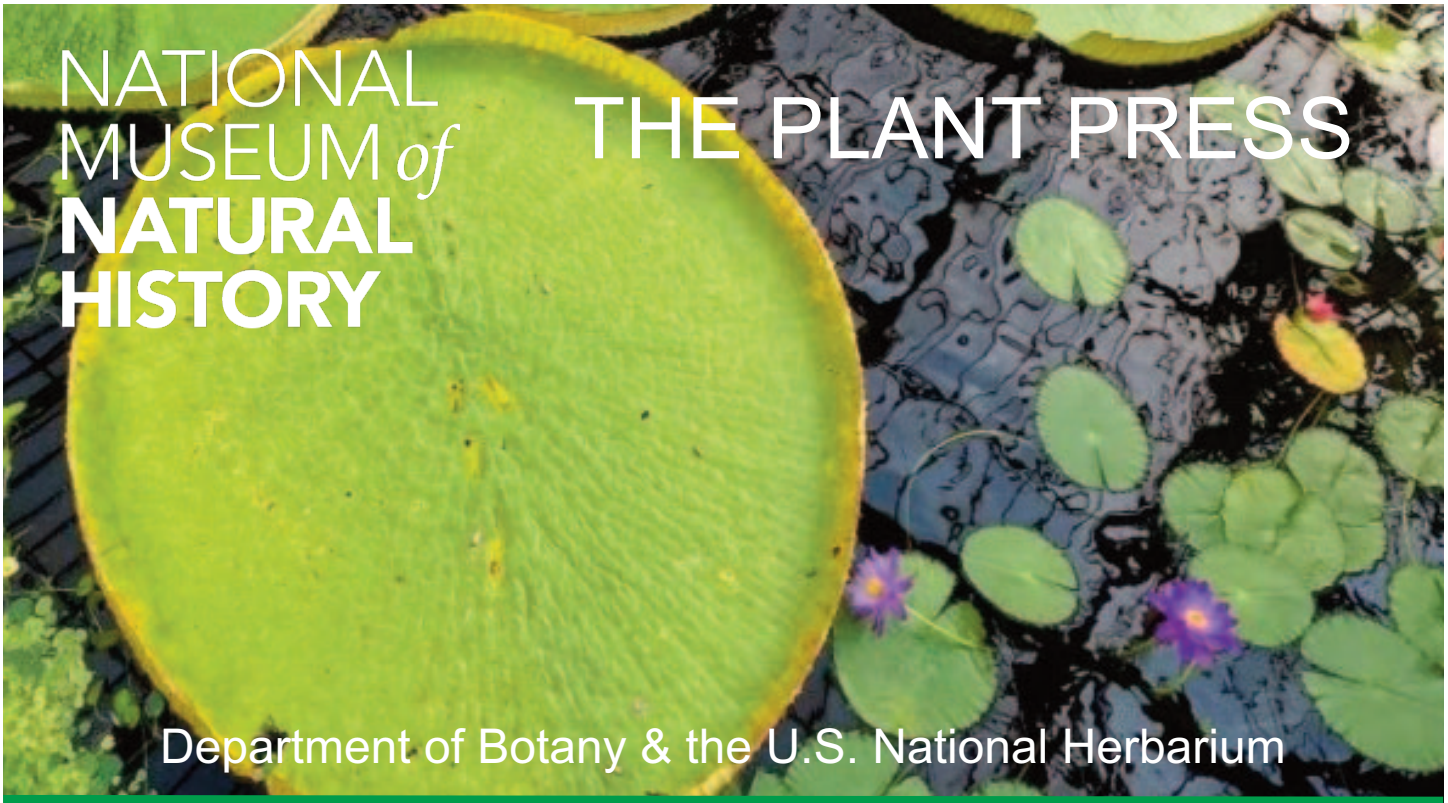

NATIONAL MUSEUM of NATURAL HISTORY

THE PLANT PRESS

Department of Botany & the U.S. National Herbarium

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Planting for the future:
Conservation horticulture blossoms at symposium

By Gary A. Krupnick

The Smithsonian's National Museum of Natural History (NMNH) Department of Botany, the United States Botanic Garden (USBG), and the Smithsonian Gardens held the 21st Smithsonian Botanical Symposium, "Advancing Plant Conservation Through Horticulture," on May 17, 2024. The hybrid event brought together five engaging speakers who presented their research to both an in-person and a virtual audience from around the world. Scientists and horticulturalists from botanic gardens and conservation organizations spoke about how they maintain diverse and wild-collected *ex situ* plant collections, care for plants of concern *in situ*, provide plants for population augmentation and repopulation, and support conservation education and advocacy.

Eric Schuettpelz, NMNH Curator of Botany, welcomed the audience to the symposium. Rebecca Johnson, the CW Whitney Chief Scientist and Associate Director for Science at NMNH, highlighted the mission of the Smithsonian as well as the immense collections housed in the museum and especially the U.S. National Herbarium. She particularly gave praise to the work of digitizing all pressed specimens in the herbarium and the many benefits of having that data online. Susan Pell, USBG Executive Director, also provided opening remarks and gave an orientation to the USBG, including its history, a description of the living collections, their scientific research, and their scientific and conservation partnerships.

Laurence Dorr, NMNH Curator of Botany, presented the José Cuatrecasas Medal for Excellence in Tropical Botany to Peter F. Stevens, an accomplished professor of biology at the

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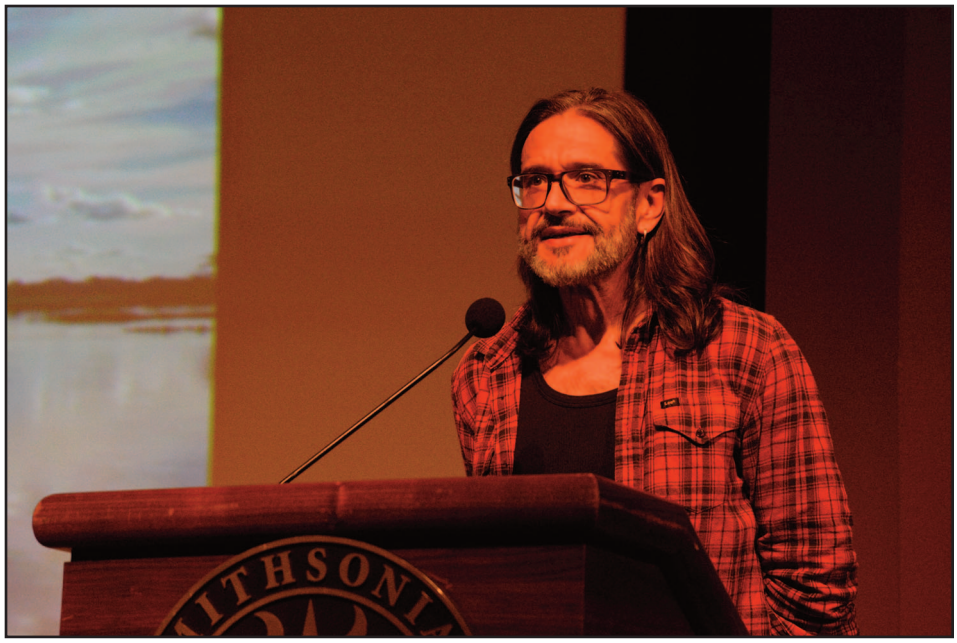
> **"As humans are causing unprecedented change across the globe, I have the good news to share that we are also the solution"**
>
> *- Abby Meyer in her talk, "Conservation Horticulture Capacity at Botanic Gardens."*

Symposium

Continued from page 1

University of Missouri, St. Louis, and a prominent research curator at the Missouri Botanical Garden. In addition to the typical biographical sketch, Dorr reminisced about the mentorship he received from Stevens in the 1970s. Accepting the award, Stevens remarked about how little we really know about the big picture in many aspects of tropical botany, including tropical trees in Ericales and Malpighiales. He said that to really understand evolution, there is more to learn about species relationships as well as basic morphology and anatomy.

