

2018 ANNUAL REPORT
The Arnold Arboretum
of Harvard University



About Us

A historic and contemporary public garden and an international center for the study of woody plants and biodiversity, the Arnold Arboretum of Harvard University disseminates knowledge and pursues a mission defined by excellence in horticulture, research, and education.

Operating as a public-private partnership between the City of Boston and Harvard University, the Arboretum stewards one of the world's most comprehensive and best-documented collections of woody plants with particular focus on the ligneous floras of eastern North America and eastern Asia. The Arboretum's 281-acre landscape in the heart of Boston was designed by Charles Sprague Sargent and Frederick Law Olmsted and is on the National Register of Historic Places.

Funded entirely through endowments, annual gifts, and membership support, the Arnold Arboretum is nonetheless a free community resource for all and a jewel in Boston's Emerald Necklace of parks.



Note from the Director

WILLIAM (NED) FRIEDMAN

DIRECTOR AND FACULTY FELLOW OF THE ARNOLD ARBORETUM
ARNOLD PROFESSOR OF ORGANISMIC AND EVOLUTIONARY BIOLOGY, HARVARD UNIVERSITY



The mission of the Arnold Arboretum on the preceding page of this report has, at its core, remained constant and elemental for nearly 150 years. Through eight directors, hundreds of thousands of living and preserved plants, and revolutionary changes in how scientists study and reveal the mysteries of living things—the Arnold Arboretum and its collections have continued to flourish, inspire, and serve the needs of science. The reason a nineteenth-century idea has continued to be relevant in the twenty-first century extends directly from the essential value at the heart of our mission statement: the belief that collecting, cultivating, and preserving living examples of temperate biodiversity in a common garden serves humankind in critical and inimitable ways. This was true in 1872, is still true today, and will undoubtedly steer the Arboretum into the next century and beyond.

This annual report provides a birds-eye view of how the Arboretum turned those time-honored words into action in 2018. Here we present just a few of the stories marking critical milestones in our progress, like the bold successes and collaborative spirit of our Living Collections Campaign, the iterative improvements we have made to the health and sustainability of our landscape, and the thriving ecosystem of

discovery and learning in the laboratories and classrooms at Weld Hill. It also provides a historical record of the state and scope of our collections, the breadth of published scholarship borne here, and an accounting of the financial health of the institution as we approach our sesquicentennial in 2022. Most importantly, it also documents the many people whose hard work and invaluable contributions have brought life to our values to *collect, study, share, and steward*.

From our expert staff and intrepid plant explorers, to visiting scholars and interns on our grounds and in our labs, the many volunteers who help bring our mission to the publics we serve, and the members and donors whose generosity galvanizes our future—nothing shared in this report could have been accomplished without their belief and dedication to the Arnold Arboretum. Whether as a beloved landscape, an unparalleled museum of living objects, or a free and open resource for the study and appreciation of biodiversity writ large, this place inspires a limitless array of stories. As you read this report and contemplate your own relationship with trees and the natural world, you take part in the story too—the natural pursuit of our species to keep evolving and growing, and sharing responsibility in making our world a better and more enlightened place for all life on Earth.

JANUARY

Peter Del Tredici, Senior Research Scientist Emeritus, co-authors a study in *Systematic Botany* on the discovery of a new hemlock from Korea. The first conifer species to be newly described in a decade, *Tsuga ulleungensis* sparks interest due to its natural resistance to the hemlock woolly adelgid.



FEBRUARY

Science author and reporter Dava Sobel (*Longitude, Galileo's Daughter, The Glass Universe*) speaks about the history of women in science as part of the 2018 Director's Lecture Series.

MARCH

Three powerful storms in March destroy nearly 30 trees. Notable among the wounded survivors is a majestic silver maple on Meadow Road (*Acer saccharinum*, 12560°C), one of the tallest trees in the Arboretum, which staff preserved despite the loss of part of its crown in the March 13-14 storm.



APRIL

Spring planting begins, as hundreds of nursery holdings graduate to the landscape. Some 465 accessioned plants are added to the permanent collections in 2018.

MAY

Robin Hopkins, Assistant Professor of Organismic and Evolutionary Biology and Faculty Fellow of the Arnold Arboretum, accepts the Harvard Fannie Cox Prize for Excellence in Science Teaching, recognizing her dedication to teaching complex ideas in life sciences and inspiring students to pursue careers in science.



2018



JULY

Children from across the Boston area enjoy Free Fun Friday at the Arboretum, an annual offering in cooperation with the Highland Street Foundation. Activities include a caterpillar lab, StoryWalks, a building lab, and tree-climbing demonstrations by arborists.

SEPTEMBER

Michael Dosmann and Stephen Schneider join a collaborative expedition to Japan, a country unexplored by Arboretum collectors since 1977, as a part of the Campaign for the Living Collections. The trip results in collections of 55 taxa.



JUNE

The sixth annual short course in plant morphology kicks off at Weld Hill, co-sponsored by the New Phytologist Trust. The intensive, two-week course covered principles of plant form, focusing on developmental dynamics, evolutionary diversification, and ecological and physiological function.

DECEMBER

The Visitor Center hosts an exhibition exploring the past, present, and future of plant exploration. The exhibit includes maps, photographs, and artifacts from the Arboretum's nearly 150-year history of plant collecting around the world.

OCTOBER

More than 1,000 people attend a special twilight performance of *Macbeth* performed by Actors' Shakespeare Project (ASP) on the Hunnewell Building lawn, one of several free performances offered in tandem with Japanese artist Fujiko Nakaya's climate-responsive fog installation.

