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# A perfect occasion to talk about domestication

By Gary A. Krupnick

Smithsonian's Department of Botany and the United States Botanic Garden convened the 2019 Smithsonian Botanical Symposium, "What Darwin Couldn't Know: Modern Perspectives on Crop Plant Origins," at the National Museum of Natural History (NMNH) in Washington, D.C., on May 17, 2019. The unusual title for the symposium is acquired from the writings of Charles Darwin. In his 1868 book, *The Variation of Animals and Plants under Domestication*, Darwin's dim view of progress in understanding domestication in the vegetable kingdom is evident when he wrote, "Botanists have generally neglected cultivated varieties, as beneath their notice."

In today's age, there is a resurgence of research focused on the plants most essential to human life. With seven engaging speakers, the 17th Smithsonian Botanical Symposium highlighted contemporary research into the domestication of crops and their wild relatives as well as ornamental plants. Invited speakers included archaeobotanists, botanists, geneticists, and paleoethnobotanists utilizing molecular and genomic tools unknown to Darwin.

Kirk Johnson, the Sant Director of NMNH, and Eric Schuettpelz, the Acting Chair of Botany at NMNH, both provided opening remarks and welcomed the audience to the Smithsonian Institution. Kenneth Wurdack, Department of Botany at NMNH, presented the annual José Cuatrecasas Medal for Excellence in Tropical Botany to Sandra D. Knapp from the Natural History Museum in London. Unfortunately, Knapp was unable to attend in person. Ian Owens, Deputy Director of NMNH, accepted the Cuatrecasas Medal on her behalf. Owens read prepared remarks written by Knapp in which she shared that Cuatrecasas was one of her botanical heroes. She noted, "His influence and inspiration reach far, and will for generations to come." While she was sorry to have missed the ceremony, she requested that we live tweet the event (#SBS19).

Allison Miller from Saint Louis University and the Donald Danforth Plant Science Center delivered the opening keynote talk, "What Darwin couldn't know: Modern perspectives on crop plant origins and why it matters for the future of food." She spoke about Darwin's written observations on variation in domesticated systems, using pigeons as

*Continued on page 2*

**Special Symposium Issue**

## EDITOR'S NOTE

# "The Search for Santessonia Continues"… Continues

In the January 2019 issue of *The Plant Press* (Vol. 22, No. 1), Julia Beros reported on an interesting mystery in the article, "The search for *Santessonia* continues." Harold Robinson told Beros a story about Mason Hale's discovery of the highly unusual lichen, *Santessonia namibensis*, and when Robinson and Beros went to examine the type specimen, they found the specimen missing. According to the original 1978 publication describing the species, two isotypes were sent to Lund and Uppsala, and the holotype was sent to the Smithsonian.

Almost four months after the search began, motivation dwindling, a message of hope appeared in Robinson and John Boggan email inboxes. The only hint revealed in the subject line: "*Santessonia namibensis* type."

Patrik Frödén, an assistant curator at Lund University in Sweden, read about the missing type and took it as a call to action. After checking the database and the herbarium he found no inkling of the isotype that they were supposedly housing. He then checked with the herbarium at Uppsala, and they replied: no isotype to be found. After going through the accession catalogue Frödén noted as well that between 1977-1984 (in the timeline of the publication of the genus) there does not appear to be any record of African material sent from the Smithsonian.

It is possible that the isotypes were never distributed, and after Hale's death, were not well accounted for and could have been lost to disorganization. The new genus was described by both Hale and Gernot Vobis in *Botaniska Notiser* v.131, so it is also possible that the missing specimen is associated with Vobis' name. There are multitudes of slight errors or misplacements or mislabeling that could have led the isotypes astray.

It is, however, reassuring to know that when a question is put forth, our international botanical community will respond! Though as the plot thickens, the search quiets again….

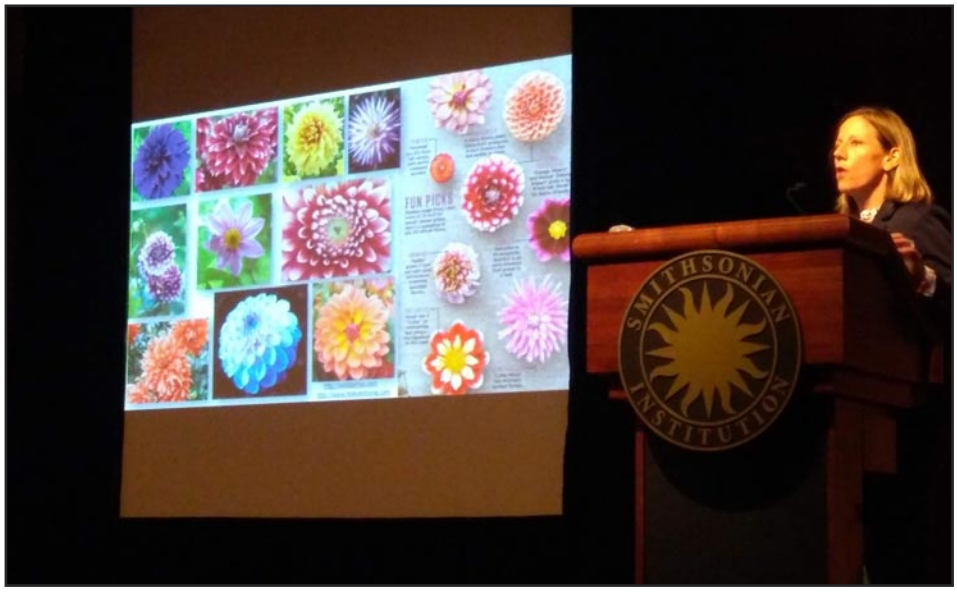
"Someday. Somebody. Somewhere," Robinson sighs, "the type will show up."

## Symposium

*Continued from page 1*

an example. While Darwin wrote extensively about animals (dogs, cats, horses, pigs, and others), his writings about crop plants (cereals and fruit trees) were more limited. Miller reviewed Darwin's contributions in understanding crop origins including steps in cultivation, geographic origins of crop plants, variation among cultivated varieties, and rapid evolutionary change in response to artificial selection.

Miller continued her talk by describing how traits among domesticated grapevine species (*Vitis*) vary under common conditions. She explained that when a scion is grafted to a rootstock, the rootstock system affects which genes are turned on. Thus, the rootstock influences the shoot system phenotypes. The future of food, the development of new crops, and food security were among other topics that Miller discussed. She argued that understanding crop plant origins is important for the conservation of crop genetic resources, improvement of contemporary crops, and the development of new crops to meet the needs of a growing population in a changing climate.




**Allison Miller delivers the opening keynote talk about modern perspectives on crop plant origins. (photo by Gary Krupnick)**

Natalie Mueller from Cornell University spoke about the past domestication of plants in her talk, "Lost crops and ancient landraces: Deep histories of communities and their crops." She uses long history to understand how social and environmental circumstances both foster and reduce agrobiodiversity. Her research focuses on 2,500 years of cultivation of erect knotweed (*Polygonum erectum*). Her work has uncovered evidence of at least two domestication events, the existence of distinct landraces, and the preliminary evidence of feralization of erect knotweed. She explains that for extant crops, it is possible to work backwards from known landraces to the archaeological record. With lost crops that are no longer present, it is necessary to explore variability through experimentation.

Mueller then went into detail on a project of hers exploring five lost crops: sumpweed, goosefoot, erect knotweed, little barley, and maygrass. She documented and

**Briana Gross placing domesticated apple in a global and local context. (photo by Ken Wurdack)**

collected seeds from populations of eastern North American crop progenitors. By doing so, she was able to document variability. Because the crops she studied are no longer in cultivation, she reconstructed best practices for cultivating the lost crops. She explored the role of developmental plasticity in plant domestication by conducting both fieldwork and greenhouse experimentation. By exposing progenitors to different kinds of growth conditions, she was able to effect plant architecture, yield, and seed and fruit morphology. She hypothesizes that unlike other wild plants, crop progenitors are usually plastic, and that ancient people chose to cultivate the select plants because they responded rapidly in beneficial ways.

For the last talk of the morning session, Nyree Zerega from the Chicago Botanic Garden and Northwestern University presented, "Seeing the forest for the fruits: Cultivation, domestication, and wild fruit trees in Southeast Asia." She began her talk by discussing a five-step biological process of domestication – wild, wild harvested, cultivated, semidomesticated, and domesticated. The domestication syndrome involves the selection of traits that are suited to the human rather than the wild environment. Forest tree crops, however, may not fit in this syndrome. Zerega asks if forest tree crops are a result of domestication or intensification. One challenge in domesticating fruit trees in a forest is that humans are not the only animal acting on selection. For example, elephants act on seed germination of jackfruits in Southeast Asia. Another challenge is that many fruit trees are clonally propagated instead of grown from seed since many tropical trees have recalcitrant seeds.

Zerega described in detail the domestication of four Southeast Asian tree species in the genus *Artocarpus* (Moraceae). Tarap (*A. odoratissmus*) has two genetically distinct forms – a wild form with hairy buds and a domesticated form with smooth buds. The local people of Sarawak, Indonesia, recognize these forms. In cempedak (*A. integer*) the putative wild progenitor has been identified, and molecular analysis shows distinct cultivars that have different colors, tastes, and sizes. Jackfruit (*A. hetrophyllus*) has a long history of human use going back 6,000 years. While the wild relative has not been identified yet, there is a high level of diversity in morphology. Jackfruit is harvested from forests, cultivated and managed in agroforests and homegardens, and grown in commercial orchards. Finally, Zerega shared a Hawaiian origin story for breadfruit (*A. altilis*), a species which has lost the ability to survive in the wild. Zerega concluded her talk by stressing that rather than focusing on improved control and increased production of individual species, tropical forest culture aims at the domesticating production processes of an entire ecosystem, encouraging diversity, and representing an alternative model of forest domestication.

