Department of Botany & the U.S. National Herbarium

The Plant Press

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Botany Profile

Putting Plants on Display

By Gary A. Krupnick

As the Smithsonian Institution strives to meet its mission of "the increase and diffusion of knowledge," how does botany stack up against this objective? The three cornerstones of any natural history museum are research, collections, and exhibits. In terms of research, the Department of Botany has an excellent track record. In 2016, department staff published approximately 110 peer-reviewed scientific papers and described 99 new species of plants, fungi, and lichen. Regarding the collections, the U.S. National Herbarium has grown to over 5 million plant specimens and new specimens are added daily. Recent digitization efforts have yielded over a million imaged specimens that have been databased and shared online.

Botany's role in exhibitions, however, has a varied history at the National Museum of Natural History. The largest exhibit halls are currently devoted to dinosaur fossils (currently under renovation), mammal skins, animals of the deep blue ocean, human evolution, and the Hope Diamond and other gemstones. While the Museum does not currently have a hall devoted entirely to botany, plants are displayed alongside pollinators in the "Butterflies + Plants: Partners in Evolution" exhibition. The exhibition, which opened in 2008, gives visitors the opportunity to not only observe the ways in which butterflies, plants, and other animals have evolved, adapted, and diversified over tens of millions of years, but to also walk through an enclosed, climate-controlled, tropical garden and interact with both the foraging plants and the butterflies as they flutter around the pavilion.

Past exhibitions that have featured botany have primarily been delegated to temporary showings. Most prominent has been the annual orchid show. Alternating years between the U.S. Botanic Garden and the Smithsonian Institution, the orchid display has been hosted at the Natural History Museum and co-hosted by Smithsonian Gardens for over a decade. In 2017, the show moved to the Hirshhorn Museum. Previously, the Natural History Museum hosted "Orchids: Interlocking Science and Beauty" in 2015, "Orchids of Latin America" in 2013, "Orchids – A View from the East" in 2011, "Orchids through Darwin's Eyes" in 2009, "Orchids: Take a Walk on the Wild Side" in 2007, and "The Orchid Express" in 2005.

In the past 20 years, botanical artwork was featured in three exhibitions, each emphasizing the unique intersection between art and science. In 1999, the traveling exhibition, "Margaret Mee: Return to the Amazon," documented the life and work of Margaret Mee (1909-1988), a British botanical artist. The exhibit bridged the worlds of art and natural science while confronting the global issues of rainforest destruction and preservation. Mee's botanically accurate watercolors were featured alongside her field sketches, diaries, and a large model of a bromeliad with many of the organisms dependent on it for their existence. The exhibit sought not only to present to the visitor the beauty and scientific accuracy of her art, but also to educate the public about the conservation of irreplaceable ecosystems, and the biodiversity, pollination mechanisms, botanical research and other current scientific efforts in the Amazon.

In 2003, "A Passion for Plants: Contemporary Art from the Shirley Sherwood Collection," displayed 100 works by 67 artists from the collection of Shirley Sherwood, an independent scholar and collector of botanical watercolors and paintings. The exhibition addressed the history of botanical art. Also on view were botanical specimens from the U.S. National Herbarium to highlight aspects of scientific observation.

In 2010, the traveling exhibition, "Losing Paradise? Endangered Plants Here and Around the World," showcased 44 botanical illustrations from renowned artists, along with live plants and specimens from the Museum's collection. Focusing on global conservation, stories of endangered, threatened and extinct plants were featured. A companion website to the exhibition included a study of the illustrations paired with digitized herbarium specimens and a discussion of how conservation assessments are made.

Other past exhibitions featuring botanical specimens were those that combined objects and specimens from several research departments. For example, in the 2010 exhibition, "Since Darwin: The Evolution of Evolution," specimens including fossils, insects, plants, dog skulls, goat horns, mice and birds, along with documentation of ongoing research at the museum,

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Travel

Vicki Funk traveled to Athens, Ohio (3/16 – 3/18) to give a lecture at Ohio University; and to Oahu and Kauai, Hawaii (2/9 – 3/9) to conduct research and collaborate with staff at the University of Hawaii and the National Tropical Botanical Garden.

Joe Kirkbride traveled to Bronx, New York (3/3) to attend a symposium at the New York Botanical Garden celebrating the 125th anniversary of the Garden.

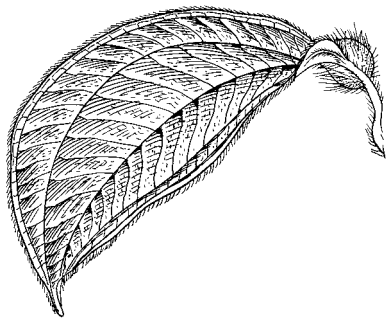
W. John Kress traveled to San Jose, Costa Rica (3/9 – 3/13) to participate as a member of the Assembly of Delegates and Board of Directors of the Organization for Tropical Studies.

Marcelo Pace traveled to São Paulo, Brazil (1/9 – 1/17) to collect specimens of plants and lichens in São Sebastião, Bertioga, Assis, and Botucatu, during a trip sponsored by the Global Genome Initiative (GGI).

Eric Schuettpelz traveled to Gainesville, Florida (3/20 – 3/22) to present an invited talk at the University of Florida.

Laurence Skog traveled to Sarasota and Gainesville, Florida (2/11 – 2/19) to study the Gesneriaceae collections at the Marie Selby Botanical Garden and at the University of Florida.

Warren Wagner traveled to St. Louis, Missouri (3/14 – 3/22) to finalize a manuscript on Onagraceae for the Flora of North America.



Visitors

Monica Carlsen, Missouri Botanical Garden; Araceae and Zingiberales (2/17/15-2/16/17).

Morgan Gostel, George Mason University; Compositae and GGI-Gardens Program (9/1/15-8/31/17).

Vikram Shivakumar, Alexandria, Virginia; Clauseneae (Rutaceae) (9/12/16-3/10/17).

Lyra Morina, University of Maryland, College Park; Valuing botanical collections (9/14/16-3/10/17).

Yash Kalburgi, Northern Virginia Community College; Vitaceae (9/19/16-3/15/17).