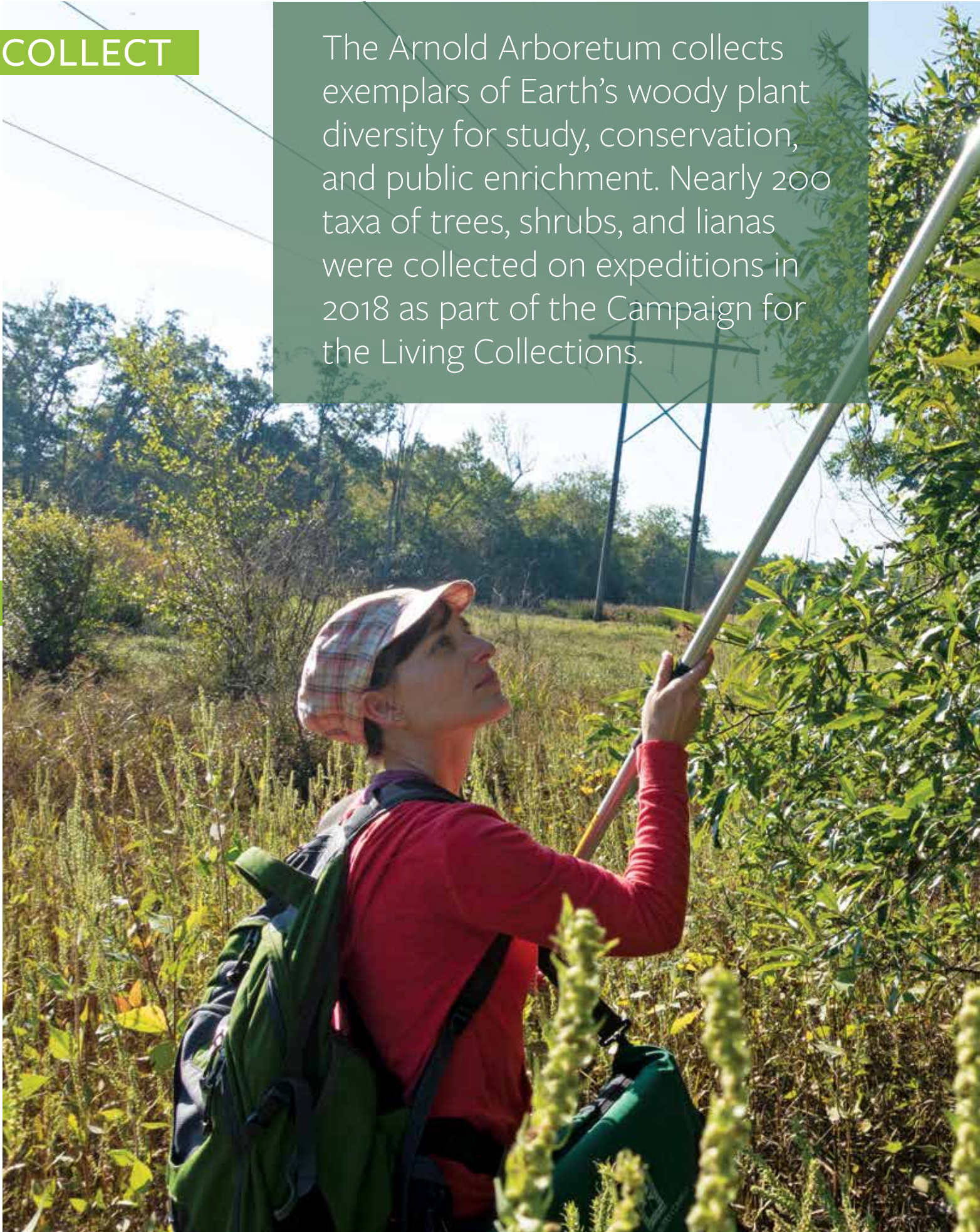


NOVEMBER

Meryl Streep shoots a scene for a major motion picture adaption of Louisa May Alcott's *Little Women* on Meadow Road.

COLLECT

The Arnold Arboretum collects exemplars of Earth's woody plant diversity for study, conservation, and public enrichment. Nearly 200 taxa of trees, shrubs, and lianas were collected on expeditions in 2018 as part of the Campaign for the Living Collections.





Robert Meyer

Ginkgo biloba 'Hayanari', 824-83*A

Ginkgo and Forsythia

join the Arboretum's National Collections

In 2018, two collections received national accreditation through the Plant Collections Network of the American Public Gardens Association. *Forsythia* and *Ginkgo* joined *Acer* (maple), *Carya* (hickory), *Fagus* (beech), *Stewartia*, *Syringa* (lilac), and *Tsuga* (hemlock) as some of the most important generic collections of their kind. Living Collections Fellow Terry Huang prepared application packets and facilitated a two-day audit in August during which an external reviewer examined records, visited plants in the landscape, and interviewed staff to evaluate the Arboretum's commitment to the collections' long-term stewardship. The *Ginkgo* collection—represented by the singular species *Ginkgo biloba*—is one of the most significant on Earth, due to the collections from China made by Senior Research Scientist Emeritus Peter Del Tredici. The *Forsythia* collection is one of the most species-rich in cultivation, and contains many historic cultivars. Both collections have served valuable research, conservation, and educational purposes, and with this recognition, we imagine a dramatic increase.

Yin Kaipu Archive

brings a contemporary view of Wilson's China

In May, the Horticultural Library and Archives received a donation of a significant photographic archive from Professor Yin Kaipu of the Chengdu Institute of Biology, Chinese Academy of Sciences. The collection documents his nearly twenty-year project to re-photograph locations in Sichuan and Hubei Provinces first captured a century earlier by Arboretum plant collector Ernest Henry Wilson. By identifying and revisiting nearly 300 locations in Wilson's images, Professor Yin has provided an invaluable resource documenting the history of change in the landscape and the effects of environmental change over the past century. One may also make comparisons between Yin's older and more recent photographs that show China in a period of intense development. His "before and after" photographs documenting the devastating earthquakes in Sichuan in 2011 show the effects of nature to re-sculpt mountains and change the course of rivers. In conjunction with this generous donation, Professor Yin traveled with a delegation from China to the Arboretum for an exhibit featuring his images paired with their Wilson partners. More than a hundred people attended an opening reception amidst our bonsai and penjing collection. In addition to the exhibition, Dr. Jun Wen, Research Botanist and Curator at the Smithsonian National Museum of Natural History, performed the miraculous: a talk about the East Asian and North American botanical connection in both Mandarin and English! Keeper of the Living Collections Michael Dosmann introduced clips from the documentary series *Chinese Wilson* produced for Chinese television. The series links China and Arnold Arboretum exploration history with modern-day quests to preserve these locations and their biodiversity.