The afternoon session began with John Burke from the University of Georgia presenting his talk, "Genetics and the evolution of crop plants: Insights from sunflower (and related species)." Using *Helianthus annuus* as a model system, Burke described how a domestication gradient exists, where high levels of genetic diversity is present in the wild progenitor but that diversity drops as landraces and then modern cultivars evolve. He then asked which traits drove the evolution of the

*Continued on page 4*

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On the cover: *Helianthus annuus* by G.A. Cooper

## Symposium

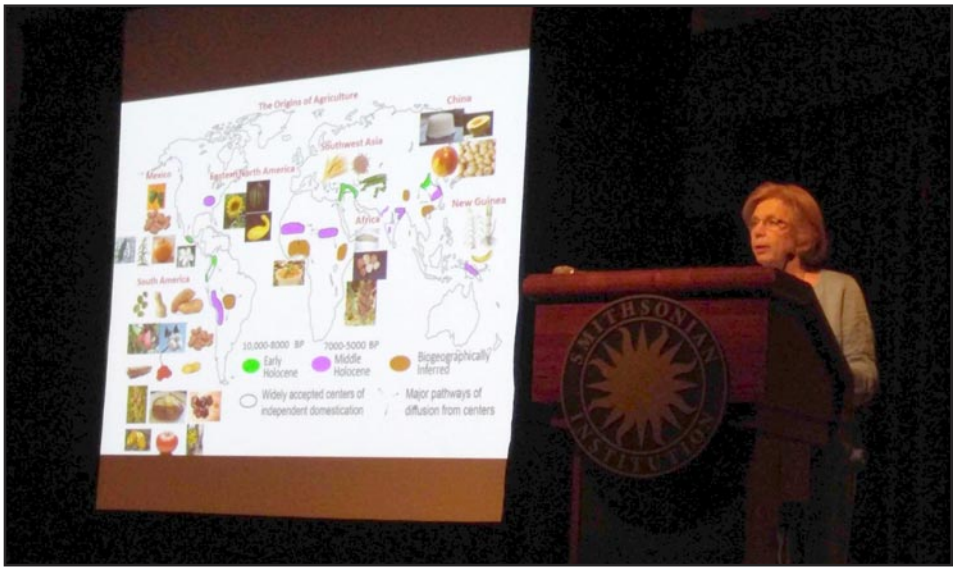
*Continued from page 3*

domesticated sunflower. Selection on larger seed sizes was highly influential, but surprisingly some directional selection effects were often in unexpected directions. Burke explained that it was possible that selection on oil-related traits may have led to these surprising findings.

Burke then focused on the timing of selection. He examined if seed size was a selecting trait early in the process of domestication, and oil traits were selected later in the process. By crossing wild sunflower with a primitive landrace, he discovered that past breeding efforts may have had unintended consequences. He explained that a post-domestication selection process for high oil content led to maladaptive alleles being introduced into the modern sunflower gene pool.

Briana Gross from the University of Minnesota Duluth next spoke on, "Domesticated apple in a global and local context." Apple (*Malus* x *domestica*) is a global temperate perennial crop with its wild progenitor from western China. Gross explained that perennials show much more mild genetic bottlenecks – while annuals retain an average of 60 percent of their genetic diversity, perennials retain an average of 91 percent. Using collections from USDA-ARS' Plant Genetic Resources Unit in Geneva, New York, she sampled the genotypes from 45 countries of domesticate apple, and compared the genotypes to the main progenitor *M. sieversii*, and two species that may have contributed to the crop, *M. orientalis* and *M. sylvestris*. Gross found *M. x domestica* has retained 95 percent of the variation present in *M. sieversii*. Thus, domesticated apple has maintained its diversity for over thousands of years. She did not find an improvement bottleneck either—modern domesticated apple has as much variation today as was present in the 1600s.

Gross spoke about diversity in the local landscape. Domesticated apple has become naturalized in North America, surviving without care for many years. Unidentified apple trees are common on the landscape. She spoke about a project in northeastern Minnesota, examining microsatellite markers to identify unknown local trees. She was able to genetically match 76 unknown trees to 20 named cultivars, of which eight were developed by the University of Minnesota apple-breeding program in the late 1800s and early 1900s. Six other cultivars were Russian dating back to the 1700s and early 1800s. Gross concluded that local breeding programs have a strong influence on regional genetics.




**Dolores Piperno presenting the closing keynote talk on agricultural origins in the lowland Neotropics. (photo by Gary Krupnick)**

After an afternoon coffee break, Logan Kistler from NMNH presented his talk, "Unraveling the evolution of domestication in maize with ancient genomes." He spoke about how corn became a global success, primarily due to genomic plasticity. Kistler examines ancient DNA to understand the order of events into domestication. Maize evolved from teosinte, an inedible plant. Origins of domestication date back approximately 9,000 years ago in the Balsas River valley in Mexico where starch grains and phytolith evidence has been found. Maize then arrived in Central America about 7,500 years ago and spread into South America around 6,500 years ago. Kistler, however, has discovered evidence that shows the domestication process was still happening in Mexico after it spread.

Examining 40 maize landraces, 9 archaeogenomes, and 70 published datasets, Kistler uncovered a stratified domestication process, where semi-domesticated maize led to semi-domesticated subgroups leading to the diverse landraces we see today. In other words, the diversity of modern maize is the result of multiple waves of human-mediated dispersal. Thus, maize domestication was not complete before people started moving maize around. Some lineages failed while others were successful.

To close out the presentations, Dolores Piperno from NMNH delivered the closing keynote talk, "Current perspectives on agricultural origins in the lowland

## Acknowledgements

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Neotropics." Archaeological evidence shows that the earliest sites of farming are often in caves and rock shelters, where grinding stones, *Cucurbita* phytoliths, popped teosinte grains, *Phaseolus* beans, chili pepper seeds, and avocado stems have been found. Piperno spoke about the importance of phenotypic and developmental plasticity, which gives plants the ability to adjust their phenotypes in response to environmental variability and change.

Piperno explained that $CO_2$, temperature, and precipitation levels were quite different in agricultural societies 12,000 years ago. She spoke about a greenhouse experiment where she grew teosinte in $CO_2$ and temperature conditions that resembled late-glacial and Early Holocene environments. Teosinte grown in growth chambers resembling modern conditions resulted in plants having the architecture and inflorescences we see today; but those that grew in the late-glacial and the Early Holocene growth chambers resulted in plants with an appearance that was more maize-like. She explained that gene expression might be the key that gives rise to phenotypic change. Piperno thus argues that foragers and early cultivators worked with teosinte phenotypes and gene expression levels considerably different—and already with some maize-like traits—than the modern teosinte presently used as the morphological and genetic baseline for the domestication process. In other words, we cannot assume ancestral plants were similar in morphology to today's plants. Piperno plans to follow up this research by looking at other traits such as fruit bitterness in squashes and pod twisting in lima beans.

**Presenters and guests interact at the closing reception and poster session of the 2019 Smithsonian Botanical Symposium. (photo by Gary Krupnick)**

The Symposium's evening events at the U.S. Botanic Garden's Conservatory included a closing reception and a poster session. Poster topics ranged from the domestication of edible hibiscus, mushrooms, and *Agave*, to the conservation of crop wild relatives both in the wild and maintained in botanic gardens.

An optional field trip allowed attendees the opportunity to partake in three behind-the-scenes tours of the Joseph F. Cullman 3rd Library of Natural History, an event hosted by Smithsonian Libraries. The library located at NMNH had on display a wide selection of stunning books highlighting Darwin's publications, medical botany, Native American plant use, and more. Leslie Overstreet, Curator of Natural History Rare Books, spoke about the collection of James Smithson's books housed in a temperature and humidity controlled vault within the library. Other books presented included John Hill's *The British Herbal* (1756) and William Jowit Titford's *Sketches Towards a Hortus Botanicus Americanus* (1811).

The 18th Smithsonian Botanical Symposium is scheduled to take place at the National Museum of Natural History and the U.S. Botanic Garden on Friday, May 15, 2020. The topic is still to be determined. Check the Department of Botany's website <https://naturalhistory.si.edu/research/botany> for updates.

**Leslie Overstreet highlights special notations in a botanical book on commercially important plants on display at the Cullman Rare Book Library. (photo by Allie Alvis)**

# Abstracts from the Speakers of the 17th Smithsonian Botanical Symposium

The 17th Smithsonian Botanical Symposium, "What Darwin Couldn't Know: Modern Perspectives on Crop Plant Origins," was held 17 May 2019. The invited speakers explored contemporary research into the domestication of crops and their wild relatives. Below are the abstracts from the papers that were presented by the invited speakers.