Sarah Brown, Tarleton State University; Collection management internship (12/5/16-1/27/17).

Afzal Shah, Quaid-i-Azam University, Pakistan; Tylophorinae (Apocynaceae) (12/29/16-6/1/17).

Yousheng Chen, Chinese Academy of Sciences, China; Pan-Himalayan Cardueae and Gnaphalieae (Asteraceae) (12/31/16-12/30/17).

Xu Su, Qinghai University, China; Triticeae (Poaceae) (12/31/16-3/1/18).

Elena Meyer, Northern Virginia Community College; Collections management internship (1/9-2/3).

Ricardo de Oliveira Perdiz, Instituto Nacional de Pesquisas Amazonia, Brazil; *Protium aracouchini* species complex (Burseraceae) (1/9-2/9).

Joy Winbourne, Brown University; DNA barcoding (1/9-1/13).

Dave Gammon and 6 students, Elon University; Plant conservation and herbarium tour (1/12).

Amanda Williams, Eastern Mennonite University; Collections management internship (1/17-4/28).

Zachary Rogers, Missouri Botanical Garden, Missouri, United States; Thymelaeaceae (1/30-2/4).

Jacob Suissa, Harvard University; Isoëtes and Asteraceae internship (2/2-8/1).

Lionel Gagnevin, Centre de Coopération Internationale de Recherche en Agronomie pour le Développement, France; Pathogens on Rutaceae, Poaceae, and Euphorbiaceae (2/6-2/13).

Ivone Vásquez Briones, Universidad Peruana Unión Tarapoto, Peru; Malpighiaceae (2/8-2/17).

Wesley Knapp, North Carolina Natural Heritage Program; Research (2/13-2/15).

Slawomir Nowak, Univeristy of Gdansk, Poland; Orchidaceae (2/13-2/22).

Boris Szurek, Institut de Recherche pour le Développement, France; Pathogens on Rutaceae, Poaceae, and Euphorbiaceae (2/13).

Marion Leménager, University of Montpellier, France; Fog-collecting plants (2/14-2/17).

Dwayne Estes, Austin Peay State University; Research (2/15-2/17).

Adam Williams, Hawaii Department of Land and Natural Resources; Flora of Hawaii (2/17).

Theo Witsell, Arkansas Natural Heritage Botanist; Flora of Arkansas (2/17-2/23).

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April is the Cruelest Month

Chair With A View — L.J. Dorr

If the poet T.S. Eliot wrote *The Waste Land* today he would have to modify the first verse. What are we to make of this unusual winter? Spring arrived in Washington three weeks earlier than expected, in February rather than March or April. We saw the warning signs of climate change long before this and certainly an article published over 15 years ago by our staff and collaborators (Abu-Asab et al., *Biodiversity and Conservation* 10: 597-612. 2001) presented the first hard evidence of earlier spring flowering times in the Washington area as a response to global warming. But the signal they detected was 4.6 not 21 days. Record high temperatures are wonderful for those of us who dislike cold and snow, but while 30º Fahrenheit above normal in the heart of winter seems kind, 30º above normal in summer will be very cruel.

Our data set is static now; 31 years of observation made its point. Its assembly was a nice example of community or citizen science; over 125 persons contributed first-flowering dates throughout the years. Nonetheless, it does not take a community to record phenological data. Subsequent to the publication of the Washington-area data, researchers plumbed the unpublished records of the "Hermit of Walden" who made observations of first flowering dates for over 500 species of wildflower in Concord, Massachusetts from 1851 to 1858 (Primack & Miller-Rushing, *BioScience* 62: 170-180. 2012). Their conclusions were more or less the same. They were able to establish that the plants Thoreau observed in Concord more than 150 years ago are now flowering, on average, ten days earlier than they were when Thoreau "went to the woods".

The science of phenology may well "date" from the English naturalist Robert Marsham who published *Indications of Spring* (1789) based on notes that he started in 1736 and continued for more than 60 years. It was not only English gentlemen who recorded their observations of flowering times. Botanists became engaged early, too. I cannot claim to have done a thorough search but I do know that the French botanist Jean Emmanuel Gilibert, who holds the unfortunate distinction of having many of his botanical works officially suppressed by the *International Code of Nomenclature for Algae, Fungi, and Plants* (2012), recorded flowering dates when he was in Lithuania to teach natural history and medicine and he combined them with similar notes from Lyon, France compiled by Mme. Clémence Lortet (*Le calendrier de flore, pour l'année 1778, autour de Grodno, et pour l' année 1808, autour de Lyon*, 1809). If Gilibert had not delayed publication he would have anticipated Marsham. In any case, a systematic search of the botanical literature likely would yield more records that could be analyzed, but I do not think it would change the story. Similarly, now that we are assembling large herbarium datasets I am certain that we can begin to abstract phenological data that will inform us about climate change in the near term and on very local scales.

Surprisingly (to me at least), a generation passes quickly. I have my own 25 years of phenological records for Washington. Nothing is written down but my casual observations represent my own private daybook, my mental notes on what flowers when and what to expect from my garden in each season. Growing up much further north (and not too terribly far from Walden Pond) it took me a long time to accept that my concept of when spring occurred had to change. Here lilacs flower "with the perfume strong I love" well before May (and only now do I understand why Walt Whitman spoke of lilacs blooming in mid-April) and roses do not wait until June. I do not remember when we planted our garden when I was younger or if there was a fixed signal other than perhaps a prediction about the last frost in the *Old Farmer's Almanac*. Here I have always struggled with timing. Some years I get it right and others not. If I judge correctly I enjoy the sunflowers, zinnias, and cosmos at the end of the summer. If I get it wrong what have I lost? The price of a few packets of seed. I should be more concerned when data and reason tell me something is wrong about the way I perceive the world. Getting it wrong on a global scale is more costly than a few packets of seed. But what can I (or you) do? We can agitate and speak loudly with our research, or like Candide "il faut cultiver notre jardin".