Tiffany Enzenbacher

Targeting Conservation

in the Campaign for the Living Collections

With one in five plant species globally threatened with extinction, the Campaign for the Living Collections was launched by the Arnold Arboretum as an institution-wide effort to boost biodiversity study and collections development. After four years and sixteen major expeditions, the ten-year initiative has yielded 199 of the 395 high-priority targeted species. These include rarities threatened with extinction like bracted arrowwood (*Viburnum bracteatum*) from the southern United States, as well as *Decaisnea insignis*, a bizarre-looking plant from East Asia that goes by many interesting common names including “dead man’s fingers.” With each addition, the Arboretum acquires not only a species with a fascinating natural history, but also a host of individual stories, observations, and reflections of collectors in the field.

In 2018, Arboretum explorers engaged in four expeditions. Manager of Plant Records Kyle Port and Living Collections Fellow Terry Huang botanized through Washington and Oregon, making many collections of exemplar Pacific Northwest species, particularly conifers. The two hiked high and low to gather a bounty that included Engelmann spruce (*Picea engelmannii*), sugar pine (*Pinus lambertiana*), and the endangered whitebark pine (*Pinus albicaulis*). Manager of Plant Production Tiffany Enzenbacher and Plant Growth Facilities Manager Kea Woodruff also explored the North American flora, collecting in Arkansas, Missouri, and Oklahoma, another region replete with biodiversity. Among the notable species they collected was *Alnus maritima*, a rare alder with three isolated occurrences: coastal Delmarva Peninsula (from where its common name of seaside alder comes), northwest Georgia, and central Oklahoma where the two collected material.

On the international front, Keeper of the Living Collections Michael Dosmann and Director of Operations Steve Schneider were on Honshu Island in Japan, a country not notably explored by the Arboretum since 1977. One of their highlights included a rare location where the ranges of both species of katsura tree (*Cercidiphyllum japonicum* and *C. magnificum*) overlap; they excitedly collected seed of the latter. Western Hubei Province, China, was the destination for Head of Horticulture Andrew Gapinski and colleagues as they explored a region made famous in the 1980 Sino-American Botanical Expedition to Shennongjia. *Acer*, one of the Arboretum’s most important genera, was well represented: the explorers made collections from a dozen different maple taxa.





Michael Dosmann and colleagues collect *Hydrangea hirta* on the 2018 expedition to Honshu, Japan.




Director of Operations and Public Engagement Stephen Schneider (left) and Head of Horticulture Andrew Gapinski sort seeds received by the Dana Greenhouses from their 2018 expeditions in Japan and China, respectively.

Jon Hetman

Expeditions yield new germplasm to infuse the dynamic living collections. Our landscape changes with each new class of graduating trees planted from the nurseries at the Dana Greenhouses. And, in time, these small juveniles grow to become tomorrow's canopy. The collections change in other ways as well. Aging trees senesce, raging Nor'easters pummel, and lower-value accessions are removed to make way for new plants of greater value. It is a never-ending cycle.

The Nationally Accredited beech (*Fagus*) collection is perhaps one of the most dramatic examples. Due to the ravages of beech decline and tough environmental conditions (particularly recent droughts), many accessions have recently perished. Others, showing signs of significant decline and harboring disease, have also been removed. From 2014 to 2018, there were 21 deaccessions, some quite venerable and old. However, most (18) were of garden or unknown provenance, limiting their value to conservation and research. Their vacancies, while stark, will only be temporary, for to date 15 new accessions of six species of *Fagus* have been collected in the campaign, including American beech (*F. grandifolia*) from varying portions of its native range, to the rare-in-cultivation *F. longipetiolata* from China. Soon, these young plants will acquire permanent homes. The cycle continues.

Stephen Schneider



Investigative use of the Arnold Arboretum's extensive collections center at the Weld Hill Research Building and Greenhouses, where state-of-the-art equipment and facilities support study across a broad array of disciplines and provide a powerful platform for learning and scholarship.

Field Methods and Living Collections

A creative experiment in pedagogy between a landscape designer-theorist and an evolutionary biologist at the Arnold Arboretum enables students from the Harvard University Graduate School of Design (GSD) to bring plants and the plant sciences to life.

In 2018—for the third year running—eighteen GSD master's-degree candidates from various disciplines including landscape architecture, design, and urban planning, extended their academic exploration into the Arboretum's complex and ever-changing landscape for the innovative course, Field Methods and Living Collections.

The collaboration is led by Rosetta S. Elkin, Associate Professor of Landscape Architecture at the Harvard Graduate School of Design and Faculty Fellow of the

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

Through hands-on fieldwork utilizing social theory and methodology examining plant evolution, morphology, human surroundings, and landscape design and technique, students studied the Arboretum's collections and habitat. Discussions and experiments took place both in the field and in Arboretum classrooms and laboratories.

Using multimedia, drone videos, photography, visual scanning, soil and root analysis, excavation, mapping, models, and even ascents into the canopy in a bucket lift, students examined variability and the fundamental connection between observation and meaning.



Harvard Graduate School of Design/Maggie Janik

Faculty Fellows

of the Arnold Arboretum of Harvard University

Faculty Fellows of the Arnold Arboretum of Harvard University are Harvard professors who contribute meaningfully to the Arboretum's research and education mission. In 2018 there were four Faculty Fellows, **William (Ned) Friedman**, Arnold Professor in Organismic and Evolutionary Biology and Director of the Arnold Arboretum; **Robin Hopkins**, Assistant Professor in Organismic and Evolutionary Biology; **Noel M. Holbrook**, Professor of Organismic and Evolutionary Biology; and **Rosetta Elkin**, Associate Professor of Landscape Architecture in the Harvard Graduate School of Design.

The **Friedman Lab** is based at the Arboretum and focuses on reconstructing the evolutionary origin and early diversification of flowering plants. Its research efforts have focused on the evolution of double fertilization and endosperm, and a quest to understand the evolution of diverse structural patterns of winter buds in members of the walnut family.