**Speakers of the 2019 Smithsonian Botanical Symposium at the National Museum of Natural History (from left): Dolores Piperno, Natalie Mueller, John Burke, Logan Kistler, Nyree Zerega, Briana Gross, and Allison Miller. (photo by Ken Wurdack)**

**Allison Miller**
***Saint Louis University and Missouri Botanical Garden***

Opening keynote: "What Darwin couldn't know: Modern perspectives on crop plant origins and why it matters for the future of food"

Charles Darwin regarded domesticated plants and animals as powerful models for understanding variation and evolution by selection. In the first chapter of his 1859 work The Origin of Species by Means of Natural Selection ("Variation Under Domestication") together with his subsequent book The Variation of Animals and Plants Under Domestication (1868), Darwin described several themes related to the origin of crop plants. First, I review some of Darwin's key contributions to understanding crop origins, including first steps in cultivation, geographic origins of crop plants, variation among cultivated varieties, rapid and dramatic evolutionary change in crop plants in response to artificial selection, and hybridization in crop evolution, among others. Second, I share modern perspectives on a subset of these topics using a crop that Darwin addressed in his work, the grapevine (*Vitis vinifera*). Third, I highlight three contemporary challenges for which Darwin's evolutionary perspective is directly relevant: conservation of crop wild relatives, improvement of contemporary crops, and the development of new crops. In summary, Darwin established a strong foundation for understanding of crop plant origins and evolution, and much progress has been made in recent years; future work can use this foundation to enhance food and ecosystem security in a changing climate.

**Natalie Mueller**
***Cornell University***

"Lost crops and ancient landraces: Deep histories of communities and their crops"

Agrobiodiversity is a priceless but threatened resource. It took over 10,000 years of evolution under human management and selection to create the many varieties of crops and crop relatives that are available today, and many of these only exist in seed banks. While extant crop diversity is impressive, there is increasing evidence that many more crops and useful variants were lost in antiquity. Moreover, our knowledge of the practices and circumstances that tend to increase agrobiodiversity is limited and there are fewer and fewer living communities where this process can be studied. I use two case studies from my current research in eastern North America and Kenya to illustrate that the archaeological record, coupled with experimental methods, has an untapped potential to reveal lost crops and practices, as well as the social conditions that create and support agrobiodiversity. These are pressing concerns in an era of ecological knowledge loss, global climate change, and population growth.

**Nyree Zerega**
***Northwestern University and the Chicago Botanic Garden***

"Seeing the forest for the fruits: Cultivation, domestication, and wild fruit trees in Southeast Asia"

The farm is not bounded by the field and continues into the forest; and the lines between wild, cultivated, and domesticated plants are often somewhat obscure. This is especially true in the case of fruit trees, many of which can have life spans longer than humans. The idea of domestication syndromes that are prescribed to many annual crops is not quite so clear cut for trees, and domestication terminology can sometimes lead to ambiguity and confusion. Thinking about domestication as a process rather than an end point or a state to be reached is valuable. This is true in polycultural tropical agroforestry systems, where humans have to some degree domesticated the forest, and the diversity of fruits have evolved alongside other large animal dispersers – sometimes begging the question of whether some fruits were "ready-made" in nature, and how much were humans involved in changing them. Examples from Southeast Asian fruit trees are of interest when considering the wild to domesticated continuum and informing conservation of agrobiodiversity.

**John Burke**
***University of Georgia***

"Genetics and the evolution of crop plants: Insights from sunflower (and related species)"

The origin and evolution of crop plants is a topic of great interest to researchers in a variety of disciplines. From an agricultural perspective, the value of such work is clear. Elucidation of the genetic basis of traits that make for a desirable crop plant has the potential to facilitate ongoing breeding efforts. From an evolutionary perspective, studies of the domestication and improvement of crop plants have the potential to shed light on fundamental biological processes. In my talk, I will discuss what is known about the evolution of cultivated sunflower (*Helianthus annuus* L.), with a particular focus on the origin of this important oilseed crop, the genetic architecture of domestication-related traits that distinguish it from its wild progenitor, and the genomic consequences of selection and introgression during its evolution. This work builds on a foundation of population and quantitative genetic analyses, and extends through the generation and analysis of large-scale genomic datasets to identify the unique contributions of wild sunflowers to the modern sunflower gene pool.


**John Burke speaking about the genetics and the evolution of crop plants. (photo by Ken Wurdack)**

**Briana L. Gross**
***University of Minnesota Duluth***

"Domesticated apple in a global and local context"

The domesticated apple (*Malus* x *domestica*) is a perennial fruit crop of global importance, having expanded out of Eurasia to the temperate regions of the northern and southern hemispheres. Documenting the changes associated with apple domestication and the spread of apple cultivars into new environments is critical for understanding of the evolution of this important crop, and also for understanding perennial plant domestication in general. A variety of genetic approaches used to compare domesticated and wild apples show that domesticated apple is distinct from its wild relatives, but also that it lost almost no genetic diversity as it moved around the world over time. This stands in sharp contrast to patterns seen in annual crops, which usually undergo moderate to severe bottlenecks during domestication. On a local scale, orchard trees can survive for decades after abandonment, and domesticated apple has naturalized and spreads autonomously in some regions. In northern Minnesota, abandoned and naturalized apple trees are common on the landscape, and genetic identification of unknown trees has shown that most are cultivars from the fruit breeding program at the University of Minnesota. This work demonstrates the importance and impact of local plant breeding efforts for global crops.

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**Logan Kistler**
***National Museum of Natural History***

"Unraveling the evolution of domestication in maize with ancient genomes"

Maize was domesticated from wild teosinte in Mexico beginning around 9,000 BP, and it traversed Central America to spread into South America by ~6,500 BP. However, recent genomes from archaeological maize dated to ~5,300 BP near its site of origin reveal partial domestication—a mix of maize-like and teosinte-like alleles at loci involved in domestication. This creates a paradox: maize was still only partially domesticated near its site of domestication long after it became established as a crop species in South America, so it is unclear how the full complement of domestication syndrome genes came to fixation in South American lineages. New genomes from indigenous South American landraces and archaeological maize help refine our understanding of maize domestication, and illuminate a scenario where humans carried maize far beyond its native range while the domestication process was still in a relatively early stage. The domestication process then continued in parallel in multiple parts of the Americas.

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**Dolores R. Piperno**
***National Museum of Natural History and Smithsonian Tropical Research Institute***

Closing keynote: "Current perspectives on agricultural origins in the lowland Neotropics"

The development of agricultural societies 12,000-9,000 years ago was one of the most transformative events in human and ecological history. The New World tropical forest was an early and independent cradle of agriculture with the emergence of plant cultivation and domestication taking place at the same time as in other major regions of the world. As in other areas of the globe, our understanding of this issue has been advanced by a steady stream of archaeobotanical, paleoecological, and molecular/genetic data, now including from ancient DNA. Also importantly, a renewed focus on formulating testable theories and explanations for transitions from foraging to food production has led to applications from evolutionary ecology and phenotypic (developmental) plasticity not previously applied to agricultural origins. New data are causing reconsiderations of how novel phenotypes, including domesticated species, originate; whether the living wild progenitors of major crops utilized in archaeobotanical and genetic research are faithful replicas of what the last foragers and first cultivators saw 12,000-10,000 years ago; and the influence of artificial selection on the domestication process. This paper reviews this body of evidence and offers comparative perspectives from other regions of the world on how, why, where, and when plant food production and domestication arose in the Neotropical forest.

# Knapp Receives 17th Cuatrecasas Medal

The Department of Botany and the United States National Herbarium present this award to a botanist and scholar of international stature who has contributed significantly to advancing the field of tropical botany. 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 in the Smithsonian Institution's Department of Botany. Dr. Cuatrecasas devoted his career to plant exploration in tropical South America and this award serves to keep vibrant the accomplishments and memory of this outstanding scientist.

The winner of this prestigious award is selected by a committee made up of four botanists on staff in the Department in consultation with other plant scientists outside of the Smithsonian Institution. Nominations for the Medal are accepted from all scientists in the Botany Department. 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.

The 17th recipient of the José Cuatrecasas Medal for Excellence in Tropical Botany is Sandra D. Knapp. She earned a B.A. from Pomona College in 1978 and her Ph.D. from Cornell University in 1986, focusing on *Solanum* sect. *Geminata* under the guidance of *Solanum* expert Michael D. Whalen. In 1992, Knapp joined the Natural History Museum in London, initially to manage the large Flora Mesoamericana project and presently as Head of the Plants Division. Knapp has received the Peter Raven Outreach Award (2009) from the American Society of Plant Taxonomists and the Linnean Medal for Botany (2016) from the Linnean Society of London, the world's oldest biological society (founded in 1788); she was elected President of the latter society in 2018. Knapp has been very active in the International Association for Plant Taxonomy, where she has served as President of the Nomenclature Section. She has written extensively about the rules governing the naming of organisms and has authored or coauthored over 150 scientific research publications (garnering over 15,000 citations), in addition to books and numerous reviews and opinion pieces. Knapp's non-technical books have focused on the history of botany and plant exploration, including on noted tropical explorer Alfred Wallace, who was a contemporary of Charles Darwin and founded the field of biogeography.

Smithsonian Botanical Symposium

The Cuatrecasas Medal selection committee took special note of Knapp's many accomplishments as a scientist, tropical botanist, and educator. Of special relevance to this year's Smithsonian Botanical Symposium is her long interest in the Solanaceae, and in particular, putting order to the challenging genus *Solanum*, with over 1500 species, including such staples as potatoes, tomatoes, and eggplants, and stunning Andean diversity. In her decades of neotropical research, Knapp has described over 75 new plant species and has advocated strongly for the importance of floristics and collections. Knapp has been a champion of conserving biodiversity and exploring the relationships between plants and people, noting the importance of the "cultural, societal, economic, and nutritional aspects of our relationships with crop plants, as well as our use and knowledge of the genetic diversity stored in their wild relatives." She has written extensively on the challenges and opportunities for 21st century botanists, as well as the changing roles of taxonomy, collections, and field research in a world with declining biodiversity.