The first presentation of the symposium was delivered by Carlos Magdalena from the Royal Botanic Gardens Kew. He opened his talk, "The many facets of botanical horticulture," with a broad description of how botanic gardens, specifically Kew Garden, have a mission to educate, provide public enjoyment, and to celebrate heritage. Focusing on botanical horticulture, Magdalena spoke about his work on the café marron, *Ramosmania rodriguesi*, a tree native to the Mauritian island of Rodrigues in the Indian Ocean. Once declared extinct, an individual plant was later discovered by a schoolboy, and several cuttings were made. After 20 years of trying to get the plants to produce seed, Magdalena was finally successful in getting the plant to fruit. More interesting was the fact that the plant takes on two forms, where younger plants look very different than mature plants. Having the plants growing in the greenhouse allows scientists to learn more about their natural history and can provide clues for conservation horticulture, which resulted in the ability to plant hundreds of seeds back into the wild. Magdalena is conducting similar research on *Elaeocarpus bojeri*, *Chassalia boryana*, and *Roussoea simplex*, the latter being pollinated by gecko lizards, one of the only plants that has the same pollinator as its seed disperser. He also spoke about the importance of training local communities on how to propagate important economic plants, and gave an example of the Brazil nut, *Bertholletia excelsa*, in Bolivia.



Carlos Magdalena discusses the many facets of botanical horticulture. (photo by Ken Wurdack)

The second half of Magdalena's presentation was on water lilies and his adventures in Australia and Bolivia. In Australia he collected species like *Nymphaea alexia*, *N. kimberleyensis*, and *N. lukei*. He spoke about the extremely rare *N. thermarum*, which at one point was stolen from Kew Gardens. The publicity of that incident brought much attention to Magdalena and the importance of the conservation of water lilies. He then wrote a book, *The Plant Messiah*, which allowed him to further convey messages about plant endangerment. In Bolivia, he studied the closely related *Victoria amazonica*, *V. cruziana*, and the largest water lily in the world, *V. boliviana*. Displaying these related species at Kew has given him an avenue to explain the importance of taxonomy, botanical illustration, molecular work, and phylogenetics of flowering plants.

The second speaker of the day was Jennifer Cruse-Sanders from the State Botanical Garden of Georgia, who gave the presentation, "From dwarf sumac, *Rhus michauxii*, to turkey beard, *Xerophyllum asphodeloides* (and other species in between): How conservation horticulture has helped to preserve imperiled species in the southeastern U.S." She asked the main question, "How can we translate what we know about how plants grow to better conserve them?" Grand challenges she highlighted include the loss of plant diversity, the loss of ecological connections, and the loss of connections between people and plants. One of the ways that botanists can address some of these challenges is through partnerships, and Cruse-Sanders pointed out that for nearly 30 years the State Botanical Garden has coordinated the Georgia Plant Conservation Alliance. Priority actions we can take include con-

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On the cover: ***Water lilies (Nymphaeae sp.) as seen growing at the Royal Botanic Gardens Kew and featured in a talk by Carlos Magdalena.***

servation horticulture, applying technological and scientific advancements to help us understand how to propagate rare species, safeguarding populations, and developing a native seed network for restoration.

Cruse-Sanders used three case studies to make her point. *Rhus michauxii*, one of the rarest shrubs in North America, is dioicous with an all-male population separated 160 km from an all-female population. She described propagating individuals in the greenhouse, applying fire to the wild locality, and introducing stems into the wild, all to encourage pollination—what she called a "botanical dating service." After the pollination trials, she initiated seed germination trials and learned lessons on how best to germinate this species. The second case study was *Xerophyllum asphodeloides*, a rare species in which seed propagation studies were needed. After experimenting in scarification, stratification, and soil mixtures, her team successfully germinated, grew, and planted this species back into the wild. In the final case study, she tested the levels of genetic diversity to determine why some plants, such *Pityopsis ruthii*, are rare and others, such as *P. graminifolia*, are more common. Unsurprisingly, she found that a majority of the genetic diversity is held within the more common species. A phenotypic plasticity project, however, found that plasticity could be facilitating habitat specialization but constraining distribution. These findings could help explain the specific habitat restrictions of *P. ruthii*.

Jennifer Cruse-Sanders describes how conservation horticulture has helped to preserve imperiled species in the southeastern U.S. (photo by Ken Wurdack)

Colin Khoury from the San Diego Botanic Garden spoke about, "Distributions, conservation assessments, and conservation action for crop wild relatives." Khoury focused his talk on describing the wild relatives of the foods we eat, how well they're conserved, how to conserve them in seed banks, and how to breed them to make our agriculture more resilient to climate change. He first described a study of a wild grape, *Vitis monticola*, and other taxa, conducting gap analyses to determine how well they have been collected and where one might go to collect possibly novel genes for each species. He then spoke about an inventory of U.S. crops, and described the 2,598 crop wild relatives and the 2,148 native crop wild relatives in the U.S. The highest richness are wild relatives of sunflowers, blackberries, blueberries, grapes, peaches, pecans, plums, and gooseberries. In describing the conservation status of wild relatives, Khoury says that much work is still to be done in collecting these species, putting them into our botanic gardens and seed banks, and protecting them in open spaces.

Colin Khoury gives an overview of conservation action for crop wild relatives. (photo by Ken Wurdack)

Khoury pointed out five important tenants: the need to understand where the species live and how well they are protected; the need to protect them in their natural habitats; the need to collect and preserve them in botanic gardens and seed banks; the need to conduct breeding science to make them usable in agriculture; and the need to raise public awareness. He wrapped up his talk by speaking about current efforts to conserve wild relative species, including a citizen science project in iNaturalist to understand where wild relatives grow, and the efforts of the North American Fruit and Nut Tree crop wild relative working group.

Dustin Wolkis from the National Tropical Botanical Garden in Hawaii spoke next about, "Applied seed conservation biology to support seed banking." Wolkis

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Symposium

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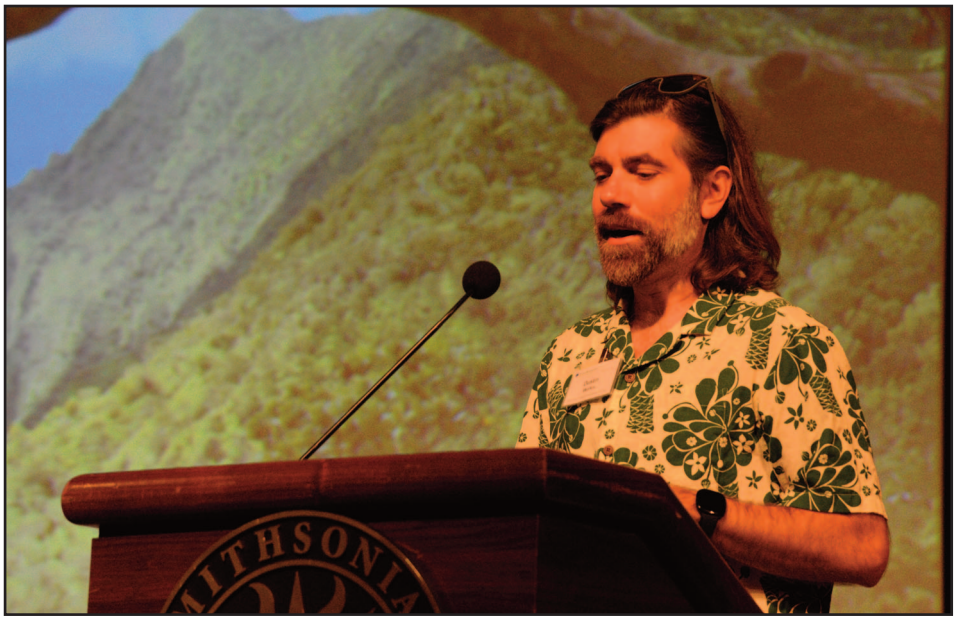
began with an overview of Hawaii and its diverse and threatened flora, and then jumped into the four major challenges of seed conservation: few seeds, storage behavior, longevity, and germination. For storage behavior, Wolkis described water balance in seeds and the need for desiccation in orthodox seed banking. For longevity, he described seed survival curves and the need to test viability to assess longevity and to calculate the recollection interval necessary to refresh the seedbank. In a test on seed longevity on herbarium sheets, he described how not a single seed germinated from the pressed specimens of ohi'a, *Metrosideros*, or from the sheets of several other target species of endangered species. Wolkis described how the Hawaiian flora has the highest proportion of freeze sensitive storage behavior than any other flora. He also spoke about conducting seed lipid thermal fingerprint studies and found very distinct signatures across species that could be related to this freeze sensitivity. Lipid thermal fingerprints offer a rapid, non-destructive test to screen for potential problems with longevity, and they could be generated for all seed bank accessions.