Also based at the Arboretum, the **Hopkins Lab** investigates the evolutionary and genetic processes underlying the formation of new plant species. The lab has collected from wild populations of distinct species of *Phlox* in Texas, Kentucky, and across the Midwest for their laboratory and greenhouse experiments. Dr. Hopkins received a 2018 CAREER award from the National Science Foundation to support her work in speciation.

Noel M. Holbrook conducts research using the living collections and the Weld Hill Research Building facilities, mentors and supports Arboretum graduate students and postdoctoral fellows, and is an instructor for the Arboretum's summer short course in organismic plant biology. Primarily based on the Harvard University campus in Cambridge, the **Holbrook Lab** conducts investigations at Weld Hill focusing on understanding plant responses to climate change and functional aspects of the water and sugar conducting tissues of plants.

Rosetta Elkin teaches a Harvard Graduate School of Design course that is based wholly at the Arboretum, both in the landscape and at Weld Hill, thus introducing a new generation of landscape architects to the Arboretum while providing valuable design input to current projects in the landscape (see page 8). Dr. Elkin was among the recipients of the American Academy in Rome's 2017–2018 Rome Prize for her work on the biological complexity of global greening projects.

In addition to research and academic activities, Faculty Fellows and their lab groups are actively involved in Arboretum outreach and education programs. They lead Tree Mobs™, teach Boston public school teachers about science in the Arboretum's Summer Institute, and share their research with visiting STEM groups. With the start of the DaRin Butz Foundation Undergraduate Research Program (see page 11) in 2017, they are also welcoming students into their labs to conduct independent projects under their mentorship.

Where the world STUDIES PLANTS

As a respected and pioneering resource for the study and understanding of temperate woody plants, the Arboretum welcomes students, researchers, and botanical colleagues from all over the world to interact with our staff, our collections, and our landscape. Here are a few snapshots of some of our international guests and collaborators in 2018.

Public Programs

For six weeks in early spring, the Public Programs department hosted Olga Mayoral, a professor and researcher in the Department of Experimental and Social Sciences and the Botanic Garden of the Universitat de València. Professor Mayoral cochaired a study group on teaching in outdoor environments with Nature Education Specialist Ana Maria Caballero McGuire, in conjunction with Roxbury Community College and Harvard University. While at the Arboretum, she also gave a lecture on environmental management and co-presented a webinar on outdoor science training through the Real Colegio Complutense at Harvard.

Curation

In 2018, the Arboretum launched a collaboration with the Chinese Union of Botanical Gardens (CUBG) to provide training to young Chinese professionals working in horticulture or curation. In the spring, Xi Yang, the coordinator for CUBG's training programs, visited the Arboretum and undertook a special project to organize and translate the correspondence of the late Arboretum scholar and plant taxonomist Shiu Ying Hu. Starting in August, Houcheng Xi from Xishuangbanna Tropical Botanical Garden spent four months shadowing staff and pursuing several independent projects, including the verification of *Viburnum* accessions and an audit of geographic data associated with our Chinese accessions.

Living Collections Research

Arboretum research fellowships and awards attract post-doctoral researchers, graduate students, and even undergraduates in the life sciences from around the world to investigate critical questions in our collections and laboratories. Harold Suárez-Baron, a PhD candidate at the University of Antioquia in Colombia, received a Deland Award for Student Research in 2018 to study the genetic mechanisms underlying trichome development in pipevine (*Aristolochia*) flowers. Trichomes are hairlike structures that attract and temporarily trap insects inside the floral tube to facilitate pollination. Suárez-Baron's research represents the first comparative and comprehensive study of its kind in the genus.

Weld Hill Laboratories

Federico Roda worked as a post-doctoral fellow in the Robin Hopkins Lab, studying the causes and consequences of hybridization between species in *Phlox*. At Weld Hill he spearheaded a new area of research in the Hopkins Lab studying the molecular basis of pollen-pistil interactions. In August 2018, Dr. Roda started as a Max Planck Tandem Group Leader at the Universidad Nacional de Colombia, Sede Bogotá, where he leads research studying how plants interact with the environment to produce compounds with potential medicinal properties.

Arnold Arboretum Archives

Margaret Gross, a senior lecturer at the University of Melbourne, Australia, received a 2018 Sargent Award to explore the history and results of Ernest Henry Wilson's collecting trip to Australia in 1920-21. Margaret spent many hours combing through the Arboretum library archives to examine Wilson's field notes, letters, and images documenting his experiences in Australia, the details of which remain undocumented and unknown in that country.

Mentoring Tomorrow's Leaders in Plant and Environmental Research

DaRin Butz Foundation Research Internship Program

Since 2013, the DaRin Butz Foundation has contributed funding to the Arnold Arboretum to create opportunities for those interested in pursuing careers in the sciences. Beginning in 2017, the Foundation increased its annual commitment to undergraduate education at the Arboretum, and the DaRin Butz Foundation Research Internship Program was launched.

The rigorous, ten-week program is based primarily in the laboratories and classrooms at Weld Hill, offering participants a unique opportunity to experience research from start to finish while gaining training and connections among scientific colleagues. DaRin Butz Foundation Interns not only conduct research that assists the ongoing studies of their host laboratories, but they also develop an independent project with their advisors and gain experience in sharing their investigations through written reports and oral presentations. Interns participate in a number of learning and networking activities through the summer with their cohort, including a weekly reading group and formal classes and tours with Arboretum staff.

From mid May through the end of July 2018, DaRin Butz Foundation Interns became vital collaborators in the laboratories of three Faculty Fellows at the Arnold Arboretum—Professors William (Ned) Friedman, Robin



Hopkins, and Noel Holbrook—as well as the labs of Arboretum Putnam Fellows Kasia Ziemińska and Elizabeth Spriggs, Boston University Professors Pam Templer and Lucy Hutyra, and MIT professor and Arnold Arboretum Associate David Des Marais. Our 2018 interns investigated a diverse array of issues, including plant speciation and reinforcement, ecology and climate change, atmospheric pollution, tree anatomy and water storage, and evolution and conservation. On their final day, the interns delivered a research symposium for Arboretum staff, providing an overview of their experiences and, for some, foreshadowing the next exciting steps in their career trajectories.