Published research by Department of Botany staff and collaborators in 2001 shows a statistically significant advance of spring blooming of Yoshino cherry trees in Washington, DC by 7 days, over a 30-year period from 1970 to 1999. (photo by Gary Krupnick)

Staff Research & Activities

On February 13, **Gary Krupnick** gave two behind-the-scenes tours of the U.S. National Herbarium to participants of the 2017 National Native Seed Conference. The conference was held February 13-16 at the Omni Shoreham Hotel in Washington, D.C., and attracted attendees from 41 states and 11 countries. The mission of the meeting was to connect research, industry, land management, and restoration professionals to share information about the collection, research and development, production, and use of native plant materials. A series of task forces was launched at the conference to coordinate efforts to implement the actions of the National Seed Strategy for Rehabilitation and Restoration.

Sy Sohmer gave an invited talk, "A year in the Jungles of Papua New Guinea," to the Discovery Club of Honolulu on January 19. The talk described how Sohmer spent a year on leave from the University of Wisconsin-La Crosse working for the government of Papua New Guinea as a Forest Officer. He was charged with training young Papua New Guineans in the arts of botany and how to collect plants and document them through preparing botanical specimens in the herbarium of the Forest Research Institute. He had the privilege of organizing expeditions throughout the country, mostly in the lowland and montane rainforests.

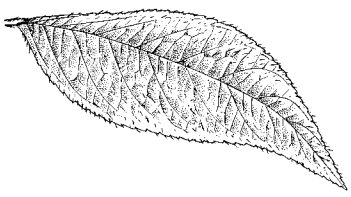
Alice Tangerini and U.S. Department of Agriculture's entomology illustrator Taina Litwak are displaying their scientific illustrations in a special temporary exhibit, "Scientific Illustration: Artistry in the Age of Science," at the Ward Museum in Salisbury, Maryland. The Ward Museum is known for its wildfowl art and collection of decorative and antique decoys. Tangerini has a selection of prints of her artwork depicting various media including color digital (*Globba sherwoodiana*, *Fulcaldea steussyi*, and *Eriolaena rulkensii*), pen and ink (*Melicope stonei*, *Cephalocarpus glabra*, and *C. rigidus*), and graphite (*Erato costaricensis*, *Gymnanthemum koekemoerae*, and a lichen plate with *Parmotrema perlatum, Parmotrema stuppeum,* and a *Leucanora* species). The exhibit runs from January 27 through May 14, 2017.

At the invitation of Smithsonian Associates, Tangerini presented a joint lecture with Grace Costantino of Smithsonian Libraries' Biodiversity Heritage Library for the program, "Science as Art: The Beauty of Botanical Illustration," on February 12. Tangerini discussed a short history of botanical art as it pertained to how plants were illustrated with different printing methods and gave a synopsis of her steps used in producing a botanical illustration today, showing a progression of styles used for print publication and for on-line digital publication. Costantino discussed the technical evolution of the art of printing with woodcuts, copper-plate engraving, lithography, and chromatography as it is showcased in the library's collection of natural history art.

Tangerini is exhibiting a graphite with watercolor illustration of a flower of *Paeonia suffruticosa* in a show by members of the Botanical Art Society of the National Capitol Region (BASNCR), "Natural Attraction: Virginia Plants and Pollinators," at the Athenaeum in Alexandria, Virginia. Running concurrently is a photography show of Virginia Bees by Deana Marion. The exhibit runs from April 6 through May 14, 2017.

In another exhibit by BASNCR members, Tangerini has two artworks, a graphite of *Yucca filamentosa* and a pen and ink of a peony, on display at the Washington National Cathedral. The exhibit runs from April 4 through May 17, 2017.

On March 22, **Liz Zimmer** attended a mentorship fair at Thomas Jefferson High School for Science and Technology in Alexandria, Virginia, where former intern **Vikram Shivakumar** presented a poster with co-authors Zimmer and **Gabe Johnson** on "The transcriptome analysis of the curry tree [*Bergera koenigii* (L.), Rutaceae] during leaf development." A manuscript from the project was submitted for review to *Scientific Reports* at the end of March.



Staff on the Move

Nancy Khan, museum specialist, has accepted a supervisory detail which includes serving as Acting Collections Manager for the U.S. National Herbarium. She began this detail on March 6. Khan joined the Department of Botany in 2010, working with Warren Wagner on the Flora of the Pacific Islands and the Onagraceae family. Department Chair Laurence Dorr says that he "looks forward to working with her to facilitate continued improvements, innovations, and development of the U.S. National Herbarium, an important botanical resource that underpins our scientific work and those of many other researchers throughout the country and the world."

Visitors

Continued from page 2

Tomas Fer, Charles University, Czech Republic; Zingiberales (2/20-3/3).

Fred Barrie, Missouri Botanical Garden; Gesneriaceae (2/21-3/10).

Maria Alves, Universidade Federal de Feira de Santana, Brazil; Brazilian Heliantheae (Asteraceae) (2/27-4/15).

George Schatz, Missouri Botanical Garden; Ebenaceae and Annonaceae (3/8-3/10).

Patrice Sonnelitter, Flamingo Gardens, Florida; Herbarium tour (3/10).

Andrea Weeks, George Mason University; Research (3/16).

Meaghan Parker-Forney, World Resources Institute; National Wood Collection (3/17).

The 2017 Smithsonian Botanical Symposium, May 19, to Explore Exploration

The Department of Botany and the United States Botanic Garden will convene the 2017 Smithsonian Botanical Symposium, "**Exploring the Natural World: Plants, People and Places**," to be held at the National Museum of Natural History in Washington, D.C., on May 19, 2017.

History hides behind our garden and museum displays. Plants and artifacts can be themselves objects of wonder, but scratch the surface and every item on display or curated for scientific study has a deeper story as to how it was collected and came to be included in our mostly urban cultural institutions. Large sponsored expeditions or even just curious individuals set off to explore remote corners of the world and brought back plants, animals, and other natural history treasures. Often the focus was on a particular route or region. Sometimes circumstance caused an individual to take up residence in an unfamiliar part of the world and day-to-day observations of the new environment lead to discoveries that were sent home to eager audiences. Every garden, museum, and herbarium collection has grown and continues to grow through a delightful and maddening combination of purpose and accident.