The 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); and Alan K. Graham from the Missouri Botanical Garden (2018).

**Sandra Knapp**

# Ernani Guingona Meñez (15 August 1931 – 01 May 2019)

**Ernani Guingona Meñez** was born on 15 August 1931, in Manila, Philippines. He finished his secondary schooling at Mapa High School in Manila and his undergraduate degree (BA in Botany) at the University of the Philippines, Diliman. At UP, he worked with Gregorio T. Velasquez, considered the father of Philippine phycology, as a student assistant-laboratory instructor. Velasquez introduced him to Maxwell Doty, phycologist at the University of Hawaii and recommended him to be Doty's field assistant on his project of *Caulerpa, Gracilaria* and *Eucheuma* species around the Philippines.

In 1958, he left the Philippines to pursue further studies at the UH while at the same time working as Doty's assistant under the sponsorship of the U.S. Atomic Energy Commission and the National Science Foundation. He finished an MS in Botany in 1962. He was offered an assistantship by Robert Scagel, foremost Canadian marine phycologist at the University of British Columbia.

In 1964, Elmo Yale Dawson (foremost American phycologist), curator in the Department of Botany at the Smithsonian's National Museum of Natural History, invited him to supervise and fill a vacant position in the Smithsonian Oceanographic Sorting Center. At SOSC, Ernani worked as botanist and was appointed as director in 1988 to 1998. He retired from the Smithsonian as Botanist Emeritus. While at the Smithsonian, he got time off to finish a PhD (major in Botany) at the University of New Hampshire.

Meñez was author and co-author of more than 20 publications on algae, specializing on the order Ceramiales (*Polysiphonia* and *Tiffaniella*), and seagrasses. He published extensively on the seaweeds of the Philippines, Tunisia, the Mediterranean, and Libya. Among his notable publications was a monograph on seagrasses with Ronald Phillips (*Smithson. Contrib. Mar. Sci.* 34: 1-104; 1988). He also scientific illustrated four books (Scagel, R., et al. 1967. *An Evolutionary Survey of the Plant Kingdom*; Scagel, R. 1967. *Guide to the Common Seaweeds of British Columbia*; Scagel, R., et al. 1969. *Plant Diversity*; Hale, M. 1969. *How to Know the Lichens*).

Meñez collected extensively in the Philippines, Christmas Islands, Queen Charlotte Islands, southern Chile (1969), southern Argentina (1971), Tunisia, and the Mediterranean. He was consultant to the UNESCO in the establishment of the University of Mexico Marine Sorting Center; the Italian Marine Sorting Center in Genoa; the Harbor Branch Foundation in establishing the phycological herbarium at Fort Pierce Facility, Florida; and the US-EPA for the EPA Lake of Tunis Eutrophication Project in collaboration with the Tunisian Institute of Fisheries. He was also Senior Advisor to the Philippine Science and Technology Advisory Council in Washington, DC (1988 until retirement) and Contributing Scientist at the Silliman University Marine Laboratory (now Institute of Environmental and Marine Science).

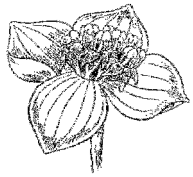
For his contributions in advancing marine science in the Philippines, Meñez was awarded the Pamanang Pilipino Award by Philippine President Fidel Ramos in 1993 at the Malacañang Presidential Palace. The award is conferred to "Filipinos overseas, who, in exemplifying the talent and industry of the Filipino race, have brought the country honor and recognition through excellence in his profession or line of work." He was also presented with a Certificate of Recognition by President Ramos, at Los Angeles, California for "his dedication and commitment toward the promotion of the common good and in keeping the 'balikbayan' spirit alive through aspirations, ideals, and work in the service of the Filipino people and the community of nations." He expanded and opened new areas for collaboration on science and technology between the Philippines and Smithsonian by drafting and facilitating the signing of a memorandum of understanding in 1989.

A Plaque of Recognition was awarded to Meñez by the Department of Environment and Natural Resources and Silliman University in the Philippines for "his support, cooperation and contributions in the progress and development of phycology" by organizing the 1st and 2nd US-Philippines Phycology Workshop" (1984; 1992) in the Philippines;" for having pioneered the first successful investigation of the feasibility of mariculture of *Eucheuma* in the

country resulting in the economic boom and added livelihood of the Filipino fisherfolks; and his continued and sustained support of marine botanical studies" by serving as external adviser to post graduate students, raising funds to support Filipino students/junior scientists for advanced training in marine biology at the Smithsonian Institution and the National Cancer Institute, and for marine botanists and other scientists for research in the USA; giving free summer courses on seaweeds and seagrasses; providing invaluable references, specimens, equipment and supplies to Philippine colleagues doing research/teaching and for publishing monographs and articles on Philippine seaweeds and seagrasses, thus contributing to the knowledge on Philippine seaweeds and seagrasses to the scientific community worldwide and opened new areas of research.

Dr. Meñez died on 01 May 2019 at the age of 87. He is survived by his wife Chuchi Rosal, four sons, and six grandchildren.

*-Submitted by Hilconida P. Calumpong*
*Director, Institute of Environmental and Marine Sciences, Silliman University*



# Designing a state-of-the-art taxonomic research workstation

As botanists develop more knowledge the science of taxonomy becomes increasingly complex. Between 1753 and 2016, the number of known plant species has risen from about 6,000 to 390,000, an average increase of nearly 1,500 species each year. Over 2,000 new species were discovered in 2015. The number of specimens held globally in herbaria has also increased. There are now over 3,000 herbaria around the world holding nearly 400 million specimens.

Any taxonomist working now therefore has an immense and expensive task of gathering information about the species that they are studying, involving travel to various herbaria or the risk of damage or loss to specimens if they are sent on loan. With about 10-20 percent of flowering plant species still to be described, it is estimated that about half of these have already been collected and are held in herbaria around the world.

Scientists need to find solutions to making collection information more widely accessible in order to speed up the research process given the scale of the challenges they are facing. In many cases, a high-resolution digital image of the specimen with electronic collection data attached will enable researchers to carry out much of the basic work. By digitizing botanical collections, herbaria can provide these resources to taxonomists in every part of the world.

Digitization, however, is only one step of the process. Herbaria also need to create an environment where taxonomic researchers can bring all the digital resources together with the physical specimens, using tools and equipment to make working with massive amounts of complex information easy and intuitive. This kind of workstation is most famously seen in television programs such as CSI, but herbaria need to be implementing the technology and data management in our institutes if they are going to have a chance to produce the taxonomic basis for global biodiversity in time to help its survival.

**Elspeth Haston**, the Deputy Herbarium Curator of The Royal Botanic Garden Edinburgh, University of Edinburgh, is visiting the Smithsonian's Department of Botany during the months of June, September and October to focus on the practical development of a taxonomic research workstation which enables the best use of hi-tech and lo-tech solutions to enable a researcher to effectively use both physical and digital resources. She is very interested in the work processes that the museum staff and associates employ to study the botanical specimens, and she is also interested in the ways in which visitors do their research when using the herbarium.

In designing an integrated taxonomic workstation, her objectives include (1) transforming the workflows of fundamental taxonomic research using digital resources to increase efficiency and effectiveness; (2) ensuring that data resulting from the research are consistently and accurately recorded to ensure accessibility and availability for reuse; and (3) integrating molecular processes and data to increase speed of identification and characterization of specimens.

Haston's research is supported by a Fellowship in Digital Scholarship sponsored UK's Arts and Humanities Research Council (AHRC) and the Smithsonian Institution.

**A large number of specimens are still being collected and these all need to be identified, digitized and included in revisions, with some undoubtedly being new species. (photo by Elspeth Haston)**

# New publication highlights the Guiana Shield plant collections

*Report from Guyana, June 1994:* Having just flown into Kaieteur National Park, Carol Kelloff, Paula DePriest, and Mike Tamessar (University of Guyana) realize that Eric Christenson, who had flown in with them, is missing. Christenson is found at the airstrip, with camera and gear unpacked, focused on a *Vanilla bicolor* Lindl. vine in bud. "Christenson had only seen an illustration of this flower and was questioning whether the subtle colors of blue and pink that were "painted" on the original drawing were the true colors. He […] was willing to camp out under the vine not to miss the opportunity. […] The next morning the flowers opened, and Christenson was very pleased to see that the artist's rendering of the colors was correct."