Isabella Welles Hunnewell Internship Program

Participants in the Isabella Welles Hunnewell Internship Program receive on-the-job training in horticulture and public gardens management at the Arboretum. Working alongside a dedicated team of arborists, horticulturists, gardeners, and collections managers, Hunnewell interns learn all aspects of plant propagation, cultivation, and care. They also coordinate and execute a comprehensive strategy to address a major landscape design or collections management issue. In 2018, interns focused on improving collections display at the Walter Street Gate, performing a curatorial review of *Taxus* (yew) accessions, and recommending future improvements to the area as a visitor portal.

Norfolk Agricultural High School Practicum

Each season our Hunnewell interns have the opportunity to collaborate with another group of horticultural trainees—students from Norfolk County Agricultural High School (NCAHS). Since 2008, the Arnold Arboretum and NCAHS have partnered to offer students a practicum in the care of plant collections and public garden landscapes. Modeled in part on the Hunnewell program, students spend five-weeks working in the landscape and attending specialized classes. In 2018, nine “Aggie” interns also received mentoring from our staff experts on topics ranging from pruning, planting, and IPM practices to archival management and landscape renovations.

Horticultural Library Internships

Two master's candidates of library and information science at Simmons University interned in the Arnold Arboretum Horticultural Library to work with its specialized collection devoted to the study of temperate woody plants. In spring, Vanessa Formato began a curatorial investigation into the manuscript materials of botanist Shiu Ying Hu, late Emeritus Senior Research Fellow of the Arnold Arboretum, whose legacy for scholarship continues through the Shiu Ying Hu Research Exchange Award. In fall, Mary Perez analyzed and consolidated the Arboretum's special events records.



Committed to the educational mission of Harvard University and a leader in community engagement in Boston, the Arnold Arboretum offers a multitude of rigorous and diverse learning and enrichment opportunities for people of all ages.





Fujiko Nakaya

brings atmospheric art to the Arboretum

For a three-month run from August through Halloween, the Arnold Arboretum and four additional parks in Boston's Emerald Necklace provided beautiful and evocative settings for climate-responsive "fog sculptures" by Japanese artist Fujiko Nakaya, part of the celebration of the twentieth anniversary of the Emerald Necklace Conservancy. Nakaya's unique installation near the Hunnewell Building—*Fog × Hill*—enticed visitors from around the world at every age to relish and interact with the beauty, immediacy, and fluidity of this atmospheric art form. The dramatic ebb and flow of the fog provided an opportunity to showcase original Arboretum events influenced by its ephemeral qualities: *Songs in the Fog*, *Clouds and Particles in Climate*, *Flow Through*, *Music for Atmosphere and Ground*, and a site-specific *Macbeth*. Families participated in free, kid-friendly programs like *Fog Fall × Rain Fall*, *Hydrophobic Lab*, and *Engineering in the Fog*—each activity and performance a singular and immersive experience.

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Exploration Then and Now and our legacy of botanical discovery

Plant collecting expeditions have long been at the heart of the Arnold Arboretum, from the days of Charles Sprague Sargent and his inaugural expeditions to our current Director Ned Friedman and this decade's Campaign for the Living Collections. The inspiration of discovery, the wonder and appeal of the biodiversity of Asia, and the spirit of explorers from Ernest Henry Wilson to Michael Dosmann have made an indelible impact in preserving global biodiversity for study and conservation. On November 8, the Arboretum hosted a gala opening of a special exhibition in the Visitor Center celebrating this heritage: *Plant Exploration, Then and Now*. Displayed through mid-March 2019, both the exhibition and the opening were generously supported by Arboretum friends Peter and Leslie Ciampi, and developed through a collaboration by Visitor Engagement, Horticultural Library, Curation, and Institutional Advancement staffs.

Connecting to the Community

through nature and learning

Our Public Engagement staff created and shared spectacular events, programs, and other educational opportunities with our visitors in 2018. Art at the Arboretum captivated and informed, from the inspirational *Spirit Books* of Susan Kapuscinski Gaylord to botanical works by Bobbi Angell, Beverly Duncan, and Regina Gardner Milan. A full decade of creative and contemplative interactions between photographer Jim Harrison and the Arboretum's collections and landscape were featured in a special exhibition, *Continuation: Seasons at the Arboretum*. In May, New Englanders celebrated the 110th anniversary of Lilac Sunday on a beautiful spring day, enjoying numerous tours, family-focused activities, picnicking, and musical performances.



Ernest Henry Wilson and his houseboat in China—*The Harvard*—photographed circa 1908.



Our Visitor Center logged more than 67,000 interactions with the public in 2018. Staff and docents provided dynamic perspectives on our living collections and Arboretum history to more than 2,250 visitors, and more than 1,500 toured our Bonsai and Penjing Collection in monthly open houses in the pavilion at the Dana Greenhouses. Interpreters in the Landscape, Wellness Walks, Art Receptions, Family Hikes, Forest Bathing, Yoga in the Park, Collections Up Close, Free Fun Friday, and Woodturners Weekend connected thousands more to this public greenspace—to its value as a living museum and free community hub for culture, recreation, and discovery.



Jeff Blackwell



More than 2,500 students, primarily from Boston Public Schools, explored life science outdoors in Field Studies Experiences (grades Pre-K to Grade 5), guided by Manager of Children's Education Nancy Sableski, Nature Education Specialist Ana Maria Caballero Maguire, and 53 trained volunteers. Visiting students studied trees, flowers, seeds, and ecosystems. Younger participants developed skills for close observation and scientific language. Programming also facilitated meaningful self-guided visits by hundreds of classrooms, enabling nearly 4,000 additional students (pre-K to High School) to learn in our landscape.



Ana Maria Caballero offered professional development programming (Arboretum for Educators) to 71 educators, amounting to nearly 180 hours of learning in our landscape. Teachers represented sixteen schools from within the Boston Public School System in addition to schools in Lynn, Chelsea, Malden, and adjacent suburbs. The Summer Institute: Investigating Ecosystems Through Field Work immersed 22 teachers (Grades 3–High School) in the practice of fieldwork.