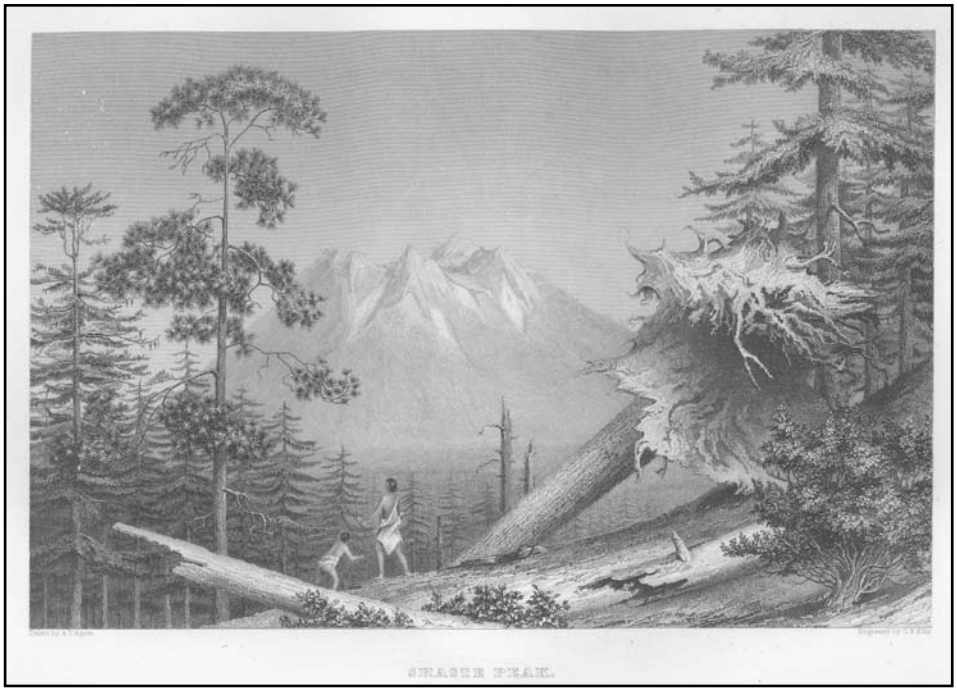
The 15th Smithsonian Botanical Symposium will highlight the history of exploration undertaken by individuals and groups with an emphasis on exploration of the Americas. Several of our presentations are based on recently-published books or books in preparation.

A full lineup of speakers will present their talks during the day at the National Museum of Natural History's Baird Auditorium. The event will be followed by a reception and poster session at the U.S. Botanic Garden that evening.

In addition, the 15th José Cuatrecasas Medal in Tropical Botany will be awarded at the Symposium. This prestigious award is presented annually to an international scholar who has contributed significantly to advancing the field of tropical botany. The award is named in honor of Dr. José Cuatrecasas, a pioneering botanist who spent many years working in the Department of Botany at the Smithsonian and devoted his career to plant exploration in tropical South America.

Abstracts for poster presentations may be submitted online at botany.si.edu/sbs/. The deadline for abstract submission is April 14th.

There will be no registration fee this year, but attendees must register online at botany.si.edu/sbs/ to attend the event. Visit the website, call 202-633-0920, or email sbs@si.edu for more information.



Pacific coastal forest from US Exploring Expedition journal 1838-1842.

Awards & Grants

Four fellowships have been awarded to students who will be based in the Botany Department during 2017-2018.

- A 10-week "Grad" fellowship is being awarded to **Jun Ying Lim** of the University of California at Berkeley for a project entitled, "Evolution, ecology and historical biogeography of Hawaiian *Peperomia*." He will be working with **Warren Wagner** and **Liz Zimmer** during the summer of 2017.

- A 15-week "Predoc" fellowship is being awarded to **Joyce Chery** of the University of California Berkeley for a project entitled, "Systematics of *Paullinia* and the evolution of vascular cambial variants." She will be working with **Pedro Acevedo** and **Marcello Pace** on wood anatomy and also in the Laboratories of Analytical Biology (LAB) setting up libraries for Next Generation Sequencing. Chery will arrive during June 2017.

- A 6-month "Predoc" fellowship is being awarded to **Peter Schafran** of Old Dominion University for a project entitled, "Unraveling the evolutionary relationships of allotetraploid species of *Isoetes* in the eastern United States and adjacent Canada." He will be working with **Liz Zimmer** and **W. Carl Taylor** starting in October 2017 after doing extensive field work this summer. Schafran previously was a 10-week "Grad" fellow during the summer of 2015 when he started work on plastomes of *Isoetes* diploids.

- A 2-year Buck Postdoctoral Fellowship is being awarded to **Marcos Caraballo-Ortiz**, currently finishing up his doctoral work at Pennsylvania State University. His proposal is entitled, "Phylogeography and plastome evolution of Neotropical mistletoes." He will be working with **Jun Wen** and **Pedro Acevedo** starting in the fall of 2017.

Botany Digitizes Its 1,000,000th Herbarium Specimen

For the past 17 months, the U.S. National Herbarium has been digitizing a significant portion of the collection's 5 million specimens using conveyor belt technology. On March 29, 2017, the team digitized its one millionth plant specimen.

What specimen was chosen to mark this occasion?

The digitization team is currently processing specimens in the Rubiaceae. To mark this milestone, we selected an economically important member of this cosmopolitan plant family, *Cinchona micrantha* Ruiz & Pav. The herbarium specimen we chose consists of a portion of a branch with a leaf and an inflorescence (cluster of flowers) along with a separate infructescence (cluster of fruits or capsules) and a piece of bark. Relatively few of our herbarium specimens include bark samples but there is an important reason why this one does. An annotation indicates that the bark was sampled for cinchona alkaloids. The specimen label further hints at the importance of this chemical analysis. The plant was collected in Peru in January 1944 by Walter H. Hodge whose field work as stated on the label was on behalf of the "U. S. Gov't. Board of Economic Warfare".

Malaria, war, and the story of specimen 02364440. Meet the one-millionth herbarium specimen we've digitized, *Cinchona micrantha*, collected in Peru by W.H. Hodge in 1944 on behalf of the U.S. Government Board of Economic Warfare.