Carol Kelloff, Vicki Funk, and Sara Alexander have published "Smithsonian Plant Collections, Guiana Shield: 1985–2014, Biological Diversity of the Guiana Shield Collectors" (2019, Smithsonian Institution, *Smithsonian Contributions to Botany*), which covers the collections of 36 collectors. This volume is intended as a reference for herbaria holding collections

*Continued on page 11*

# Origin and diversification of the sunflower family

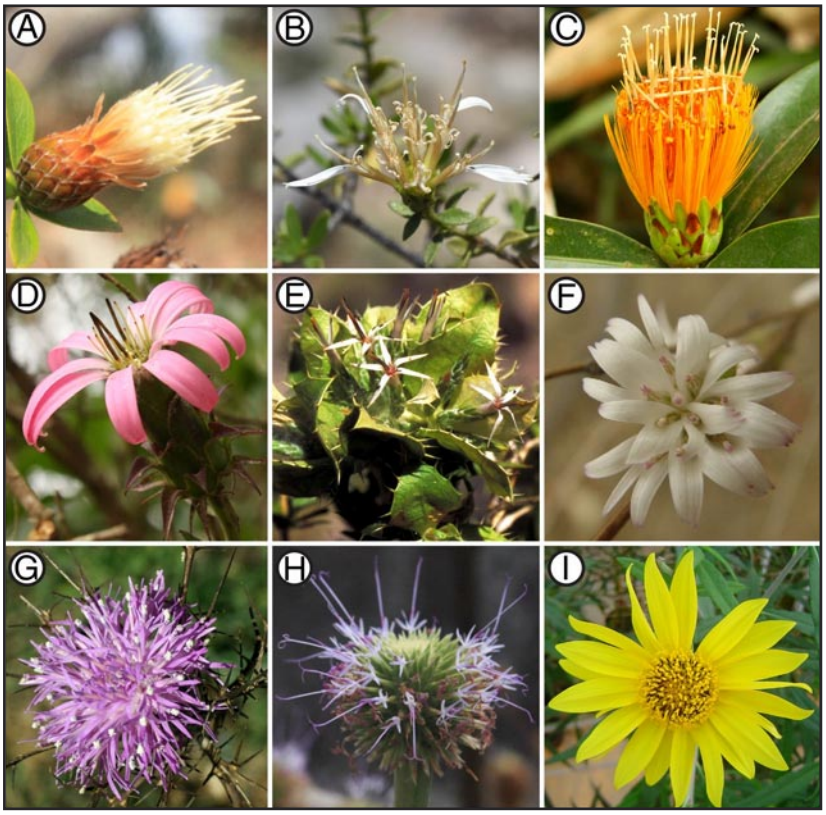
*-Adapted from EurekAlert*

A study that explores the origin and diversification of Asteraceae, the sunflower family, was recently published in *Proceedings of the National Academy of Sciences* (https://dx.doi.org/10.1073/pnas.1903871116). Asteraceae, composed of an estimated 25,000-30,000 species, accounts for nearly 10 percent of all flowering plants. Global in distribution, the family occupies nearly every type of habitat on Earth and is marked by a complex inflorescence exemplified by the North American sunflower, in which individual flowers are clustered to mimic a single, large flower to lure pollinators. The origins, migration routes, and patterns of diversification that led to the family's ecological success remain unclear.

Using phylogenetic analysis of nearly 1,000 genomic locations in around 250 species, Jennifer Mandel (University of Memphis) and colleagues, including **Vicki Funk** (Smithsonian Institution), found that the family likely originated around 83 million years ago in the Late Cretaceous Period in southern South America. The earliest diversification out of South America may have occurred around 50 million years ago, during a period of dramatic climate change. Subsequently, the family rampantly diversified during the middle-to-late Eocene epoch, 42-37 million years ago, a period marked by global cooling, resulting in more than 95% of existing species.

Biogeographical analysis suggests that the family migrated to North America, south and central Africa, and Asia, with ancestral range estimates suggesting different possible dispersal routes out of South America. Regardless of the route, the family's prolific diversification and global colonization likely began once it reached Africa around 42 million years ago.

According to the authors, the findings illuminate the evolutionary processes underlying the wide reach and vibrant diversity of a major group of flowering plants.

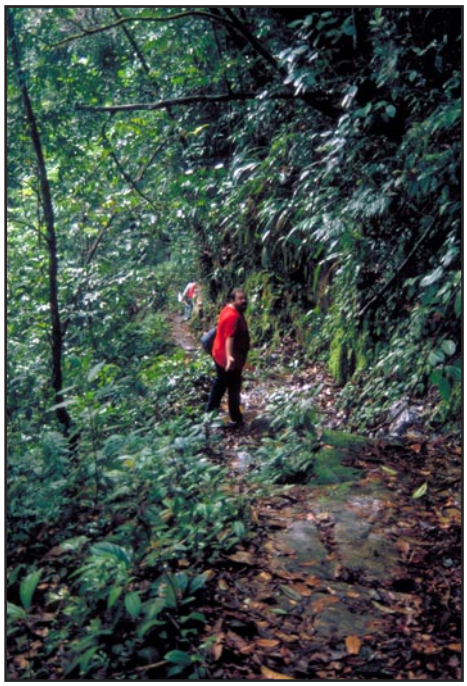



**Floral diversity of tribes in the Asteraceae family. A recent study suggests the family originated in the Late Cretaceous Period in South America and later migrated to Africa where it diversified rampantly. (A) Barnadesieae; (B) Famatinantheae; (C) Stifftieae; (D) Mutisieae; (E) Hecastocleideae; (F) Pertyeae; (G) Cardueae; (H) Vernonieae; and (I) Heliantheae. (Image courtesy of *PNAS*)**

## Guiana Shield

*Continued from page 10*

made during collection trips sponsored by the Biological Diversity of the Guiana Shield Program (BDG), and as an aid to botanists and taxonomists interested in the region. Part I contains expedition narratives and maps of teams' routes; part II lists collection localities by collector, with collection number ranges, habitat descriptions, geographic coordinates, and assisting collectors; part III lists collections in numerical order with identifications; and part IV lists collections ordered by determined taxonomic name; followed by four plates of color photos. It also includes a dedication to Tom Hollowell, data manager of the BDG from 1996 to 2005. The publication is available as a free pdf download at https://opensi.si.edu/index.php/smithsonian/catalog/book/210.



**Eric Christenson on the trail from Kaieteur Falls to Tuiket, June 1994. (photo by Carol L. Kelloff)**

# Herbarium specimen conservation project: Agnes Chase and Albert Hitchcock's 1908 field expedition

*By Shannon Hicks and Erika Gardner*

Tucked away in the US National Herbarium's mounting preparation room is a specimen conservation cabinet that temporarily holds specimens in need of repairs. Many specimens are in need of simple repairs, but in some instances, the specimens require a major overhaul. One bundle awaiting repairs is a stack of 55 Poaceae specimens collected by Agnes Chase and Albert S. Hitchcock. The original herbarium paper and specimen label was acidifying and extremely brittle. With time, the plant material on the sheet would be compromised and eventually succumb to shattering with the slightest bump. It was pertinent to get these specimens remounted and filed back into the main collection as soon as possible for scientific use. **Shannon Hicks**, Botany summer volunteer, worked to get these specimens fully conserved.

Agnes Chase, born Mary Agnes Meara in 1869 in Illinois, was a pioneer for women in botany. In 1903, Chase began work as a botanical illustrator in the National Herbarium for the U.S. Department of Agriculture (USDA). Chase was a self-taught botanist; she would often stay late at the herbarium so that she could learn as much as possible about botany. Since her highest level of formal education was grammar school, her years as a botanical illustrator served as her primary form of education. She became very passionate about Poaceae, the grass family, later saying that, "Grass is what holds the earth."

After a few years as a botanical illustrator, Chase's enthusiasm and aptitude for botany was noticed by agrostologist Albert S. Hitchcock. Chase and Hitchcock worked together for many years, and she later succeeded him as Senior Botanist in charge of systematic agrostology at USDA in 1936. In 1937, Chase became in charge of the grass section of the National Herbarium, gaining the title of Custodian. Throughout her career, Chase traveled worldwide to study grasses; she often funded her own trips with the help of several women's rights organizations she was a part of because the government would not pay for her to travel on other expeditions. In 1922, *Agnes Chase's First Book of Grasses* was published, intended to demystify the study of grasses. By the end of her career, Chase had over 70 publications describing and classifying America's grasses and had contributed 12,000 grass specimens to the herbarium.

This summer, Hicks conserved specimens from a 1908 field trip that Chase took with her mentor, Hitchcock, for the book they coauthored, *The North American Species of Panicum.* The specimens were mainly from Colorado, Wyoming, and Idaho. The grasses collected were primarily from the genus *Poa*, a very common group of grasses.

The specimen conservation process is a very intricate one with many steps to ensure that the specimen is returned to a state where it will last for at least another


**Specimen before and after restoration. Left: Signs of brittle paper crumbling is found near the bottom left corner of the sheet. Tears and rips would continue to occur if specimen is left in this condition on acidic paper. Right: All restored specimens are mounted on paper products that are pH neutral and museum archival quality. The original label is kept with the specimen.**

100 years. The first step in specimen conservation is to carefully dismantle or remove the plant from the herbarium sheet without incurring damage. Fortunately these specimens were not glued directly to the herbarium paper. The original adhesive strips that were used to tack down the specimens had begun to deteriorate or had broken. Using tweezers and a probe, Hicks carefully removed the strips and placed the plant in a newspaper folder, and loose seeds and flowers in an archival fragment packet. These fragments contain genetic material that could potentially be valuable to researchers. Each specimen label, sheet number, and annotation/note were cut from the sheet and kept with the plant to later be transcribed onto archival paper.

After the sheet was dismantled, the specimen was mounted onto archival paper. Remounting grasses requires an artistic eye because the goal is to make the specimen a usable identification and research tool. Hicks rearranged the specimens in a way that showed significant characters, such as the flower spikelets, auricles and ligules, which are used as a means for identification. The trick to mounting specimens is to not use too many strips and to arrange them in a way that is both functional and aesthetically pleasing. Some specimens, those that had bulky bases and roots, required sewing. After mounting, Hicks tested each specimen to make sure that all parts of the plant were properly tacked to the sheet.