In describing dormancy and germination, Wolkis said that seeds need optimal germination conditions and an external signal to get robust germination. While experiments have been performed on individual species, he thinks it's time to take a holistic look at dormancy and germination in the entire Hawaiian flora and look for larger patterns. He spoke about rapid ohi'a death and a study that found that there were no correlations with initial viability and any bioclimatic variable, but there was a correlation with seed zones. Wolkis briefly spoke about fern spore banks and pollen banks as well. He gave case studies of developing protocols for pollen conservation for *Hibiscus clayi* and *Pritchardia minor*. He thinks that pollen storage is the next critical tool in the plant conservation toolkit.



Dustin Wolkis delves into the science of applied seed conservation biology. (photo by Ken Wurdack)

The final invited speaker of the day was Abby Meyer from Botanic Gardens Conservation International (BGCI), who spoke on "Conservation horticulture capacity at botanic gardens." She described the global botanic garden community as ~3,500 institutions that collectively maintain at least 30% of known plant diversity, at least 40% of known threatened species, employing collectively ~60,000 technical experts who know how to grow and document the plants of most terrestrial ecosystems on Earth, and collectively engage 1 billion visitors every year, making this community the world's greatest force for plant conservation. She spoke about the various unique roles that botanic gardens fill, including plant science, horticulture and breeding, *ex situ* collections, *in situ* collections, and outreach and education, and she expanded in detail upon each role. Meyer described a case study of sand blasting seedlings of *Penstemon havdenii*, a species native to the sand hills of Nebraska, as an example of how each species has a code to crack that allows one to successfully grow it across its conservation path.

Meyer spoke about a global survey that was recently conducted by BGCI. The survey characterized the current work being done and the perceptions of conservation horticulture by those who work at botanic gardens. One key finding is that after tak-

Abby Meyer gives insights into the capacity of conservation horticulture at botanic gardens. (photo by Ken Wurdack)

ing the survey, most respondents said that their view either has not changed as they were already engaged in conservation horticulture or that they realized that they are more engaged in conservation than they previously thought. The most reported needs from the respondents included funding, mentorship, information (propagation protocols), and training (seed conservation and genetics). Additional interviews provided a deeper dive into entry points into the career of conservation horticulture and valuable learning experiences. The main findings of the surveys were that awareness and perspective seem to be critical factors in conservation horticulture, the most effective tools are hands on training in the field, nursery, and lab, and institutional value and priority by garden leadership is important. Meyer finished by talking about a new propagation exchange tool that connects repositories of data among botanic gardens and about the Keller Scholarship in Conservation Horticulture which is offered annually to undergraduates who are hosted at botanic gardens in the U.S.

The final session of the Symposium was a panel discussion with the five speakers and moderator Susan Pell (USBG). Questions from the in-person and virtual audiences and the moderator included: how should we better unite the fields of conservation and horticulture?; how should we balance the connection of displaying charismatic plant species and having the resources to conserve the endangered ones?; what current trends exist for students, volunteers, citizen scientists, and lifelong teachers?; how can we better utilize commercial growers for plant conservation?; and what is the best approach for homeowners to support endangered native plant species? To hear the fascinating responses to these questions by each of the speakers, a video of the panel discussion is available on YouTube.

"Everything that we do *ex situ*, it directly supports *in situ* restoration efforts."

- Dustin Wolkis, in answering the panelist question, "How do you balance germplasm restoration with restoration?"

The Symposium concluded with evening events at the U.S. Botanic Garden's Conservatory, including a closing reception and a poster session.

Smithsonian Gardens and Smithsonian Libraries and Archives provided optional behind-the-scenes tours the morning of the Symposium. Both units offered two sessions each and all were well attended.

Staff from the Smithsonian Gardens led a tour around the NMNH grounds highlighting the gems of the gardens surrounding the building. Arborist Jake Hendee discussed the significance of local trees and the importance of evaluating their health. Sylvia Schmeichel, lead horticulturist, highlighted the design of the pollinator garden and the value of trying new species, like the Loblolly Bay tree recently added. Horticulturist Phil Evich walked the groups through different sections of plants on the Mall side of NMNH emphasizing the value of experimental gardens using different textures, colors, and sizes to keep the collections interesting. As educators and garden curators, they all explained that the gardens are a living museum, always changing, and always accessible. They also spoke about how the living collections are a way to support conservation efforts in the garden and to support local ecology.

The Smithsonian Libraries and Archives hosted a tour of the Joseph F. Cullman 3rd Library of Natural History. Leslie Overstreet, Curator of Natural History Rare Books, and Sydney Fitzgibbon, Library Technician, provided background information about the selected botanical books on display. Overstreet also talked about the uniqueness of the library and the services offered. Participants were able to peruse the books up close to view the detailed illustrations about early herbals, travels, taxonomy, and trees. There was even a book detailing the theory and practice of planting forest trees, William Pontey's *The Profitable Planter* (1808). Then a bonus: attendees were given a view into the temperature and humidity-controlled vault housed within the Cullman library to view Jonathan Singer's *Botanica Magnifica* (2009), a lavishly bound massive double elephant folio volume of 250 photographs of exotic and rare flowers and plants.

The symposium attracted an audience of about 400 attendees, with about 150 people in-person and 250 people online. Those who viewed the proceedings virtually watched from 22 countries from around the world. All speaker presentations, opening remarks, the presentation of the José Cuatrecasas Medal, and the roundtable panel discussions were recorded and are available for viewing on NMNH's Natural History for Scientists YouTube < https://www.youtube.com/watch?v=HETRpJkrhAk&list=PLQmxS2U3B6Kbo8GKodMg6FB6K5EHaBaVI&index=19&t=2s> page.

The 22nd Smithsonian Botanical Symposium is tentatively scheduled to take place at the National Museum of Natural History and the U.S. Botanic Garden on Friday, May 16, 2025. The topic is still to be determined. Check the Department of Botany's website for updates.

Susan Pell, USBG Deputy Executive Director, delivers opening remarks. (photo by Ken Wurdack)

Peter F. Stevens receives the 21st Cuatrecasas Medal

The José Cuatrecasas Medal for Excellence in Tropical Botany is named in honor of Dr. José Cuatrecasas, a pioneering botanist and taxonomist, who spent nearly a half-century working at the National Museum of Natural History. Cuatrecasas had a distinguished career devoted to systematic botany and plant exploration in tropical South America, especially in the Andes, and this award serves to keep vibrant his accomplishments and memory. The Department of Botany and the U.S. National Herbarium present this award at the Smithsonian Botanical Symposium to a botanist and scholar of international stature who has contributed significantly to advancing the field of tropical botany. The award consists of a bronze medal bearing an image of José Cuatrecasas on the front with the recipient's name and date of presentation on the back.

This year the 21st José Cuatrecasas Medal for Excellence in Tropical Botany was presented to Peter F. Stevens, an accomplished scientist, botanist, and author.