Why is *Cinchona* economically important?

Cinchona, a Neotropical genus of 23 species, is the source of quinine, an historically important antimalarial, and the bitter flavoring of tonic water. The medicinal properties of this plant were known to the Quechua who inhabited the Andes of Ecuador, Peru, and Bolivia. (There is some debate as to whether or not malaria was indigenous to the New World). In early colonial times Jesuit missionaries observed the efficacy of "fever tree" bark in curing malaria and they introduced it to Europe in the early 1600s. Several Andean countries hoping to maintain a monopoly on this important medicinal plant began to impose restrictions on the export of seeds and cuttings. The monopoly was broken in 1860 when the British explorer Clements Markham, working for the India Office, introduced cinchona seed and plants into cultivation in British India and Ceylon. Subsequently large plantations were developed in the Dutch East Indies and by the middle of the 19th century these were the principal global source of quinine and the basis of a new monopoly.

What was the U.S. Board of Economic Warfare?

World War II disrupted global trade and forced the United States and its allies to seek alternatives for many essential products. Java in the Dutch East Indies, which then had extensive cinchona plantations and the world's largest quinine factory, fell to the Japanese in 1942. This was an enormous disaster for the United States because it had failed to stockpile sufficient quantities of quinine before the war and as fighting in the Pacific Theater became more intense, malaria threatened the well-being and battle-readiness of American and Allied soldiers. A synthetic substitute for quinine existed but its side effects prevented it from being widely adopted. New sources of quinine were needed and by 1942 the Board of Economic Warfare became responsible for finding them. The Board, with the cooperation of the U.S.D.A. and the U.S. National Arboretum, established the Cinchona Mission. Missions were established in Colombia, Peru, and Ecuador and at peak activity thirty American botanists were engaged in the search for quinine-rich populations of *Cinchona*. By the end of the war a useful synthetic quinine had been developed but from 1942 until 1944 the American botanists taking part in the Cinchona Missions had found and shipped over 10 million

pounds of quinine bark back to the United States.

Who was Walter Hodge?

Walter H. Hodge (1912-2013) was a native of Massachusetts. He completed his Ph.D. at Harvard University and worked on the flora of the Caribbean Island of Dominica before World War II. During the war, from 1943 to 1945, he was employed by the U.S. Board of Economic Warfare to take part in the Cinchona Missions in South America that were searching for new sources of quinine. After the war he held several academic positions, first at the Universidad Nacional de Colombia (1945–1946) and then Harvard University (1950). Later he was employed by the U.S. Department of Agriculture (1950–1955) and the National Science Foundation (1961–1973). The Smithsonian has the botanical field notes he made in Peru during the war. His specimens and those of other Cinchona Mission participants were transferred to the U.S. National Herbarium in 1952.

Why is digitizing this *Cinchona* specimen important?

Herbarium specimens are important to the documentation of the Cinchona Missions. The botanical specimen images show not only the collection labels, reporting the collection date and locality, but additional annotation labels detail the analysis of the bark samples for cinchona alkaloid levels. The digitization of this *Cinchona* specimen and many others of the same expedition give researchers open access to a botanical voucher of historical importance. The U.S. National Herbarium specimen online-catalog can be found at <http://collections.nmnh.si.edu/search/botany/>.

What is the Rubiaceae and why is it important economically?

The Rubiaceae is a cosmopolitan plant family of more than 600 genera and 13,000 species. Most of our local mid-Atlantic representatives of this family are herbs such as bedstraw (*Galium*), partridge berry (*Mitchella*), and bluets (*Houstonia*). Probably the best known and most-frequently consumed member of the family is coffee (*Coffea arabica* L.), native to Yemen and Ethiopia but now cultivated throughout the tropics and served in restaurants and cafés throughout the world. The family also has a number of ornamental species, the most familiar probably being species of the strongly-scented *Gardenia*.

Many plants supply us with medicines and stimulants. The Rubiaceae is notable because of the antimalarial quinine, derived from *Cinchona*, and the stimulant caffeine, derived from *Coffea*.

Selected references

Hodge, W.H. 1948. Wartime *Cinchona* procurement in Latin America. *Economic Botany* 2(3): 229-257.

Smocovitis, V.B. 2003. Desperately seeking quinine: The malaria threat drove the Allies' WWII "Cinchona Mission". *Modern Drug Discovery* 6(5): 57-58.

Photographs of Hodge and his Peru expedition can be seen at <http://www.huntbotanical.org/botanists-art/detail.php?4>.

The Botany Digitization Conveyor project continues to work full speed ahead to digitize the pressed specimens of the U.S. National Herbarium. The conveyor is currently working at a rate of 15,000 new specimen images per week. (photo by Ingrid Lin)

Winter Interns Contribute to Botany

The resources available within the National Museum of Natural History, including staff, herbarium specimens, living greenhouse specimens, and a molecular lab, make the Department of Botany an attractive place for students to further their training as young botanists. Internships in Botany are aimed at actively engaging students, providing hands-on education and training in research, collections management and even administration, benefiting both the intern and the Department. Internships have an element of educational training built into the appointment and this training complements the education and career goals of the intern. Botany was fortunate to host several interns this past winter, and we got the chance to hear from a few of them here.

Sarah Brown, an undergraduate from Tarleton State University, was a Collection Management Intern from December 5, 2016 to January 27, 2017. During her internship, Brown assisted the core Collection Management Unit and learned about the care and maintenance of a large collection. She diligently worked on processing incoming Seeds of Success specimens, as well as incoming exchange/gifts, and loans. Brown also helped package, transport and reintegrate our *Cladonia* lichen collection from our off-site facility to our main collection. Brown tackled the challenging task of filing specimens, collected by Lt. Charles Wilkes from the 1800s, back into the main collection. Brown was enthusiastically engaged in every activity and eager to learn as much as possible about the daily functions of the collection. The information that Brown gathered during her internship will be applied towards the herbarium at her university. In April, Brown will be presenting a poster about the Tarleton Herbarium at the 64th annual meeting of the Southwestern Association of Naturalists (SWAN) in association with the Texas Oklahoma Regional Consortium of Herbaria (TORCH) 10th annual meeting.