Recreating labels is a very important part of the conservation process as it documents the scientific name of the plant, who collected it, and where it was collected. Chase often described the habitat where the plant was found and how it grew. Transcribing the labels was very challenging at first because Chase hand wrote all her labels. Often Hicks compared words and letters on different labels in order to decipher another. It became like detective work, and Hicks learned to recognize how Chase wrote specific letters and words. Once each label was printed on archival acid-free paper, it was glued onto the sheet. All original labels and notes were then stored in separate fragment packet, which were also attached to the sheets.

Hicks checked each scientific name for taxonomic changes. **Paul Peterson** and **Rob Soreng's** recently published grass family phylogeny proved useful. For each grass specimen that had a name change, Hicks attached an annotation label to the specimen. After the specimens were conserved, they were handed over to the Poaceae team, which is currently working on rehousing and organizing the entire Poaceae collection. These valuable specimens will be refiled into the main collection and will be of great use to the scientific community for many years to come.

## Winner of youth art contest visits Smithsonian

**Alice Tangerini** participated as one of the seven judges for the 2019 Saving Endangered Species Youth Art Contest, an event sponsored by The Endangered Species Coalition (ESC) and open to K-12 grade students. The student's artwork depicted threatened or endangered animal and plant species found in the United States. Artwork was sent digitally to all of the judges, which included artists, photographers and conservationists. The contest is an integral part of the annual Endangered Species Day, held this year on May 17, 2019.

The contest winner was first-grader Sam Hess of Portland, Oregon. Sam's collaged drawing of the Texas Blind Salamander won the grand prize which included a private drawing lesson given by Tangerini. In order to give the lesson, Tangerini procured specimens of the preserved salamander, courtesy of the Department of Vertebrate Zoology's Herpetology Division through Keven de Quieroz and Addison Wynn.

Tangerini photographed the specimens and researched images online as resource material for Sam. The liquid collection of a dozen salamanders in a jar proved fascinating for Sam and his mother, who accompanied him. Sam had a great time drawing from the resources and using Tangerini's microscope and camera lucida. Sam was honored at an award ceremony later that evening at the Rayburn Building.

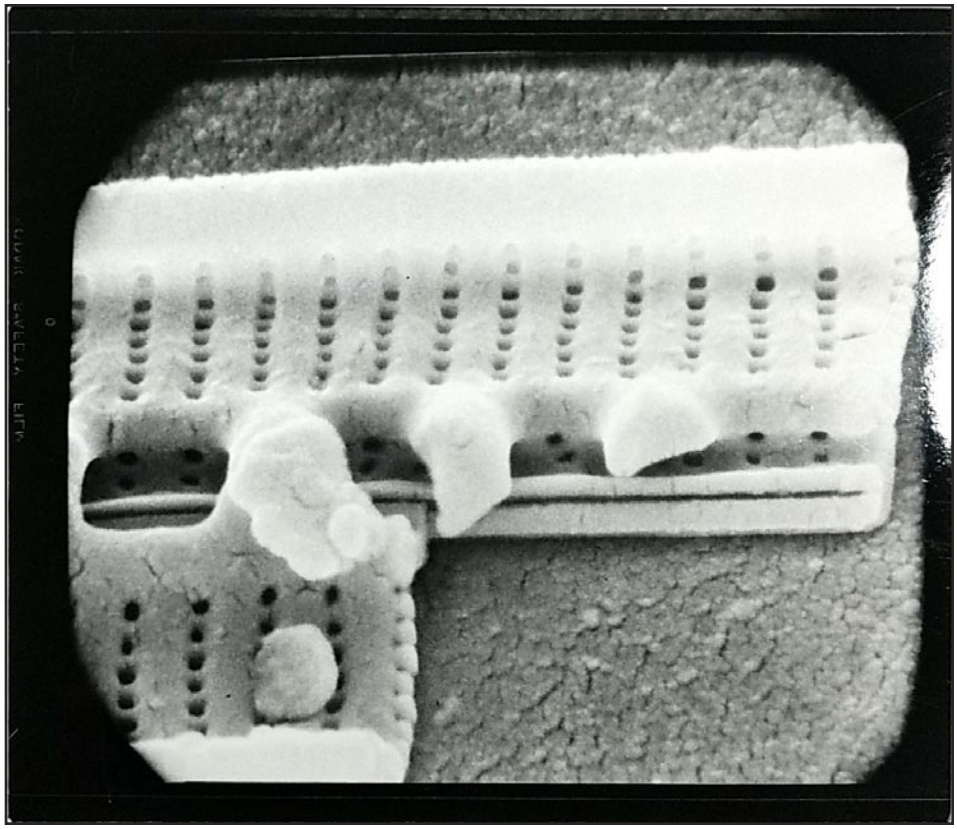
More information about the winners of the 2019 Saving Endangered Species Youth Art Contest is available at http://www.endangered.org/winners-of-2019-saving-endangered-species-youth-art-contest-announced/.

**Oregon 1st-grader, Sam Hess, winner of the Grand Prize of the 2019 Saving Endangered Species Youth Art Contest, receives a private drawing lesson by Alice Tangerini. (photo by I. Hess)**

# Conger and the diatoms

*By Julia Beros*

Paul Sidney Conger made only one concession to using the Scanning Electron Microscope. That is, only once were the habits of Conger interrupted by the forces of change. For a career that spanned decades in the field of microscopy, Conger's steady work was technical, meticulous, and though only visible under the lens of a microscope, monumental. After assisting Albert Mann at the Carnegie Institution for Science in his study of diatoms (1922-1935), he moved onto the USDA, which segued him to his career at the Smithsonian Institution (though his associated library material did not make the same institutional transition and remains with the USDA, much to Conger's chagrin). Conger was named honorary custodian of diatoms, 1935-1943; then associate curator, 1944-1966; and botanist emeritus of cryptogams, 1967-1979. In a recent conversation with Harold Robinson the story of Conger's contributions to the Smithsonian, microscopy, and diatoms sparked a long query into the quirks and legacy of Mr. Conger.



**Paul Conger's unpublished scanning electron microscope image of the diatom, *Baccillaria paradoxa*. Broken valve showing interior structure and exposing one side of the raphe.**

Revealing whole worlds to our human eyeballs, new images for neural pathways to decode and translate, the mystifying imagery of the microscopic world is nothing short of something unbound and celestial. Universes that exist under the guise of our human habitual. For Conger this universe was his second home. Known for mounting material on a slide with tight precision, he was able to manipulate indiscernible material with great accuracy. He was a mechanic of fine hand skills, using pieces of threads to slice or angle material, to mount and affix even the tiniest sliver of a specimen so that it would willingly reveal its hidden structures beneath the scope. He was a gifted technician, even in his early eighties.

In Conger's day there were two methods of mounting diatoms: smearing them on a slide and recording the positions on the microscope setting, which meant the microscope was commandeered for the entirety of the time needed to study the material (i.e. indefinitely). Then there was Conger's way; mounting the selected diatom on the center of the slide (sometimes a row of diatoms), and marking the position on the slide by surrounding it with the girdle removed from a large discoid diatom (ever resourceful), so that his subject was findable without coordinates. Many of his innovative ideas came from testing out new methods that he read about in one of his favorite magazines, *Popular Mechanics*.

Single celled alga with rigid silica shells, diatoms, were the focus of most of Conger's microscopy endeavors. Too small to see, they exist en masse floating in oceans, rivers, lakes, the water; all one need do is dip a rope into the water and a "party-mix" of diatoms will eagerly attach. Viewed under high powered light microscopes, their great variety in structure and patterning are reminiscent of tiny jewels, pocket lint, or miniature plastic figurines. Many diatomists made great artworks under the microscope, creating mosaics from these tiny alga, and Conger even kept a collection of slides with these microscopic realist "paintings," one even depicting a man with a cane on a leisurely stroll past a house.