Stevens most recently held joint appointments as a Professor of Biology, University of Missouri-St. Louis and Research Curator, Missouri Botanical Garden. After receiving a B.S. from Oxford University, he went to Edinburgh where he received a Ph.D. in 1971. His dissertation was simply titled *Taxonomic studies in Ericaceae*, but it was deceptively influential in influencing subsequent research on that family.

His first professional post was as a Forest Botanist in Papua New Guinea. There he collected plants mostly in the highlands, gained further experience with tropical Ericaceae, and developed interests in other primarily tropical families such as the Clusiaceae. His three years in New Guinea were influential in fostering his interests in plant families, identification, and tropical botany in general.

Leaving New Guinea, Stevens moved half-way around the globe to accept an appointment as an Assistant Curator at the Arnold Arboretum of Harvard University, which had a long-standing interest in Asian (and Malesian) botany. Eventually, he became a tenured professor at the university. While at Harvard he also had teaching responsibilities and served as principal advisor to a number of graduate students interested in tropical plant systematics. He also began publishing on aspects of systematic philosophy, especially examining the conflicts between morphological character states and phylogenetic hypotheses.

Moving half-way across the continent to St. Louis in the late 1990s, Stevens continued his research and teaching but also was one of the principal architects in constructing the Angiosperm Phylogeny Website, which continues to be a remarkable and valuable tool for anyone interested in up-to-date information on the 400 plus families of flowering plants. Without doubt, Stevens has contributed in innumerable ways to advancing the field of tropical botany.

Laurence Dorr presented the medal to Stevens at the 21st Smithsonian Botanical Symposium at the National Museum of Natural History in Washington, DC, on May 17, 2024.

Past recipients of the Cuatrecasas Medal are Rogers McVaugh from the University of North Carolina at Chapel Hill (2001); P. Barry Tomlinson from Harvard University (2002); John Beaman from the Royal Botanic Gardens, Kew (2003); David Mabberley from the University of Leiden, The Netherlands, and the Royal Botanic Gardens, Sydney (2004); Jerzy Rzedowski and Graciela Calderón de Rzedowski from Instituto de Ecología del Bajío, Michoacán, Mexico (2005); Sherwin Carlquist from Rancho Santa Ana Botanic Garden and Pomona College (2006); Mireya D. Correa A. from the University of Panama and Smithsonian Tropical Research Institute (2008); Norris H. Williams from the Florida Museum of Natural History and the University of Florida, Gainesville (2009); Beryl B. Simpson from the University of Texas at Austin (2010); Walter S. Judd from the University of Florida at Gainesville (2012); Ana Maria Giulietti Harley from the Universidade Estadual de Feira de Santana, Brazil (2013); H. Peter Linder from Zurich University (2014); Paulo Günter Windisch from Universidade Federal do Rio Grande do Sul, Brazil (2015); Kamal Bawa from the University of Massachusetts Boston (2016); Robin B. Foster from the Field Museum (2017); Alan K. Graham from the Missouri Botanical Garden (2018); Sandra Knapp from the Natural History Museum in London (2019); Sebsebe Demissew from the Gullele Botanic Garden and Addis Ababa University, Ethiopia (2021); Fabián Michelangeli from the New York Botanical Garden (2022); and Rafaela Campostrini Forzza from Jardim Botânico do Rio de Janeiro, Brazil (2023).

Peter F. Stevens (right) accepts the 21st José Cuatrecasas Medal for Excellence in Tropical Botany presented to him by Laurence Dorr. (photo by Ken Wurdack)

Abstracts from the speakers of the 21st Smithsonian Botanical Symposium

The 21st Smithsonian Botanical Symposium, "Advancing Plant Conservation Through Horticulture," was held on 17 May 2024. The invited speakers included botanists, horticulturalist, conservation biologists, and scientific curators. Below are the abstracts from the papers that were presented by the invited speakers.

The speakers of the 2024 Smithsonian Botanical Symposium at the National Museum of Natural History (from left): Carlos Magdalena, Colin Khoury, Jennifer Cruse-Sanders, Dustin Wolkis, and Abby Meyer. (photo by Ken Wurdack)

Carlos Magdalena
Royal Botanic Gardens Kew

"The many facets of botanical horticulture"

In this talk, Carlos will draw on his 20 years of experience in botanical horticulture and recount some highlights of his career. In doing so, it will become apparent that the term "botanical horticulture" encompasses far more than meets the eye. While plant cultivation in a botanic garden is at the core of most botanical horticulturists' job description, the range of skills and activities involved in conservation surpasses this. To safeguard species in a holistic manner, the emphasis cannot and should not be solely on single species conservation, but also consider the wider context that the work is set in. This includes but is not limited to local flora, habitat restoration efforts and practices, and engagement with local partners. Carlos' talk will challenge what you understand botanical horticulture to be and explore the interdisciplinary links in plant conservation.

Jennifer Cruse-Sanders
State Botanical Garden of Georgia

"From dwarf sumac, *Rhus michauxii*, to turkey beard, *Xerophyllum asphodeloides* (and other species in between): How conservation horticulture has helped to preserve imperiled species in the southeastern U.S."

Globally, plant species diversity is fundamental for supporting ecosystem function, landscape resilience, and food security. And yet, plant species diversity is threatened with some of the highest rates of extinction in our world. It is imperative that conservation horticulture methods for propagation and restoration of species are not only developed widely, but are also shared generously to meet the pressing grand challenges we face. As one example, the southeastern U.S. is a global biodiversity hotspot, recognized as such for high rates of endemism and perceived threats to natural ecosystems. The state of Georgia, in the southeastern U.S., with some of the highest numbers of plant species diversity in the U.S., has more than 700 plant species that are imperiled and facing significant conservation challenges. Even more significant are diverse plants considered common species that are not tracked through conservation programs but are nearly disappearing before our eyes. This program will share highlights from our efforts to conserve rare species through horticultural interventions and our efforts to make common plants even more commonly available for essential conservation needs that anticipate a growing need in our communities.

Colin Khoury
San Diego Botanic Garden

"Distributions, conservation assessments, and conservation action for crop wild relatives"

Crop wild relatives - the wild progenitors and cousins of agricultural crops - are valuable genetic resources used by plant breeders to increase pest and disease resistance, stress tolerance, nutritional value, and other traits critical to productivity, quality, and sustainability. Many of these species are threatened in their natural habitats and are under-represented in seedbanks and other *ex situ* conservation repositories, limiting the portfolio of useful plant diversity that may be available to

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Acknowledgments

The success of the Symposium was due to the significant time and efforts of the following people:

Symposium Organizing Committee: Amy Bolton, Eric Calhoun, Joy Columbus, Laurence Dorr, Rose Gulledge, Carl Johnson, Gary Krupnick, Susan Pell, Eric Schuettpelz, Warren Wagner, and Kenneth Wurdack

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Symposium Sponsors: José Cuatrecasas Botanical Fund, Mellon Foundation, National Museum of Natural History, Smithsonian Gardens, and United States Botanic Garden

Abstracts

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present and future generations. In this presentation, I detail efforts at local to global scales to better understand the distributions and conservation status of the wild relatives of important crops, and to take action to address conservation concerns.