Yash Kalburgi, an undergraduate at Northern Virginia Community College, has been working with **Jun Wen** and **Liz Zimmer** since the fall of 2016. He has been conducting bioinformatics research

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Interns

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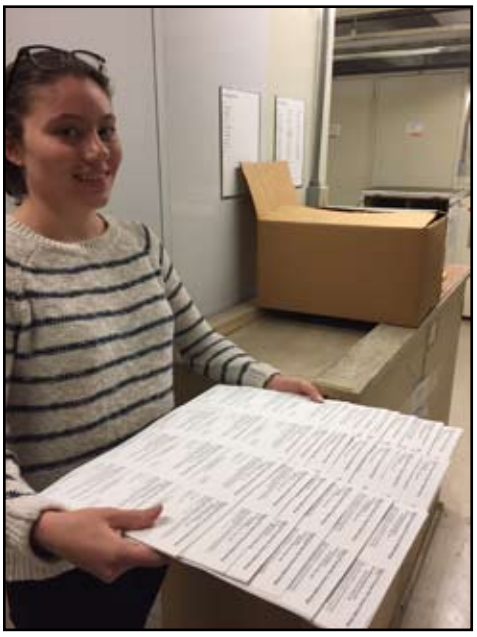
(genome skimming) on Next Generation Sequencing data for the grape genus, *Vitis*. In addition to extracting whole plastome sequences from the data, he will be assisting in producing phylogenies from the aligned sequences. Kalburgi will be transferring to a four year college in August 2017.

Elena Meyer, a student from Northern Virginia Community College, returned as an intern from January 9 to February 3, 2017. Meyer first interned in the Department of Botany during the summer of 2013. After her initial internship, she undertook a research project with former staff member Elaine Haug to conduct a floral survey of Occoquan Bay National Wildlife Refuge in Woodbridge, Virginia, with the dual goals of generating a species list and documenting the changes that had occurred under U.S. Fish and Wildlife Service management of the property in the 20-year period since an earlier survey was conducted. The objectives for her current internship was to integrate both her collections from 2014-15 and Haug's collections from 1991-98 into the EMu database system and to prepare these specimens properly for submission for mounting, as well as selecting sets for possible donation. The specimens Meyer processed and submitted for mounting or donation came from 420 distinct collections of plants, the majority of which were collected with duplicates, for a total of 851 plant specimens. These yielded a set for donation to the U.S. National Herbarium of around 400 pressed plant specimens, a set of duplicates numbering around 200 specimens, and a third set of 200 extra specimens. These plants represent 82 families and 269 species. At least five species are potential county records for Prince William County.



Interns from the Department of Botany (clockwise from top left): Elena Meyer, Sarah Brown, Jacob Suissa, and Alison Taylor.

As an undergraduate at the University of Vermont, **Jacob Suissa** studied plant biology, conducting various research projects ranging from plant physiology to fungal taxonomy. He found a passion for plant systematics and phylogenetics during a tropical plant systematics field course in Costa Rica. He continued his studies in plant systematics during a semester at the University of Hawai'i Manoa. His current research includes elucidating the evolutionary histories in various plant lineages using a phylogenetic framework. Presently, Suissa is working on two projects: using high-throughput (NextGen) sequencing to resolve the phylogeny in a clade of North American heterosporous aquatic lycophytes (Isoëtes); and utilizing new microfluidic technology to analyze a large number of taxa using 276 loci in the Sunflower family (Asteraceae). Starting in late January, Suissa began conducting research on these projects during an internship in the Smithsonian's Department of Botany under the mentorship of **Liz Zimmer**. After he concludes his internship at the end of July, he will begin his doctoral studies at Harvard University under William (Ned) Friedman.

Alison Taylor, a student from American University, held a Collections Management internship from October 11 to December 14, 2016. Mentored by **Melinda Peters**, she worked with staff to acquire, catalog, repair, and loan out specimens. Memorable activities included determining how to carve out foam to secure a specimen of the largest seed in the world, Coco de Mer, *Lodoicea maldivica*. Taylor also learned that mounting and repairing specimens requires, as she says, "an eye for placement, delicate hands for strapping between tiny leaves, and patience for the whole process."

Increasing Research Impact by Cross-Linking NCBI & EMu Records

By Tom Hollowell and Vicki Funk

While modern systematics research usually involves genetic analyses, sequences such as those submitted by researchers to the National Center for Biotechnology Information's (NCBI) public databases still rely on voucher specimens held in all biological collections (including herbaria) for identification and future reference.

Genetic sequences are usually submitted to NCBI in association with a researcher's scientific publications. NCBI accession numbers are generated, but they are not automatically associated with data about voucher specimens, including National Museum of Natural History Botany records. While this is sure to improve going forward, there is a wealth of legacy data that need to be identified and integrated. We became aware of new possibilities once these data are united after the University of Alaska Museum Herbarium (ALA) brought their NCBI cross-linking efforts to our attention. Here at NMNH, and really at collections everywhere, we need to appeal through several channels to researchers holding these legacy data. So here we go!

Museum researchers: Are your GenBank or other NCBI sequence numbers in EMu, NMNH's Research and Collections Information System? If so, you are already part of a Museum-wide project making our voucher and sample records accessible from NCBI. Although EMu records have included links from GenBank numbers to NCBI for a while, now it is a two-way street. NMNH now participates in NCBI's LinkOut service so NCBI GenBank and BioSample records can also link back to our online EMu records, which increasingly includes Smithsonian Institution biorepository information, Global Genome Biodiversity Network (GGBN) links, and images of voucher specimens.

Would you like to see an example? Visit <http://collections.nmnh.si.edu>, select the Department of Botany link, and search for Funk 12700. Or better yet, follow this link: http://n2t.net/ark:/65665/3ad350607-c883-41b5-9eed-c3e1b270c52b directly to the EMu web record (Fig. 1). The GenBank numbers at the bottom of the page link directly to NCBI records. There you will see that the NCBI records include, in the column to the right, a return link to the EMu record (Fig. 2, see arrows).

