for it the next time your kids visit the Habitat Hut.



There is an out-of-place sandstone boulder right off the Woodland Trail with a horizontal crack in it. A red maple (*Acer rubrum*) seed blew into that crack decades ago. Not the best place to plant a tree, or so we would think. However, the red maple has managed to endure.



Streams meander, always redefining their banks. This red maple (*Acer rubrum*) is trying to prevent the inevitable in the Myrtle S. Holden Wildflower Garden. The entire bole of the tree now hovers above the stream flowing underneath it. Water, erosion and gravity will win in the long run, but this maple has outlasted our expectations.



Along a slope down to Pierson Creek, a Canada hemlock (*Tsuga canadensis*) was damaged when it was young. Maybe a log flattened it rolling its way downhill; we will never know. What we do know is that the roots held on and the tree eventually re-oriented itself. It is large enough now not to be bullied by the next log.

Speaking to the Dead

Scientists at Holden Forests & Gardens and the Carnegie Museum of Natural History are Using Ancient Plant Collections For Current Research

Plant specimens collected and archived in museums more than a century ago may increase our understanding of how human actions affect the natural world, creating collaborations for new research that stretch across the decades.



Human activities have significantly transformed our planet over the past 100 years. This transformation, often referred to as global change, can include the effects of habitat fragmentation, climate change and invasive species, all of which pose threats to natural systems including temperate forests. These threats can directly impact plant growth and survival or may affect plants by altering their relationship with beneficial soil microbes.

Seeking answers to how human activities affect the natural world, scientists at Holden Forests & Gardens and the Carnegie Museum of Natural History in Pittsburgh, Pa., are using the repositories of plant materials collected by museum botanists over the past century. These repositories of plant material collected and archived by generations of botanists are called herbaria (*herbarium singular*).

“Herbarium specimens allow us to look at plant communities in the 1800s and tell how these communities have changed over time.” – David Burke

by scientists. Botanists have collected herbarium specimens for centuries, but these specimens are now being used in new ways.

The work started in 2017, when Mason Heberling, PhD, now an assistant curator of botany at the Carnegie Museum of Natural History, received a postdoctoral research fellowship from the National Science Foundation to use herbarium specimens to look at trait changes in non-native, introduced species in the region.

“At the start of my fellowship, I went through many herbarium specimens, looking to see what traits or information may be captured in the specimens,” Heberling said. “One thing that stuck out to me was the number of specimens that not only had intact roots, but also old soil still stuck to roots. I was unaware of anyone studying these roots or soil. I was interested in using these specimens to better understand these changes. In my previous projects, I was working closely with Dr. Susan Kalisz [who is now the head of the department of ecology and evolutionary biology at the University of Tennessee] on a widespread invasive forest species, garlic mustard. Garlic mustard has been shown to produce chemicals that disrupt the interactions between native plants and the belowground microbes.”

His connection to Kalisz led Heberling to David Burke, HF&G’s chief program officer for science and conservation. Burke had collaborated with Kalisz on past projects and worked with mycorrhizal fungi at a field site near Pittsburgh that Heberling had used for his research.



Mason Heberling, PhD, Carnegie Museum of Natural History



David Burke, PhD, Holden Forests & Gardens Chief Program Officer

“Although I had not met David Burke in person, I knew his work well and thought – I wonder if he can do anything with 100-year-old roots? So, I called him, he was super enthusiastic about the idea, and that was the start of this cool project together,” Heberling said.

The result was a paper, published in the journal *Applications in Plant Science*, demonstrating for the first time that herbarium samples can successfully be used to examine mycorrhizal communities collected as far back as 1881. Although many old herbarium samples could not be analyzed, at least half of all specimens for some plant species, such as the forest wildflower Wake Robin (*red trillium*), could be successfully examined using techniques that amplified a specific stretch of fungal DNA. This method holds promise for large scale examination of how human-induced changes to our environment may have altered these important communities of fungi over the past 100 years.

Using these techniques, researchers can study how human activities have affected mycorrhizal fungi – soil microbes that colonize plant roots and assist plants in nutrient capture, help plants resist disease and improve tolerance to drought. Human activities over the past decades to centuries may have impacted these important fungi by changing the communities in forest soil or reducing root colonization, which can lead to reduced plant growth and success.

The paper “*Utilizing Herbarium Specimens to Quantify Historical Mycorrhizal Communities*,” serves as a pioneering first step to show other scientists how these collections, often overlooked by plant ecologists, can help answer pressing questions about the impacts of human activity on plant communities.

“Generally, as scientists, we are restricted to the kinds of experiments that we can set up today,” Burke said. “What the herbarium specimens allow us to do is rewind the tape here and look at the plant communities in the 1800s and tell how these communities have changed over time.”

“It’s a different way of collecting information about how these communities might have changed and how human activities have affected them. We can conduct an experiment over 20 years, and that can be very powerful, but with this approach, we can look at things over the past 100 years, and that’s even more powerful.”



Carnegie Museum’s oldest herbarium specimen roots.

Searching for ways to look at the changes that have taken place over time is not new to science. It’s similar to researchers examining the pollen trapped in layers of lake sediment to see how plant communities have changed since the last ice age.

“Herbarium specimens are the same,” Burke said. “They don’t go back thousands of years, but they do give us the opportunity to go back to the late 1800s.”

The project has broader implications than just a single study. The Carnegie Museum herbarium, which has more than 540,000 specimens collected since the 1800s, is only one of about 3,000 herbaria in 165 countries containing an estimated 350 million specimens. These specimens allow modern researchers to build on the work of the botanists and ecologists who contributed to the specimen collections.

“Science is a conversation we have with one another about what we know about the world. It’s the accumulation of information over time,” Burke said. “We are having the conversation with people who are long dead through the research that they left behind. We’re also having a conversation with those who come after us because we are adding to the body of knowledge.”



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