Adult Education offered 55 programs and 10 Tree Mobs™, serving more than 1,300 learners. Classes included practical training in pruning, propagation, and tree identification. Award-winning authors and academics lectured on topics including women in science, sea level rise, sounds in nature, and ethics in conservation. Tree Mobs™ engaged learners in arboreal topics and more, from the microbes found on solar panels to the migratory habits of birds.

STEWARD



The Arboretum is committed to excellence in plant care and preservation to engage researchers and the general public, and to ensure the health and integrity of its valued living collections.

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Top: Horticulturists Laura Mele and Conor Guidarelli collect soil samples in the maple collection. Bottom: Assistant Manager of Horticulture Rachel Brinkman confers with Head of Horticulture Andrew Gapinski.



Enhancing the Health and Services of our managed ecosystem

Across horticulture operations at the Arboretum, we seek to increase the health of our plant collections, improve the aesthetics of our landscape, and enhance the value of our ecosystem by thinking critically about how our actions affect the environment. From reducing our carbon footprint through cleaner-running maintenance equipment to recycling green waste into a compost “brew”—yes, coffee and beer help feed our plants—ongoing operational modifications reflect our ever-increasing concern for a changing world.

Our effort to manage organic waste from the landscape is one such example. Leaf litter, when possible, is now left in place to build a more natural “forest floor” over time, cycling carbon and nutrients and feeding and supporting the health of the plants. Leaves that are collected from lawns and formal areas, are processed in our new composting facility along with weeds and other green waste from local partners—spent grains and hops from Turtle Swamp Brewing (Jamaica Plain) and coffee grounds from Recreo Coffee (West Roxbury). Together, these actions highlight our goals to reduce carbon emissions associated with leaf removal, reuse organic material that would otherwise be sent to landfills, and produce high-quality compost to feed our plants.

Mowing operations are also under review, resulting in new “no-mow” or reduced-mow meadows springing up across the Arboretum. These areas reduce equipment-induced soil compaction, add to the beauty of the landscape, and create habitats that support wildlife. For example, the no-mow areas increasingly support growing populations of common and butterfly milkweed (*Asclepias syriaca*, *A. tuberosa*), provide food and shelter for insects such as ground nesting bees and monarch butterflies, attract nesting red winged blackbirds and tree swallows, and increase hunting habitat for resident red-tailed hawks and great horned owls.

Overall, landscape management changes revolve around the principles of plant care, soil health, work efficiency, and “intelligent” aesthetics to make the most sustainable decisions for the health of this managed ecosystem. Taken together, these and other actions increase the value of the Arnold Arboretum as a role model for sustainable practices while highlighting the importance of the landscape to organisms of all types in Boston and beyond.

Illuminating Greater Sustainability

at the Weld Hill Research Greenhouses

Over the past several years, the Arnold Arboretum has made significant strides in boosting the energy efficiency and sustainability of its operations on many fronts, from “greening” aspects of our landscape and collections-management activities to adding extensive solar arrays at the Hunnewell Building and at the Dana Greenhouses. In the quiet days of Harvard’s winter recess, the Weld Hill Research Building greenhouses got a shiny upgrade when the high-intensity discharge lamps (HIDs) used to keep plants growing (even on the shortest, darkest days) were replaced with horticultural LED fixtures. Thanks to financial assistance from the Harvard Green Revolving Fund and Eversource, our growth facilities are now greener than ever. The high-intensity output of this LED product allowed us to reduce the number of light fixtures from 144 to 96. Additionally, the LED lamps use about one-third as much electricity as their HID counterparts. These factors are expected to lead to energy savings of nearly 135,000 kWh per year in the greenhouses. The new LED fixtures offer additional benefits including reduced waste heat, a longer lifespan, and a spectrum specifically designed to help plants grow more efficiently.





Library and Archives

Stewardship and Security

The Horticultural Library and Archives led a comprehensive review of collections security in 2018, and reviewed collections-care practices with assistance from the Weissman Preservation Center at Harvard University and independent experts. Their assessments encompassed materials preservation, evaluation of environmental conditions like humidity and lighting levels, and an in-depth analysis of security. Steven Keller of Architect's Security Group prepared a comprehensive list of recommendations for upgrading security infrastructure throughout spaces occupied by the library and archives, and since then implementation has proceeded apace.

In March 2018, the library implemented Aeon, Harvard University's special collections and archives system for patron management, request tracking, photoduplication fulfillment, and activities management. Aeon has enabled staff to decommission an outdated and inadequate patron database via a University-wide management system. Through its public interface, Hollis Special Request, researchers may request archival materials for use in the Arboretum's Reading Room or for scanning. The system now serves as a comprehensive tracking system for research requests. It includes a file transfer utility, and permits detailed tracking of library events including exhibitions, classes, tours, and receptions. This represents another key component of our collection management and security framework, and will support additional features and improvements as more Harvard special collections come online.

Plant Collections in 2018



As of December 31, 2018 the Arboretum's living collections (including nursery holdings) comprised:

2,142 species • 3,796 taxa

10,858 accessions • 16,233 individual plants

465 accessioned plants were added to the permanent collections, while **440** were **deaccessioned**.

The Arnold Arboretum herbarium contains some **1.5 MILLION specimens**.

The Arboretum's herbarium of cultivated plants contains **121,592 specimens**

Thank You for Your Support

Janetta Stringfellow, Director of Institutional Advancement



Dear friends,

As I gaze out the window at “my” cedar of Lebanon and watch a visitor walk a dog across the magnolia blossoms, which are just beginning to fall, it’s a challenge to succinctly thank all of you for the breadth and depth of work you supported in 2018.

As you can see in this report, contributions from donors made an impact—whether it was banding together to help us launch a production of *Macbeth* in Fugiko Nakaya’s fog; initiating and funding an exhibition featuring our 146-year history of plant exploration; or making a loyal donation to our fully donor-supported Hunnewell and DaRin Butz Foundation internship programs, which help young people launch careers.

Your generosity permeates our programs in horticulture, science, and education. Your gifts are vital to keep the Arboretum a free, healthy, and beautiful resource to the citizens of Boston and to the educators and researchers who come from around the globe to work here.

Thank you for supporting our wide-reaching mission. I look forward to seeing many of you on the grounds in 2019.