Dustin Wolkis
National Tropical Botanical Garden

"Applied seed conservation biology to support seed banking"

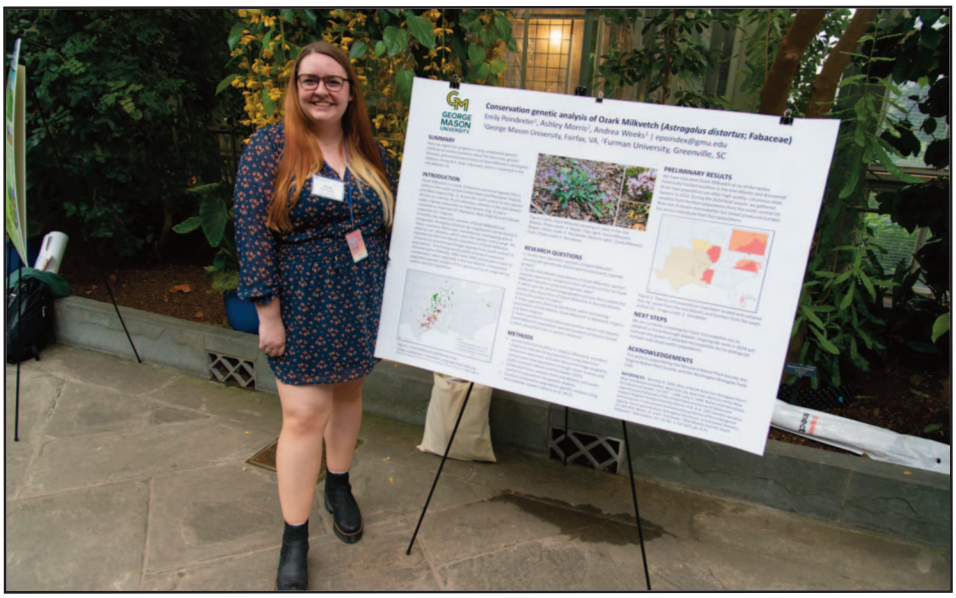
Seed banking provides the most efficient means of *ex situ* plant conservation. Conventional seed banking practices involve desiccating seeds to low moisture contents and storing them at a specific temperature below freezing. However, not all species can be conserved by conventional seed banking methods. Although many species produce desiccation tolerant seeds, some cannot be dried and even some desiccation tolerant species are sensitive to long-term freezing stress. Besides problems with desiccation tolerance and short life spans in conventional storage, other challenges to the *ex situ* conservation of seeds include the inability to acquire seeds, and the failure of viable seeds to germinate. Collectively, species exhibiting one or more of these traits have been termed "exceptional." The flora of the Hawaiian Islands harbors 90% vascular plant endemism, yet globally has experienced the highest number of contemporary plant extinctions. Using the Hawaiian flora as a model system this presentation will explore some of the mechanisms underlying species defined as exceptional and discuss methods in which to overcome obstacles to *ex situ* seed banking. The applied projects presented will be broadly relevant beyond seed science including species and land managers and to the field of conservation horticulture.

Abby Meyer
Botanic Gardens Conservation International

"Conservation horticulture capacity at botanic gardens"

Conservation horticulture refers to the skills and knowledge required to maintain plants of conservation concern in *ex situ* living collections. This is a fundamental and expanding area of expertise that is often and uniquely manifested through the work of botanic gardens. As we face major environmental and social crises around the world, the conservation and outreach work of botanic gardens is becoming more and more imperative. Specialists in conservation horticulture are more important than ever as the plant conservation community scales-up our collective efforts to halt species extinction. This presentation will describe the current state of conservation horticulture in botanic gardens globally and provide examples of how BGCI is working with partners to promote awareness of and capacity for this critical area of expertise.

The symposium's speakers participate in a panel discussion (from left): Abby Meyer, Dustin Wolkis, Colin Khoury, Jennifer Cruse-Sanders, and Carlos Magdalena. (photo by Ken Wurdack)



During the closing reception and poster session at the U.S. Botanic Garden, 11 participants displayed posters of their research and interacted with attendees. Here, graduate student Emily Poindexter (George Mason University) presents a poster on the conservation genetics of the Ozark milkvetch, *Astragalus distortus*. (photo by Ken Wurdack)

NEW PUBLICATION

Smithsonian Trees of North America

Smithsonian Trees of North America by **W. John Kress**, an indispensable illustrated source of information about hundreds of species of North American trees, will be published by Yale University Press on September 3, 2024. Nature lovers will relish the beauty and clarity of this authoritative guide to more than 325 common native and non-native trees.

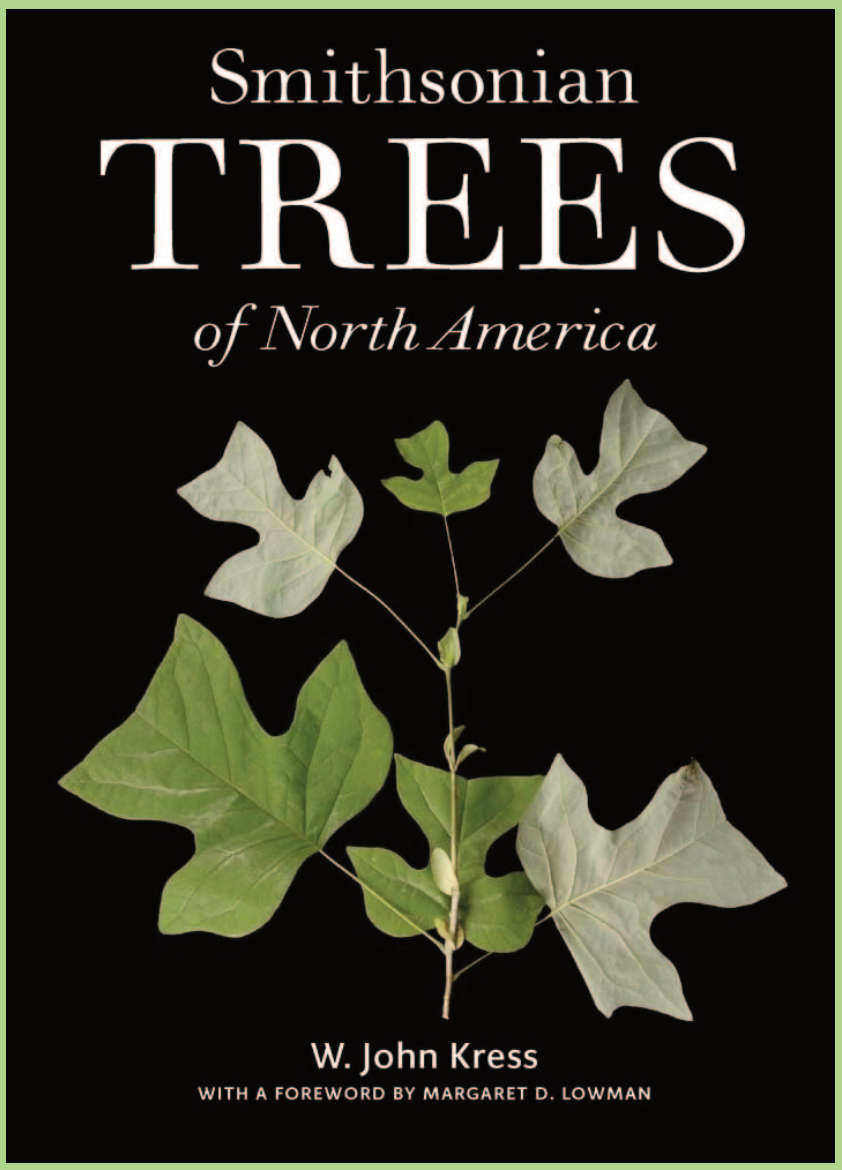
More than a field guide, *Smithsonian Trees of North America* includes more than 300 range maps and 3,000 exquisite photographs of leaves, flowers, fruits, seeds, and bark. It has an in-depth introduction to the biology of trees and their value, structure, evolution, classification, ecology, and conservation. The book has descriptions of each species, organized by genus and family. North American trees are presented from a planetary and evolutionary perspective, drawing on the latest technologies. Kress also reflects on the consequences of environmental change for the health of trees, now and in the future.

The Secretary of the Smithsonian, Lonnie Bunch III, says of the book, "Dr. Kress has deftly synthesized and presented this collected information in an accessible volume that will help people everywhere understand, appreciate, value, and conserve the planet's trees that are so critical to our shared future." Peter Raven of the Missouri Botanical Garden adds his praise, "A beautifully illustrated guide to the commonest trees of the United States and Canada—a 'must have' for any nature lover who wants to expand their horizons!"