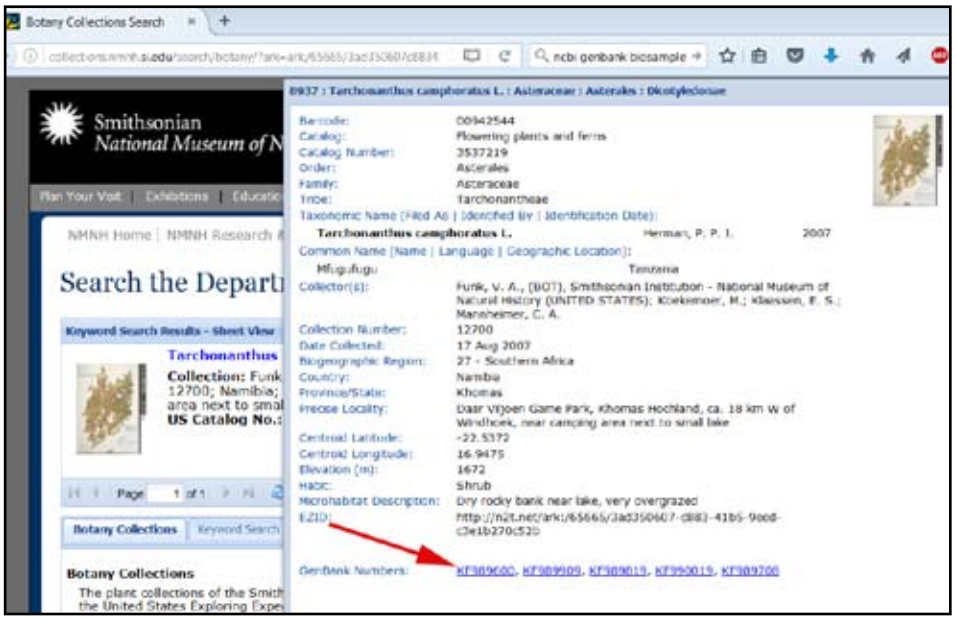


Figure 1. NMNH Collections Search record for Funk 12700. The arrow indicates four GenBank Numbers linking to nucleotide sequence records. http://n2t.net/ark:/65665/3ad350607-c883-41b5-9eed-c3e1b270c52b

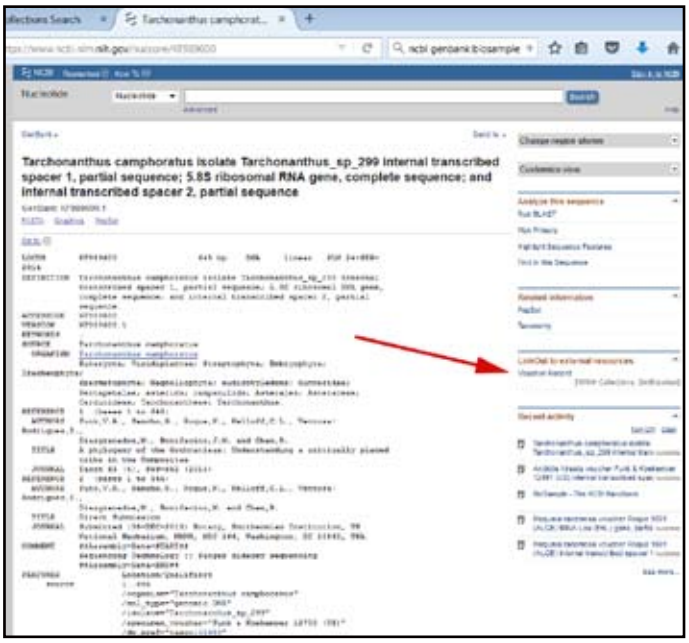


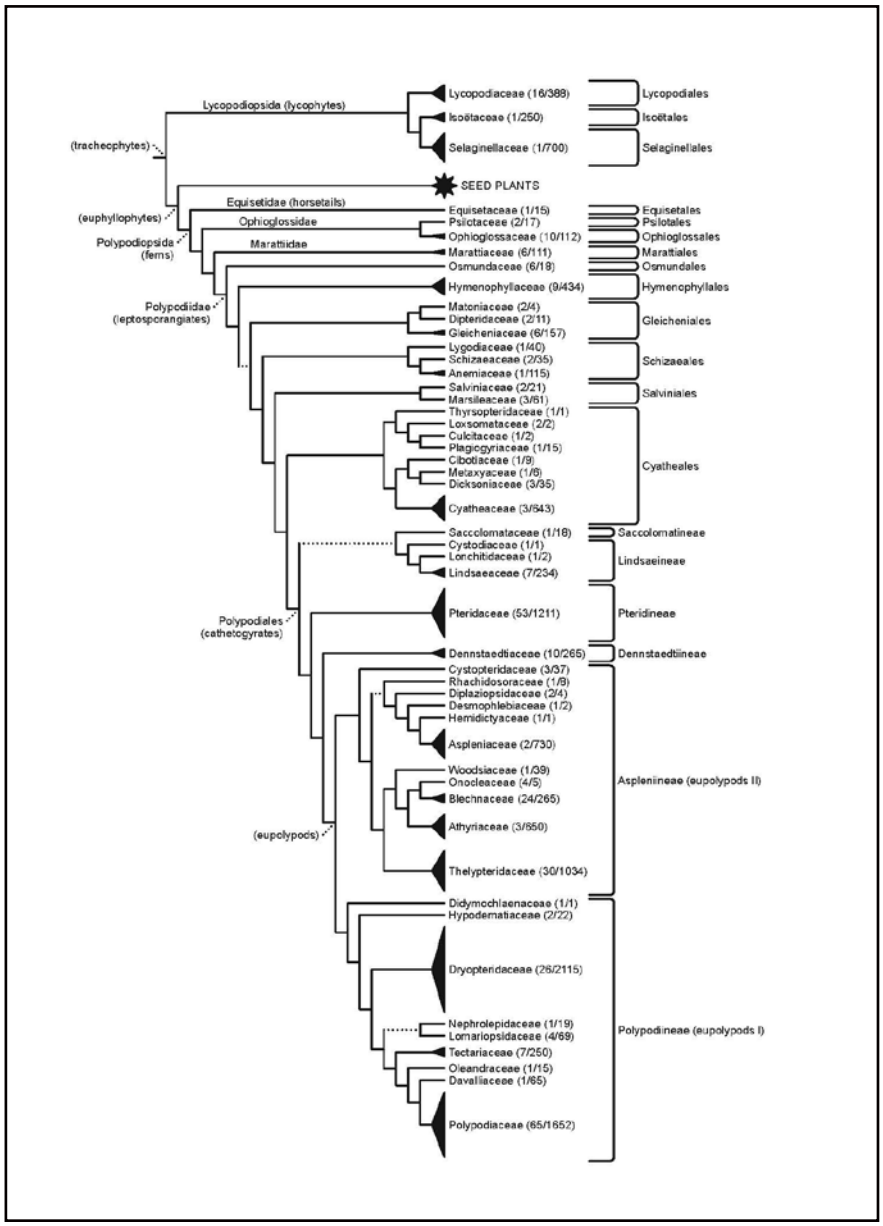
Figure 2. GenBank nucleotide record for accession KF989600. The arrow indicates the NCBI link back to NMNH's voucher specimen record, Funk 12700! https://www.ncbi.nlm.nih.gov/nuccore/KF989600