A handwritten signature in black ink that reads "Janetta".

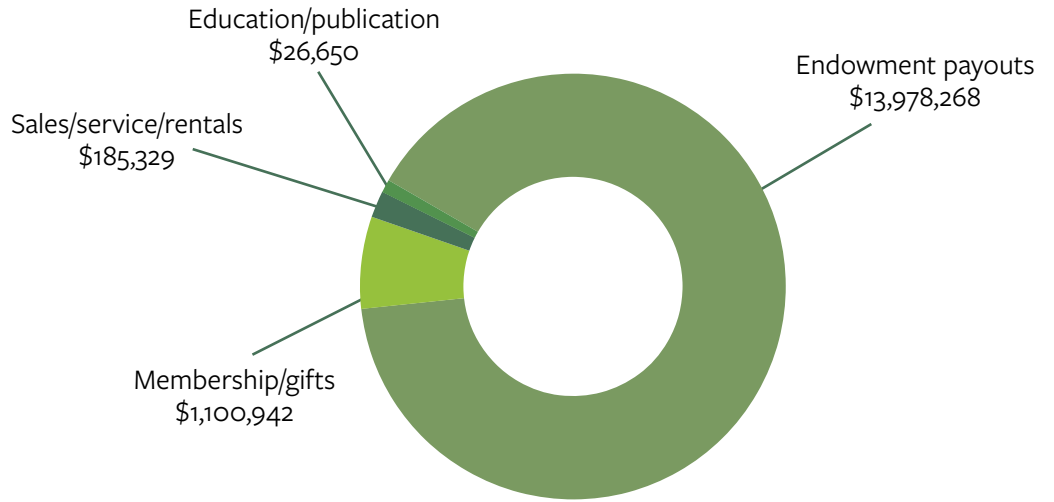


Jon Hietman

Statement of Activities

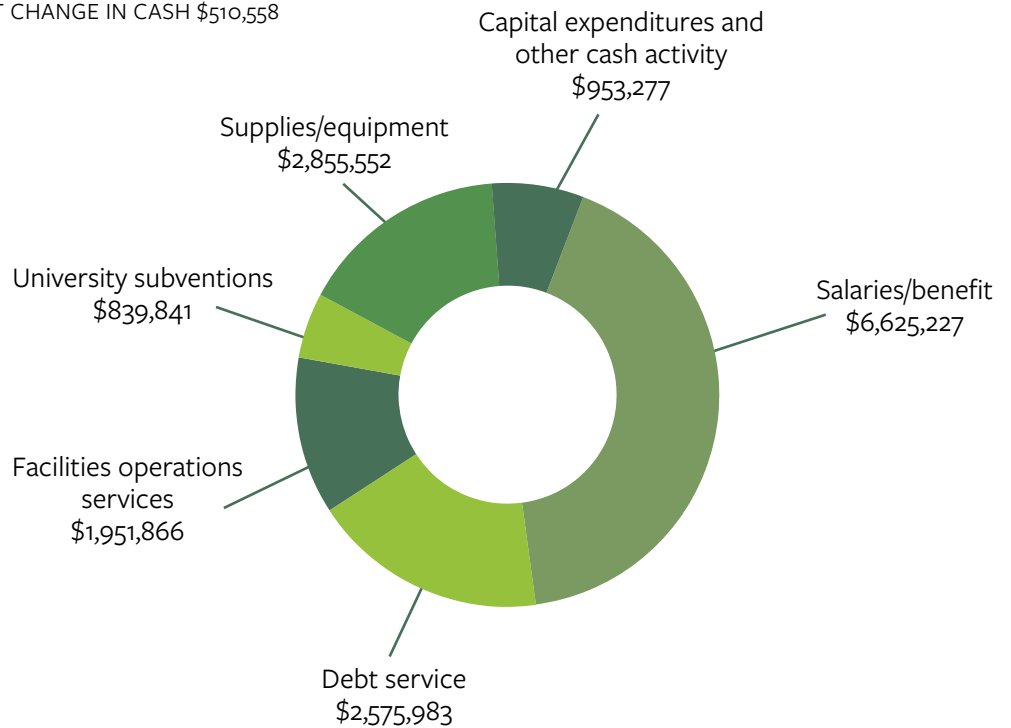
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EXPENSES: \$15,801,746

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Peter Del Tredici

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TREE SPOTTERS

Seventy volunteers participated in our Tree Spotters citizen science program in 2018, logging 60,902 phenological observations of Arboretum plants for use in climate change research through the National Phenology Network. The program is moderated by Catherine Chamberlain, Suzanne Mrozak, and Danny Schissler.

TREEVERSITY

More than 2,513 volunteers around the world participated in Treeversity, our online citizen science project to catalog thousands of images of Arboretum plants for public use. TreeVersity volunteer moderators were Eliane Escher, Sami Kananoja, Suzanne Mrozak, Julie Whelan, and Cindy Whitcome.




Research Publications

■ Arnold Arboretum Staff ■ Visiting Scholars, Fellows, and Associates

 Award Recipient

 Putnam Fellow

Briggs HM, Graham S, Switzer CM , **Hopkins R**. 2018. Variation in context-dependent foraging behavior across pollinators. *Ecology and Evolution* 8: 7964–7973.

Brinkman RA. 2018. Hidden Gem Among Vines: *Actinidia arguta*. *Arnoldia* 76(2): 36–37.

Campitelli BE, Kenney AM, **Hopkins R**, Soule J, Lovell JT, Juenger TE. 2018. Genetic mapping reveals an anthocyanin biosynthesis pathway gene potentially influencing evolutionary divergence between two subspecies of Scarlet Gilia (*Ipomopsis aggregata*). *Molecular Biology and Evolution* 35: 807–822.


Carvalho MR, **Losada JM**, Niklas KJ. 2018. Phloem networks in leaves. *Current Opinion in Plant Biology* 43: 29–35.

Damery J. 2018. Recalling Plums from the Wild. *Arnoldia* 75(3): 24–34.

Damery J. 2018. Hickory Fever: Doing Taxonomy by Mail. *Arnoldia* 76(1): 32–43.

Damery J. 2018. Overstory View. *Arnoldia* 76(2): 33–35.