An additional review by Peter Crane of Oak Springs Garden writes, "Irresistible for those who love trees and want to know more about them. In particular, the 'best in class' color photos, including more than 300 spectacular two-page illustrated spreads, set this book apart."

Ten years in the making, *Smithsonian Trees of North America* marries science and art to provide an insightful and compassionate exploration of the diversity, structure, form, and beauty of trees. Visit <https://yalebooks.yale.edu/book/9780300185218/smithsonian-trees-of-north-america/> or these QR codes for more information.

Kress is Distinguished Scientist and Curator Emeritus at the Smithsonian's National Museum of Natural History, where he served as Curator of Botany. His research has taken him to more than forty-five countries to study the evolution and ecology of tropical plants. He developed the Leafsnap plant identification app and helped to develop the tool for DNA barcoding of plants.



Outside of the cabinet and into the garden: Vicki Funk's extraordinary legacy in botanic gardens

By Morgan Gostel

When most of us in the Natural History community think of botanical collections, our first thought is of herbaria and the critical role they play in documenting and preserving the rich diversity of plants and lichens on Earth. Indeed, herbaria play an increasingly important role in advancing botanical science and are arguably the single most important scientific resource available to confront and overcome the biodiversity crisis for plants and lichens. However, another resource plays a key role in advancing plant science, conservation, and education – the diverse collections stored in botanic gardens worldwide. The history of botanic gardens and herbaria is inextricably linked. Despite the parallel role of these institutions, their connections faded throughout the 20th century. According to Index Herbariorum, there are currently 3,567 herbaria worldwide, and Botanic Gardens Conservation International (BGCI) estimates there are more than 3,000 botanic gardens and arboreta. Although the aim and scope of herbarium is often distinguished from botanic gardens, a significant historical component of these institutions is linked through their role in facilitating research, notably taxonomy and systematics (see Dosmann 2006). One individual who saw enormous potential for herbarium and botanic garden collections to grow together was Vicki Funk. Funk's impact and legacy in phylogenetic theory, biogeography, and plant systematics and evolution – particularly in the daisy family, Compositae – are enormous and widely recognized. Perhaps less well-known, however, is the great collections-based legacy she left for botanic gardens.

Vick Funk (second from left) collecting with interns Sara Gabler, Asia Hill, and Kristen van Neste (left to right) at the U.S. Botanic Garden. (photo courtesy U.S. Botanic Garden)

Ten years ago, in 2014, Funk was motivated to explore the role that botanic gardens might play in advancing collections-based research, particularly in the genomic era. To Funk, the crux of this motivation was a fervent belief that botanic gardens are in a unique position to facilitate plant collections-based research, yet surprisingly the living collections that gardens maintain and the dedicated staff who grow them were increasingly disconnected from herbaria and the broader research community. According to Funk, botanic gardens held vast collections of diverse living plants that were underutilized for research. Throughout her career, Funk was an ardent advocate for the importance of scientific vouchers and the critical role of natural history collections as foundational institutions for biological science. Encouraging botanic gardens to rediscover their historical connections to herbaria and more actively collect scientific vouchers could lead to an untapped wellspring of botanical knowledge.

Funk believed that by working more closely together, botanic gardens and herbaria could advance key research priorities for the 21st century, one of which was to address the rapidly growing need for high-quality tissue necessary to facilitate the rapidly growing demands of whole genome sequencing and the genomic revolution. This ambitious and collaborative vision – some might argue "quintessential Vicki" – also coincided with the development of the Smithsonian Institution's Global Genome Initiative (GGI). Funk decided to make a gamble – she estimated that botanic gardens contain 50% of all plant genera on Earth – a key statistic for the long-term strategic goals of GGI. She made a bet with Jonathan Coddington, then Director of the Global Genome Initiative and Senior Scientist in the Department of Entomology, that GGI could accomplish its sampling goals for the plant Tree of Life by partnering with botanic gardens. Thus began an odyssey that has now entered its 10th year: the Global Genome Initiative for Gardens (GGI-Gardens).

Thanks largely to key support from a number of interns, students, and staff in

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the NMNH Department of Botany, including Research Botanist and Associate Curator Kenneth Wurdack, Research Assistant Carol Kelloff, Ph.D. student Aleks Radosavljevic, intern Kristen Van Neste, as well as local gardens and arboreta, notably the United States Botanic Garden (USBG), Smithsonian Gardens, and the U.S. National Arboretum, Funk was able to assemble a "coalition of the willing" in January 2015. This team aimed to develop a pilot program for collecting genome-quality tissue samples from botanic gardens. In July 2015, I joined the Department of Botany as a GGI-Buck postdoctoral fellow, working with Funk with the expectation that 40% of my fellowship would be dedicated to expanding GGI-Gardens as program manager with Funk as director. We quickly got to work not only building an internship program, but also involving a number of organizations that were able to help us develop a long-term strategic plan for GGI-Gardens, most importantly the leadership and staff at BGCI and USBG.

As collections continued into 2017, we realized that GGI-Gardens needed to expand into an international partnership, where local teams of botanists, students, and interns could participate in collection at botanic gardens and deposit their voucher collections in both local herbaria and biobanks that are partnered with the Global Genome Biodiversity Network (GGBN). The pilot that was developed during the first two years was published and we asked a number of partners if they would be able to put these guidelines into action. In 2017, the first GGI-Gardens partner award was awarded to Missouri Botanical Garden and from this example, we realized the next phase of the program had begun: GGI-Gardens transitioned from a local team to a global partnership.

In August 2018, GGI-Gardens moved to the Botanical Research Institute of Texas, based at the Fort Worth Botanic Garden. One year later, GGI-Gardens took its partnership with BGCI and USBG to a new stage and hired a program coordinator who could not only help achieve the strategic goals of this partnership, but also undertake a cutting edge gap analysis that would identify priority plant collections from botanic gardens worldwide. Jean Linsky joined in January 2020 and initiated a large-scale gap analysis that would inform the next chapter of the program. Two key resources were utilized in this gap analysis: 1) BGCI's Plant Search Tool, which contains information about living collections from botanic gardens worldwide; and 2) the Global Genome Initiative Gap Analysis Tool, a resource that allows users to query a list of taxa and identify those that are not currently represented in any GGBN-partnered biobank worldwide. The results of this Gap Analysis were published in a special issue of BGCI's *BGJournal* and revealed that among the ca. 9,000 genera of vascular plants not present in any GGBN-partnered biobank, 4,320 were known to be present in a botanic garden. Utilizing this knowledge, BGCI, USBG, and GGI-Gardens set out on the largest expansion in the program's history, by launching a Partner Award program.

In 2020, the first GGI-Gardens Partner Award provided funds of up to $4,500 to 16 botanic garden partners worldwide. Despite the COVID-19 pandemic, these awards were immensely successful and resulted in the collection of nearly 7,000 herbarium and genomic tissue vouchers. In 2023, the second round of funds were awarded to 10 GGI-Gardens partners. Most importantly, this award program has supported the collection of 25% of the 4,320 priority plant genera revealed in our 2020 gap analysis. The 2023 award program alone supported the collection of ca. 1,500 herbarium and genomic tissue vouchers from 725 vascular plant genera. Below, a table summarizes the impact of each of these awards, as well as the location of each of the partners funded in this award cycle.

When most people think of Vicki Funk, a lot comes to mind – whether memories of a kind, energetic, and creative colleague who knew how to make groundbreaking projects happen, or her outsized impact in the fields of biogeography, phylogenetic theory, and Compositae systematics. Among her many enduring legacies will also be her impact in botanic gardens through the GGI-Gardens program. During her acceptance of the Asa Gray Lifetime Achievement Award in 2018, Funk chose not to tell stories about herself, but rather took the opportunity to share stories about the countless colleagues, students, interns, friends, and loved ones who helped her achieve success and fulfillment in her career. It is therefore only fitting to dedicate this article to Funk and the "coalition of the willing" that she rallied to support her vision of GGI-Gardens throughout the last ten years, along with her enduring botanical legacy.