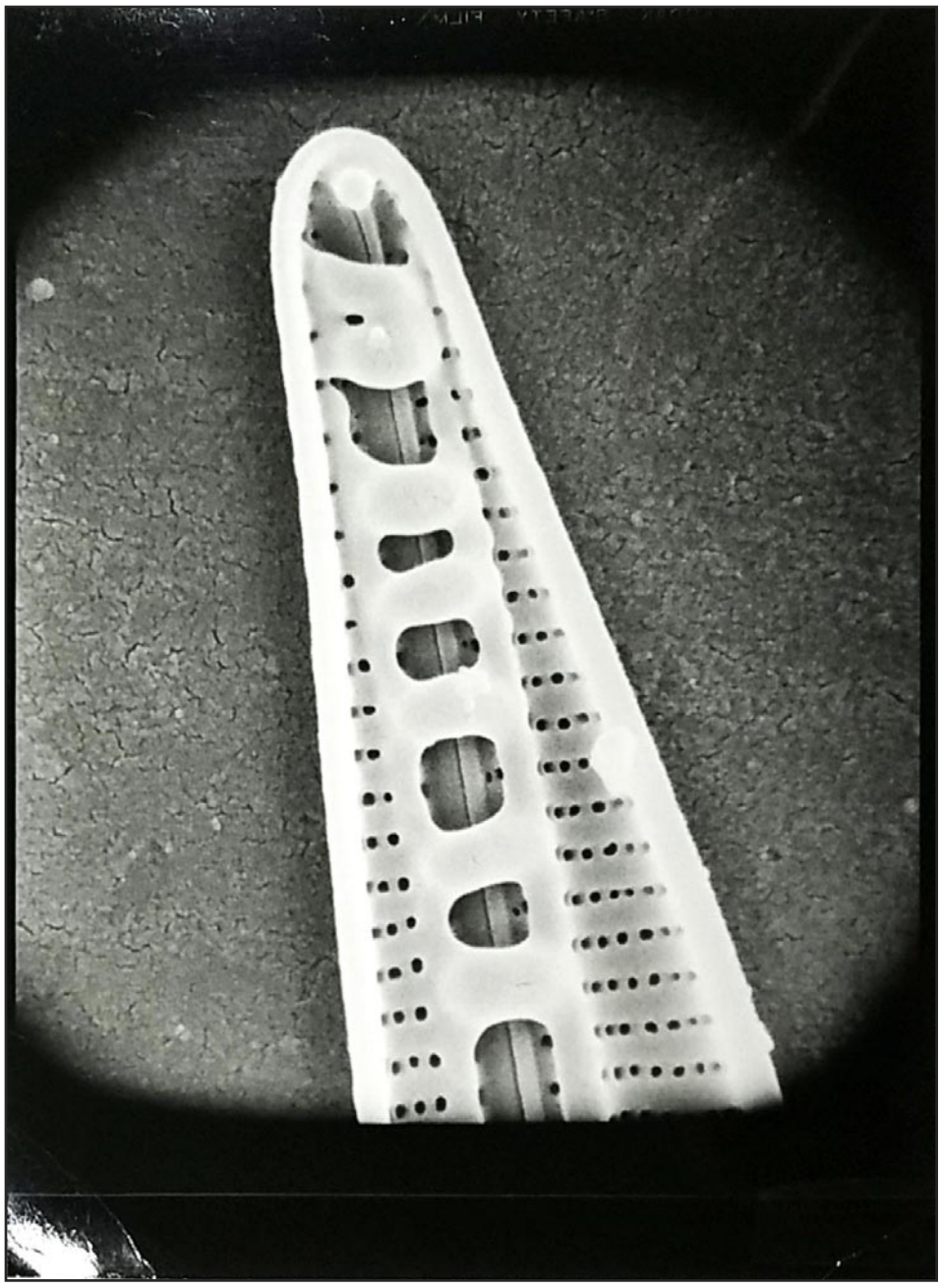
One species, *Baccillaria paradoxa*, was of particular interest to Conger and his colleague Robinson. A colonial diatom in "peculiar arrangement" the single cells lay flat atop each other sliding laterally across their bodies, much like the arrangement of a fold-out ruler, without ever disconnecting at the tip. Most diatoms move against water, but in this case they move against each other in their colony. Perhaps they exchanged a bit of protoplasm in the 1/10 of the diatom that always remained connected to the adjacent cells. In the hope to discover the mechanism of communication and movement among the diatoms, Robinson convinced Conger that the Scanning Electron Microscope (SEM) would help them understand this curious organization. "The advent of the SEM had one great advantage. Previously the limited depth of focus in microscopic images made full views of objects like diatoms impossible," Robinson recalls, "Conger would use double exposures, one to record the

surface of the valve, and second to record the outline. This resulted in an unwelcome halo-effect. SEM had a greater depth of focus, and a whole diatom or pollen grain could be seen in clear focus." The SEM shoots a focused beam of electrons back and forth that disperse throughout the microscope chamber and reconstructs these points electronically, much like a TV picture.

Conger was not the type to be rushed or corralled, even when it was time to move from the Smithsonian Tower Castle to the Natural History Museum he made special arrangements to take his time. On the second floor of the old south tower, two floors below the cryptogamic collection, and one floor below the old departmental library with the tile mosaic of the Smithsonian seal, Conger had a large work-space rarely visited by others in the department. Displaced from his oasis, he was sent to the West Wing of the Natural History Museum. Carrying his belongings over one by one in paper bags, a crusty old bottle of ether casually accompanying him across the National Mall (later attracting the attention of the bomb squad, for fear that it had crystalized into an explosive compound), the move began in 1965. Conger never quite felt settled in his new smaller office. Not one to be rushed into using a different tool either, Conger finally prepared his favorite diatom for the SEM. Using a thread powdered with crystals, he sliced the material in order to get a detailed interior look.

"I am not pleased with the views we have here," mumbles Robinson as he goes over the stack of photos that were tucked away in his office in a trove of unpacked envelopes and parcels. Eerily unfamiliar, the images they captured of *B. paradoxa* are certainly humble in comparison with the false-color images of today's microscopists. A diatom of 5 microns long, Conger was able to prop it up with a thread and make a cross section of the valves, exposing the raphe (where the streaming of protoplasm occurs) and the structure holding the valve together. These glamour shots of the diatom revealed a unique bridge design that encased the raphe, maybe this was part of the answer they were trying to uncover. Alas, after taking these first few photographs they never made it to the apical part of the diatom to see the most complex part of the structure. Shortly thereafter in 1979, at age 83, Conger was hit by a bicyclist and did not recover from the injuries, still with plans to write a paper on the subject of *B. paradoxa*.

Conger's lifelong devotion to microscopy is one to honor; he transformed what had been seen as a chore into a delicate artform. Reluctant to retire at the mandatory age of 70 (and hoping an exception would be made for him) he continued to come to work. He could finesse the invisible into revealing all its secrets, and his steady unbothered work created a foundation for many to come after him. Unfortunately his position was voided after he passed, and his office remains quiet. To Robinson, "the Scanning Electron Microscopes (SEM) have revitalized two fields of botany: palinology and diatomology," and subsequent work studying *B. paradoxa* and its mode of protoplasm streaming continues. For Conger, though, the pleasure was in the process. In being patient. The work of discovery is eternal as the nature of life is to change. A continuous cycle of exchange witnessed by those who take the time to watch stillness.



**Paul Conger's unpublished scanning electron microscope image of *Baccillaria paradoxa*. Interior view at tip of cell showing raphe enclosed by connecting bridge structures of the valve.**

## NEW FACES

**Caly McCarthy** joined ForestGEO as Administrative Assistant in April 2019 and is based at the Smithsonian's National Museum of Natural History in Washington, DC. McCarthy combines her interest in plants with her proclivity for details in this position. Prior to this role, McCarthy worked at Turtle Tree Biodynamic Seed Initiative and lived as a co-worker at Camphill Village, an agricultural community of diverse ages, origins, and developmental abilities in Copake, New York. McCarthy holds a Bachelor of Arts in both history and environmental studies from Dickinson College in Carlisle, Pennsylvania.

This summer, **Jun Wen** and **Liz Zimmer** are co-mentoring **Regina Fairbanks**, a Natural History Research Experiences (NHRE) student intern who will be a junior at the University of Pennsylvania in the fall. Fairbanks is working on phylogenomics of the ginseng genus, *Panax*. **Kathryn Picard** and **Eric Schuettpelz** are co-mentoring **Zahra Domin**, an NHRE intern who will be a senior at Dominican University this fall. Additionally, they are co-mentoring Smithsonian interns **Noah Olson** and **Blake Fauskee**, both recent graduates of the University of Minnesota Duluth. All three interns are investigating the incidence of asexuality (in the form of apomixis) within ferns and assessing the role apomixis plays in shaping fern biogeographical patterns.

# ForestGEO hosts annual analytical workshop in Singapore

From June 23 through July 5, 53 forest ecologists from 23 countries convened for ForestGEO's 2019 annual analytical workshop at Nanyang Technological University in Singapore. The group was a mix of early career scientists, students, postdocs, and professors, and ForestGEO staff scientists, each working on a specific analysis or manuscript using data from one or more of ForestGEO's 67 forest dynamics sites. This two-week intensive workshop grants participants a focused environment in which to talk with mentors, attend and give seminars, practice scientific writing skills, learn R coding and statistical methods, among other topics. The mentorship and training of early career forest ecologists through the annual workshops is one way that ForestGEO strengthens scientific capacity across the globe.

**The 2019 ForestGEO Analytical Workshop participants on their field trip to Bukit Timah Forest Dynamics Plot in Singapore.**

## STAFF ACTIVITIES

**Marcos Caraballo** gave two workshops on plant taxonomy and molecular biology on May 24 and May 31 to two groups of high school students from the Youth and Diversity Program of the National Council for Science and the Environment (NCSE). On June 3, Caraballo was a judge at the 2019 EnvironMentors National Science Fair for high school students from underrepresented groups, an activity sponsored by NCSE. On June 25, he helped train the Q?Crew High School Volunteers on the scientific value of herbarium collections for research during a "Collections Zone Deep Dive" workshop in the Q?rius Education Center at NMNH.

On April 16-17, **Gary Krupnick** presented a poster, "The immense value of museum collections in conservation research," at Smithsonian's first ConCom 2019 event hosted by Smithsonian's Conservation Commons. The event was designed to recognize Smithsonian's superheroes in science and conservation with team-building opportunities, share knowledge, increase storytelling skills, and enhance collaborations.

A number of Department of Botany research fellows and associates presented talks during the Botany Seminar Series at the National Museum of Natural History. On May 2, **Kathryn Picard** presented "Creatures from the black lagoon: Next-generation approaches to understanding the diversity and evolution of marine fungi." On May 9, **Rob Soreng** presented "Plant collecting in Far East Russia." On June 13, **Joel Nitta** presented "Ferns on islands: Community assembly, comparative ecology, and biogeography of Polynesian pteridophytes." Other seminar speakers over the past three months included Jennifer Ackerfield from Colorado State University on April 18 who spoke about "A prickly puzzle: Phylogeny and evolution of the *Carduus-Cirsium* group (Cardueae: Compositae)" and Charles Delwiche from the University of Maryland College Park on June 6 who spoke about "Assembling the embryophyte form: the evolution of streptophytes."