Davies TJ, Regetz J, **Wolkovich EM**, McGill BJ. 2018. Phylogenetically weighted regression: A method for modelling non-stationarity on evolutionary trees. *Global Ecology and Biogeography*.

Decina SM , **Templer PH**, **Hutyra LR**. 2018. Atmospheric inputs of nitrogen, carbon, and phosphorus across an urban area: Unaccounted fluxes and canopy influences. *Earth's Future* 6: 134–148.

Del Tredici P. 2018. Behind the Scenes on Naming a New Hemlock Species. *Arnoldia* 76(2): 2–9.

Dosmann MS. 2018. Keeping the Legacy: Retracing Century-old Footsteps. *Arnoldia* 75(3): 5–8.



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Dowell R, Dosmann MS. 2018. 2017: A Banner Year for the Campaign for the Living Collections. *Arnoldia* 75(3): 2–4.

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Ettinger AK , **Gee S** , **Wolkovich EM**. Phenological sequences: how early-season events define those that follow. *American Journal of Botany* 105: 1–10.

Flynn DFB, Wolkovich EM. 2018. Temperature and photoperiod drive spring phenology across all species in a temperate forest community. *New Phytologist* 219: 1353–1362.

Gallinat AS, Primack RB, Willis CG, Nordt B, Stevens A-D, Fahey R, Whittemore A, Du Y, Panchen Z. 2018. Patterns and predictors of fleshy fruit phenology at five international botanical gardens. *American Journal of Botany* 105: 1824–1834.


Garner A, Goulet B, Farnitano M, Molina-Henao Y, Hopkins R. 2018. Genomic signatures of reinforcement. *Genes* 9: 191.

Griffith MP, Barber G, Tucker Lima J, Barros M, Calonje C, Noblick LR, Calonje M, Magellan T, **Dosmann M**, Thibault T, Gerlowski N. 2018. Plant collection “Half-life:” Can botanic gardens weather the climate? *Curator* 60: 395–410.

Halloran S. 2018. *Pieris phillyreifolia*: The Opportunistic Climbing Fetterbush. *Arnoldia* 75(3): 16–18.

Halloran S, Zuckswert J. 2018. Coastal Southeast Expedition 2017: How Habitat Type Guides Collecting. *Arnoldia* 75(3): 13–15.

Hopkins R. 2018. Evolution: Flip-flopping flower color defies Dollo’s Law. *Current Biology* 28: R1337–R1339.


Huggett BA, **Savage JA** , Hao G-Y, Preisser EL, **Holbrook NM**. 2018. Impact of hemlock woolly adelgid (*Adelges tsugae*) infestation on xylem structure and function and leaf physiology in eastern hemlock (*Tsuga canadensis*). *Functional Plant Biology* 45: 501–508.

Keegan B. 2018. A Winter Beauty: *Viburnum opulus*. *Arnoldia* 75(3): 44–45.

Kharouba HM, Ehrlén J, Gelman A, Bolmgren K, Allen JM, Travers SE, **Wolkovich EM**. 2018. Global shifts in the phenological synchrony of species interactions over recent decades. *Proceedings of the National Academy of Sciences* 115: 5211–5216.

Losada JM, Leslie AB. 2018. Why are the seed cones of conifers so diverse at pollination? *Annals of Botany* 121: 1319–1331.

McDermitt M. 2018. The Pear to End All Wars: *Pyrus ussuriensis*. *Arnoldia* 75(4): 44–45.

Morris H, Gillingham MAF, Plavcová L, Gleason SM, Olson ME, Coomes DA, Fichtler E, Klepsch MM, Martínez-Cabrera HI, McGlenn DJ, Wheeler EA, Zheng J, **Ziemińska K** , Jansen S. 2018. Vessel diameter is related to amount and spatial arrangement of axial parenchyma in woody angiosperms. *Plant, Cell & Environment* 41: 245–260.



Kathleen Doohar

Arnold Arboretum—Funded Research Fellowships and Awards

ARNOLD ARBORETUM GENOMIC INITIATIVE AND SEQUENCING AWARD

Nathan Swensen, Associate Professor, University of Maryland

A hybrid genome assembly and tissue-specific expression in a parthenocarpic maple—*Acer griseum* (Franchet) Pax

ASHTON AWARD FOR STUDENT RESEARCH

Robin Hayward, PhD Student, University of Stirling, Scotland

Plant community composition across age-classes in logged tropical forests: Implications for long-term recovery

Krittika Petprakob, PhD Student, University of Maryland

Hydraulic traits variation, drought tolerance and distribution of tropical tree species

CUNIN/SIGAL RESEARCH AWARD

Avalon Owens, PhD Student, Tufts University

Does artificial light affect the courtship success of *Photinus obscurellus* fireflies?

DELAND AWARD FOR STUDENT RESEARCH

Meghan Blumstein, PhD Candidate, Holbrook Lab, Harvard University

Genomic diversity in red oak (*Quercus rubrum*) phenology

Erin Pierce, PhD Student, Templer Lab, Boston University

Impact of tropospheric ozone and nitrogen deposition on urban forest health and carbon sequestration

Harold Suarez-Baron, PhD Candidate, University of Antioquia in Colombia

Morpho-anatomical and genetic mechanisms underlying perianth trichome formation in *Aristolochia* (Aristolochiaceae) woody vines

JEWETT PRIZE

Natalia Pabón-Mora, Associate Professor, University of Antioquia in Colombia

Understanding the genetic basis of fruit development in Rubiaceae

KATHARINE H. PUTNAM FELLOWSHIP IN PLANT SCIENCE

Jacob Grossman, Putnam Fellow, Arnold Arboretum

Drought vulnerability and water-use regulation of the Arnold's woody collections

SARGENT AWARD FOR VISITING SCHOLARS

Margaret Grose, Senior Lecturer, University of Melbourne, Australia

Initial exploration of Ernest H. Wilson's Australian collection in the Arnold Arboretum

Dong Wang, Assistant Professor, University of Massachusetts, Amherst

Studying the nitrogen-fixing symbiosis among woody legumes and actinorhizal species of the Arnold Arboretum

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