A summary of 2023 GGI-Gardens Partner awardees, highlighting their contributions to collections.

Organization	Genera collected	Genera new to GGBN	Families collected	Families new to GGBN
Botanical Garden of Medellín	84	12	33	0
Centre for Plant Medicine Research		In progress		
Centro de Investigación Científica de Yucatán (CICY)	32	8	16	0
Huntington Botanical Garden	47	46	33	2
Inala Jurassic Garden	26	18	14	1
Association de Gestion Intégrée des Resources (AGIR)	140	15	52	0
Jardim Botânico do Recife (Still in Progress)	73	4	52	0
Jawaharlal Nehru Tropical Botanical Garden and Research Institute	32	18	25	0
PIBS at Bethlehem University	291	30	81	2
TOTAL	**725**	**151**	**306**	**5**

NEW FACES

Lucy Anderson is an undergraduate NHRE intern working in Botany this summer. She is a Plant Biology major at the Pennsylvania State University interested in plant genomics, systematics, and conservation. She is working on a continuation of a project with **Warren Wagner**, **Jun Wen**, and **Gabe Johnson** to further resolve the phylogeny of *Fuchsia* and *Circaea* (Onagraceae) to better understand their evolutionary and biogeographical origins and diversification. At Penn State, Anderson is also a research assistant at the Schatz Center for Tree Molecular Genetics where she studies seed morphology of imperiled Black Ash.

Destiny Brokaw is a Ph.D. student in Biological Sciences at Washington State University. Destiny previously received her master's in plant pathology from Auburn University and her bachelor's in biology from Abilene Christian University. Her research aims to understand the diversification of Hawaiian *Cyrtandra* across the Hawaiian Islands using hyb-seq high throughput sequencing approaches. Brokaw is working in collaboration with **Warren Wagner**, **Jun Wen**, and **Gabe Johnson** to thoroughly sample morphological and geographical variation of *Cyrtandra* across the Hawaiian Islands for DNA extractions. Destiny will utilize DNA sequences to obtain a genus-wide phylogeny of Hawaiian *Cyrtandra* and will further assess the influence of extensive hybridization between species. More information and updates on Brokaw's research can be found on her website at <https://destinybrokaw.weebly.com/>.

Alberto J. Coello started as a Peter Buck Postdoctoral Fellow in April 2024 in the NMNH Department of Botany. Working with **Jun Wen**, he uses phylogenomic approaches to unveil the pantropical biogeographic pattern of *Cissus*, the largest genus of the grape family (Vitaceae). Coello studied the colonization of plants in oceanic archipelagos during his doctoral work at the Royal Botanical Garden of Madrid, Spain, focused on Canarian species. After completing his Ph.D., he conducted research on the conservation of *Cistus heterophyllus*, one of the most endangered plant species in Spain, while at the Polytechnic University of Cartagena. More recently, he studied spatial phylogenetics of the angiosperm Iberian flora while working at the Autonomous University of Madrid. His research interests include biogeography, phylogenomics, dispersal, and evolution.

Asia Hightower, a Ph.D. candidate at Michigan State University, joined Botany this summer as a Smithsonian Big Ten Alliance Predoctoral fellow. She is working under the supervision of **Jun Wen**, **Alex**

New faces in the Department of Botany
Top row (L to R): Lucy Anderson, Destiny Brokaw, Alberto J. Coello, and Asia Hightower
Bottom row (L to R): Michelle-Marie Nelson, Luke Sparreo, and Brooklyn Swen

White, and **Greg Stull**. Her dissertation work focuses on leaf shape morphometrics and the environmental and genetic factors that influence leaf shape in *Capsella bursa-pastoris*, a weedy sister species to *Arabidopsis thaliana*. At the Smithsonian, she is working on the morphometric and genetic differences in leaf shape between members of the Brassicaceae supertribe Camelinodae using machine learning of specimens collected from across the U.S. She has broad interests in plant developmental and evolutionary biology. She also has interests in science communication, community engagement, and outreach.

Michelle-Marie Nelson joined the department as a summer intern under the supervision of **Alice Tangerini**, June through early August. Nelson has a Certificate in Botanical Art & Illustration and a degree in Native Plants from the North Carolina Botanical Gardens, and she has taken several courses in herbalism and permaculture. Nelson is helping with scanning, mounting drawings, and organizing the Botanical Art Collection. She is also working on an illustration for the type of *Laciasis* for a botanist from Italy. This request came through Research Associate **Rob Soreng**.

Luke Sparreo is returning to work with **Jun Wen** this summer after joining the lab last summer as part of the NHRE internship program. Sparreo recently graduated from Connecticut College and will begin his Ph.D. studies in Plant Science through the City University of New York (CUNY) and the New York Botanical Garden this fall. In Wen's lab, Sparreo is studying the origin of the Norton grape cultivar. Developed in Virginia in the early 19th century, the Norton grape was one of the first celebrated American wines and interest in the cultivar remains today. Despite its importance, little is known about the cultivar's ancestry. Sparreo is sequencing DNA from both the Norton cultivar and possible wild *Vitis* parent species as well as examining the cultivar using morphometric analyses to help determine the origin of the Norton cultivar.

Brooklyn Swen, an undergraduate Biological Sciences major at the Pennsylvania State University, joined Botany this summer as an NHRE intern working under the supervision of **Jun Wen** and **Gabe Johnson**. Her project focuses on the phylogenomic analysis of the canyon grape species complex, *Vitis arizonica*, found in southwestern U.S. Morphologically, the species complex exhibits variability depending on the regions in which they occur, including the lobing and pubescence of the leaves, variations in the small clusters of fruits, and seed morphology. The overall objective of her project is to utilize DNA sequencing to construct a phylogenomic framework to analyze the clustering of clades and to observe morphological patterns of similarities, differences, and geographic distribution.

STAFF ACTIVITIES

W. John Kress presented a lecture, "Art meets Science: How artists and botanists capture the essence of Nature through color, composition, and classification," at the Cosmos Club in Washington, DC, on June 26, 2024. In his talk, he described how artists and botanists have made unanticipated contributions to both our understanding and appreciation of the natural world for hundreds of years and how it continues today. His talk showed several artworks in the Department of Botany's art collection, including Bryan Poole's *Heliconia caribaea,* and **Alice Tangerini's** gingers, including *Globba sherwoodiana.* Tangerini and her intern, Michelle-Marie Nelson were in attendance, and then following the lecture, Tangerini spoke to several of the attendees about her work at the museum.

In April 2024, **Alice Tangerini** spent time in Springfield, Massachusetts, at the Springfield Museums as an invited guest through Smithsonian Affiliates to present a lecture on "Botanical Illustration Then and Now" and to teach a class in botanical illustration. From April 4-7, Springfield Museums held a Festival of Flowers at their five museums all centered around a green quadrangle which featured sculptures of characters in the Dr. Seuss stories. Three of the museums displayed amazing flower arrangements in front of art pieces that were the inspiration for the designs. Other museums displayed floral arrangements in front of dioramas of animals and prehistoric life. One museum held activities for children and flower arranging for adults. Tangerini worked with Clarissa Leverich, the Museum School and Lecture Coordinator, to organize the class. Participants created layered graphite and watercolor flower portraits using prints and live flowers for subjects. It was a unique method for students to learn and each student came away with a finished piece.

On April 18, in celebration of Earth Day 2024, alumni of the National Museum of Natural History's Peter Buck Postdoctoral Fellowship program presented short talks related to their own science journeys in the symposium, "Life on a Sustainable Planet: Exploring and Understanding Our Natural World". The symposium offered an opportunity for the Smithsonian science community and the public to hear from science leaders of the future on how their work is contributing to exploring and understanding our natural world. Among the speakers, **Richie Hodel** presented, "Machine learning applications with digitized herbarium specimens reveal the hybrid origin of the cherry/plum genus," and **Manuela Dal Forno** presented, "Preserving the past, exploring the future: Insights from historical lichen collections." All of the talks were recorded and are available for viewing on the museum's YouTube channel.