**Alice Tangerini** had her artwork, *Curcuma arracanensis*, displayed in the Queensland Museum in conjunction with the Guild of Natural Science Illustrators (GNSI) 2019 Conference in Brisbane, Australia, July 1-7, 2019. The juried exhibit was strictly digital this year due to the logistical constraints of shipping framed artwork. During the exhibit reception the artworks were projected on several screens simultaneously in the lobby of the museum and then individually in the theater auditorium. The artwork can be viewed online in the GNSI website, http://2019gnsi-conf.org/exhibits.


**Illustration of *Curcuma arracanensis* by Alice Tangerini**

## TRAVEL

**Betsy Collins** traveled to Tumbes, Piura, Lambayeque, Cajamarca, and La Libertad provinces in Peru (3/25 – 4/24) to collect *Bursera graveolens* and to visit the HUT and USM herbaria.

**Benjamin J. Crain** traveled to the Republic of Palau (4/24 – 5/17) to shoot a short film on the Palau Orchid Conservation Initiative for SI Global; and to London, England (5/19 – 6/2) to present a talk, "The Palau Orchid Conservation Initiative: an integrated approach to orchid research and management" at the 7th International Orchid Conservation Congress at Royal Botanic Gardens Kew.

**Robin Everly** traveled to Phoenix, Arizona (5/13 – 5/17) to attend the 51st annual meeting of the Council on Botanical and Horticultural Libraries at the Desert Botanical Garden and to give a presentation entitled, "Smithsonian libraries adopt a book program: a way to learn, preserve, and raise funds for your library collection."

**Erika Gardner** traveled to Chicago, Illinois (5/24 – 5/31) to present a poster, "Q?rius about engaging students in the Herbarium: an after school Botany program," at the annual meeting of the Society for the Preservation of Natural History Collections (SPNHC).

**Karen Golinski** traveled to Port Edward, Canada (4/24 – 5/7) to teach a field course in Bryology for the University of Northern British Columbia; and to Corner Brook, Canada (6/20 – 6/24) for the annual meeting of the Mosses and Lichens Specialists Subcommittee of COSEWIC (Committee on the Status of Endangered Species in Canada).

**Carol Kelloff** traveled to the Apalachicola area of Florida (4/12 – 4/19) with **Mark Strong** to collect vouchers and tissue samples of the rare and endangered plants of this area as the ongoing fieldwork under the Global Genome Initiative (GGI); and to Chicago, Illinois (5/27 – 5/30) to attend the talks and council and committee meetings of the Society for the Preservation of Natural History Collections (SPNHC).

**Sue Lutz** traveled to Manchester, New Hampshire (5/3 – 5/8) to organize and pack coralline algae collections made by Emeritus Curator Walter Adey during summer field work in 2018 in the Gulf of Maine, and to bring it back to the Museum Support Center to house with the coralline collection.

**Sylvia Orli** traveled to New Haven, Connecticut (6/9 – 6/12) to attend the 2019 Digital Data in Biodiversity Research Conference.

**Eric Schuettpelz** traveled to Turku, Finland (5/18 – 5/22) to serve as the opponent for a graduate thesis defense at the University of Turku.

**Meghann Toner** traveled to Chicago, Illinois (5/24 – 5/31) to present a talk, "All grasses great and small: Reorganizing and rehousing the Poaceae collection at the US National Herbarium," at the annual meeting of the Society for the Preservation of Natural History Collections (SPNHC).

*Continued on page 18*

## Travel

*Continued from page 17*

**Warren Wagner** traveled to Sarasota, Florida (4/9 – 4/11) as an invited speaker at the Marie Selby Botanical Garden.

**Jun Wen** traveled to Boston, Massachusetts (4/28 – 5/1) to conduct field work and attend a meeting at Harvard University; and to Madrid, Spain (5/22 – 5/29) to collect *Hedera iberica* (Araliaceae) and associated Mediterranean plants on the Iberian Peninsula, to give a seminar on phylogenomics of the grape family at Universidad Autonoma de Madrid, and to participate in a graduate thesis defense at Universidad Rey Juan Carlos.

**Liz Zimmer** travelled to Ithaca, New York (4/30 – 5/1) to meet with Chelsea Specht, Patrick O'Grady and Fay-Wei, and to present a seminar entitled, "Using DNA data for plant evolutionary genetics: progress and prospects" to the Department of Plant Sciences at Cornell University; and to Providence, Rhode Island (6/21 – 6/26) to present a co-authored poster with her advisee Peter Schafran, "Using flow cytometry and low-copy nuclear DNA sequences to identify new taxa in Isoëtes," and to meet with several Associate Editors of *Molecular Phylogenetics and Evolution* to discuss future plans for the journal.

# VISITORS

**Carrie Tribble**, University of California Berkeley; Alstroemeriaceae (4/3 - 4/5).

**Iasmin Laiane de Castro Oliveira**, Universidade Estadual de Feira de Santana, Brazil & Iowa State University; Poaceae (4/8 - 4/30).

**Jennifer Ackerfield**, Colorado State University; Asteraceae (4/10 - 4/20).

**Tracey Parker**, Independent researcher, Nicaragua; Plants of Central America (4/15 - 4/19).

**Kelly Allred**, New Mexico State University; Poaceae (4/16).

**Marcus Falcao**, Jardim Botanico do Rio de Janeiro, Brazil; Fabaceae (4/23 - 4/26).

**Andrew Henderson**, New York Botanical Garden; Arecaceae (4/23 - 4/24).

**Luber Jaquelini**, Jardim Botânico do Rio de Janeiro, Brazil; Capparaceae and Campomanesia (Myrtaceae) (4/23 - 4/26).

**Elio Cruz** and nine students, National Council for Science and the Environment; Herbarium tour and plant conservation (4/26).

**Raymund Chan**, Independent researcher, Singapore; Asteraceae (5/6 - 5/12).

**Tom Lovejoy** and 12 students, George Mason University; Herbarium tour and plant conservation (5/6).

**Lynn Gillespie**, Canadian Museum of Nature, Canada; Euphorbiaceae and Poaceae (5/13 - 5/17).

**Geoffrey Levin**, Canadian Museum of Nature, Canada; Poaceae (5/13 - 5/17).

**Paloma Moore**, Royal Botanic Gardens, Kew; *Pterocarpus* (Fabaceae) (5/13 - 5/17).

**Santos Miguel Nino** and **Daniela Canelón Barraez**, Universidad Nacional Experimental de los Llanos Ezequiel Zamora, Venezuela; Flora of Guaramacal (5/14 - 7/12).

**Chris Campbell**, University of Maine; Amelanchier (Rosaceae) (6/3 - 6/4).

**Issac Marck**, University of California Berkeley; Heliantheae alliance (Asteraceae) (6/3 - 8/30).

**Fabiany Herrera**, Chicago Botanic Gardens; Malvaceae and Lycopodiaceae (6/4 - 6/7).

**Juan Herrera**, Universidad de Valle, Colombia; Botanical taxonomy (6/4 - 6/7).

**Darío Schiavinato**, Universidad de Buenos Aires, Argentina; *Tagetes* (Asteraceae) (6/6 - 6/19).

**Igor Kessous**, Universidade Federal do Rio de Janeiro, Brazil; *Vriesea* (Bromeliaceae) (6/10 - 6/30).

**Olga Camacho**, University of Louisiana at Lafayette; *Lobophora* (Dictyotaceae) (6/11 - 6/14).

**Judy Stone**, Colby College; *Witheringia*, *Brachistus*, and related genera (Solanaceae) (6/11).

**Scott LaGreca**, Duke University; Lichens (6/17).

# PUBLICATIONS

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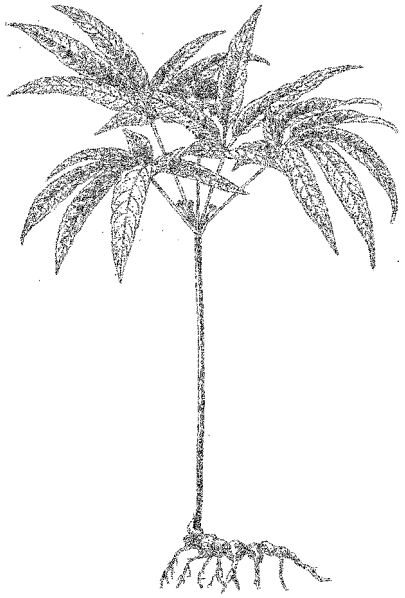

## **ART** BY ALICE TANGERINI

# *Artocarpus altilis* (Parkinson ex F.A.Zorn) Fosberg

The domestication of crop plants and their wild relatives was the theme of the 17th Smithsonian Botanical Symposium held on 17 May 2019. The challenges of domesticating tropical forest fruit trees, such as breadfruit (*Artocarpus altilis*), was presented in one of the talks. Alice Tangerini illustrated breadfruit for Edward Ayensu's second book on medicinal plants, *Medicinal Plants of the West Indies*, published in 1981 by Reference Publications. Tangerini was part of a team of illustrators for the book including artists Mary Monsma and Cathy Pasquale. Tangerini examined herbarium specimens and books in the Smithsonian Botany Branch Library for details when she drew this illustration.

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