Richie Hodel presents a talk about the application of machine learning on digitized herbarium specimens during the symposium, "Life on a Sustainable Planet" at the Smithsonian on April 18, 2024

VISITORS

Genise Freire, Universidade Federal Rural do Rio de Janeiro, Brazil; Sapindaceae (4/4-6/3).

Rachel O'Donnell, University of Rochester; *Petiveria alliacea* (Petiveriaceae) and other abortifacient plants from Central America and the Caribbean (4/4).

Craig Barrett, West Virginia University; Orchidaceae (4/5).

Charlotte Ickes and **Amy Swartz**, National Portrait Gallery, and **Wendy Red Star**, Independent artist, Oregon; *Poa pratensis* (Poaceae) (4/8).

David Goodman and a group of 12 visitors, Federal Reserve Board; Herbarium tour (5/2).

Peter Comanor, Independent researcher, Washington; Herbarium tour and *Yucca* (Asparagaceae) (5/8).

Laura Lagomarsino, Louisiana State University; Campanulaceae and Rubiaceae (5/14-5/20).

Byeong Hun Shin, **Yong Hwang**, **Seung Hyun Lee**, **Chang Jun Kim**, and **So Young Park**, Nakdonggang National Institute of Biological Resources, South Korea; Departmental tours (5/20-5/24).

Nina Davies, Royal Botanic Gardens Kew, United Kingdom; Department tour and Rubiaceae (5/28-5/29).

Sue Frisby, Royal Botanic Gardens Kew, United Kingdom; Department Tour, Bignoniaceae, and Compositae (5/28-5/29).

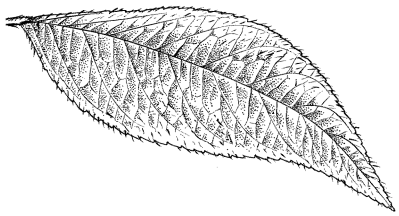
Isabel Larridon and **Xanthos Martin**, Royal Botanic Gardens Kew, United Kingdom; Department tour and Cyperaceae (5/28-5/29).

Asia Hightower, Michigan State University; Comparative leaf morphology (6/3-9/30).

Luana Sauthier, University of São Paulo, Brazil, and the Field Museum of Natural History; *Paepalanthus* (Eriocaulaceae) (6/3-6/7).

Jeanmaire Molina, Pace University; Vitaceae (6/26).

Sheetal Vaidya Pradhan, Tribhuvan University, Nepal; *Anaphalis* (Asteraceae) (6/27-6/28).



TRAVEL

Benny Crain traveled to London, England (5/20 – 5/26) to present an exhibit on orchid conservation at the Chelsea Flower Show.

Stuart Davies traveled to Peninsular Malaysia (5/23 – 5/31) to select species at the Pasoh Forest Reserve for a new ecophysiological study of forest water use under the NGEE-Tropics project; to Sarawak, Malaysia (6/1 – 6/7) to collect *Macaranga* species for whole genome analysis of myrmecophyte evolution; and to Panama (6/19 – 6/21) to attend the symposium to celebrate the 100th anniversary of research on Barro Colorado Island, Panama.

Richie Hodel traveled to Grand Rapids, Michigan (6/16 – 6/19) to attend the Botany 2024 meeting.

Emily Poindexter traveled throughout Texas, Louisiana, and Arkansas (3/26 – 4/6) to conduct fieldwork for a population genetics study of *Astragalus distortus* (Fabaceae); to Fredericksburg, Virginia (5/16) to present a poster at the Virginia Academy of Science's annual meeting; and to Grand Rapids, Michigan (6/15 – 6/20) to present a poster at the Botany 2024 meeting.

Eric Schuettpelz traveled to Grand Rapids, Michigan (6/15 – 6/20) to attend the Botany 2024 meeting.

Laurence and **Judith Skog** traveled to Duluth, Minnesota and Grand Rapids, Michigan (6/16 – 6/19) to visit the herbarium at the University of Minnesota and to attend the Botany 2024 meeting.

Alice Tangerini traveled to Springfield, Massachusetts, (4/3 – 4/6) to present a lecture and a workshop as part of a festival at Springfield Museums.

Jun Wen traveled to Grand Rapids, Michigan (6/16 – 6/20) to attend the Botany 2024 meeting.

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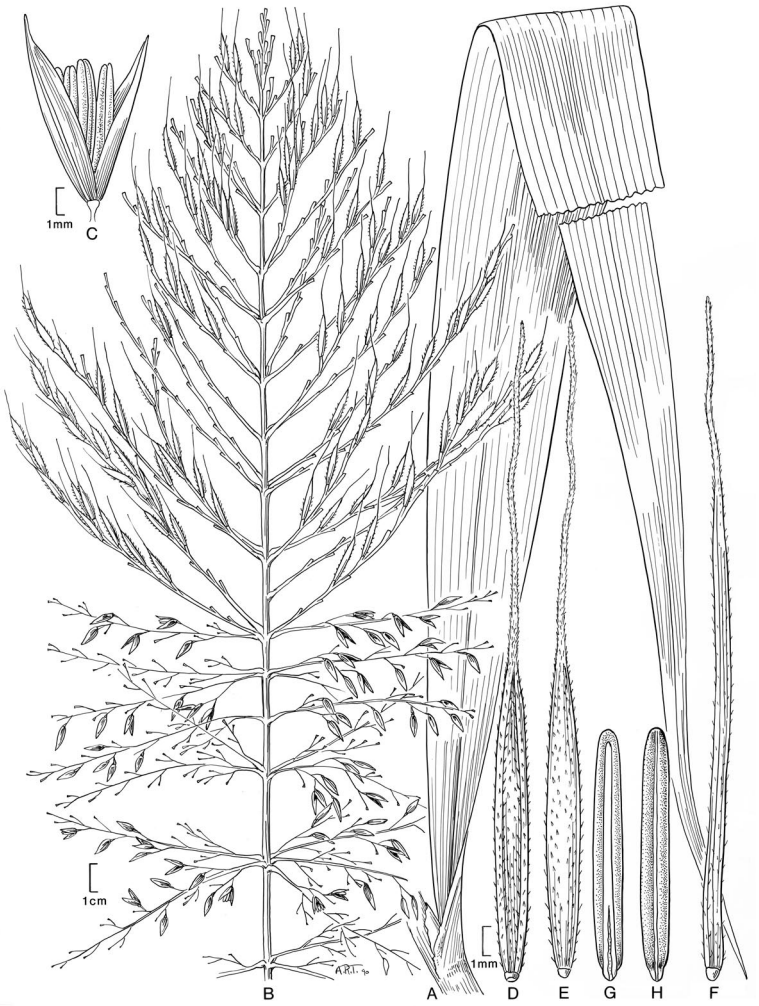
ART BY ALICE TANGERINI

Zizania aquatica L.

The 21st Smithsonian Botanical Symposium, "Advancing Plant Conservation Through Horticulture," was held on May 17, 2024. Among the talks was one about conservation action for crop wild relatives. In 1997, Alice Tangerini illustrated this image of *Zizania aquatica*, southern wild-rice, an important constituent of aquatic plant communities of the Atlantic and Gulf Coast Plains. While not cultivated, *Z. aquatica* has been grown experimentally. This illustration appeared in Terrell, et al. (*SIDA* 17: 533-549; 1997). Tangerini made all of her sketches from Ed Terrel's collections that were collected in Georgia in the early 1970s. Terrel asked for the usual full size habit and inflorescence but also wanted the details of the spikelet and caryopsis. Tangerini immersed some caryopses of the *Zizania* in a Petri dish of water and set it on her hot plate to boil so the features would be more discernible. Forgetting this was a grain that people normally cook and eat, she returned later to find a dish of cooked rice ready to eat.



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