All NMNH systematic biology departments have NCBI numbers in EMu, but many more numbers remain in researchers' files waiting to be added. If you have NCBI numbers in a spreadsheet or other tabular file with any sort of collection record identifier for an NMNH specimen (ex. Collector + Collector number, Catalog number (= Sheet number), Barcode, etc.) they can probably be loaded to EMu. NCBI links can point back to both EMu Voucher and Sample records. Researchers from outside institutions who have submitted NMNH specimen based sequences to NCBI could also have their numbers added to EMu.

This is a wonderful opportunity to increase exposure of your research. In addition to sequence and publication information, each linked NCBI record will add easy access to your primary voucher specimen data. If interested contact a data manager from the appropriate NMNH department for advice or assistance as needed.

A New, Community-Derived Classification for Seed-Free Vascular Plants

The Pteridophyte Phylogeny Group (PPG), including **Eric Schuettpelz** and 93 other authors from around the world, recently published a modern classification for all living lycophytes and ferns, down to the genus level, using a community-based approach in the *Journal of Systematics and Evolution* (54: 563-603; 2016). With monophyly as a primary criterion for the recognition of taxa, this monumental undertaking treats an estimated 11,916 species in 337 genera, 51 families, 14 orders, and two classes. The PPG I classification is not intended as the final word on lycophyte and fern taxonomy, but rather a summary statement of current hypotheses, derived from the best available data that will hopefully serve as a resource, a framework, and a stimulus to further discourse.



Summary vascular plant phylogeny showing relationships among lycophyte and fern families recognized in the Pteridophyte Phylogeny Group (PPG I) classification. For each family, the total number of genera recognized in PPG I and the sum of species estimates for these genera are provided. Where applicable, informal clade names are provided in parentheses. (From *Journal of Systematics and Evolution* 2016)

New Fern Species Discovered in East Maui

Kenneth Wood (National Tropical Botanical Garden) and **Warren Wagner** discovered a new fern species from East Maui which they named *Athyrium haleakalae*. Published in *PhytoKeys* (76: 115-124; 2017), this species appears to be an obligate rheophyte, preferring sites of fast moving water along concave walls of streams and waterfalls.

The fern is in the family Athyriaceae and the species is named after the only known location in Haleakalā, East Maui, a large, dormant shield volcano. The genus has a primary center of diversity in the Sino-Himalayan region (about 91 species) with secondary center of diversity in the Western Pacific islands (about 54 species). There are nine other athyrioid fern species endemic to the Hawaiian Islands.

About 300 plants of *Athyrium haleakalae* have been observed on the mountain of Haleakalā. Wagner and Wood have assessed this species to be Critically Endangered due to its small population size and restricted distribution. A cultivation program has begun for this fern at the Olinda Rare Plant Facility on East Maui.

Mature plants of *Athyrium haleakalae*, a new species discovered by Warren Wagner and Kenneth Wood. This fern shows a preference of growing along concave hollows of streams in Hana Forest Reserve, East Maui, Hawaii. (photo by K.R. Wood)

Profile

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illustrated the importance of evolution as a scientific foundation, and how knowledge of evolution has evolved. The exhibition, celebrating the 200th anniversary of Charles Darwin's birth and the 150th anniversary of the publication of his groundbreaking *On the Origin of Species*, displayed seven books and 80 specimens from the museum's collections. The panels discussed how new discoveries influence evolutionary theory and how the research and inquiry processes that Darwin promoted continues today. One discovery on view was a new species of *Heliconia* that was named in honor of former Museum Director Cristián Samper.

In our ongoing effort to bring plant science to the public, in 2016 the Department of Botany opened a public display outside the doors to the U.S. National Herbarium. Currently on view, "Botany in a New Era of Discovery" explains the variety of methods that new species are discovered, from traditional field work and laboratory work, to discoveries in the collection and discoveries in a busy marketplace. Specimens from the Herbarium are featured and are presented in four display cases and panels.

Encouragingly, plants will be further showcased in two new exhibits this year. The first is the exhibition, "Objects of Wonder: From the Collections of the National Museum of Natural History." Opened in March, this gallery shares the objects, science and stories behind the Museum's 145.3 million specimens and artifacts—including on display more than 1,000 unique, valuable, beautiful and strange specimens. As the welcome panel says, these items "reflect our amazing world, inspire wonder, and form the foundation for scientific discovery." Some specimens from the U.S. National Herbarium get top billing standing solo in display cases where stories of their global significance are shared, while others are paired with specimens from other departments revealing shared themes.

One specimen that stands alone on display is the Coco de Mer, *Lodoicea maldivica*, the plant species that produces the world's largest seed. The specimen in the exhibit weighs 16 pounds, but the double coconut palm can produce fresh seeds weighing over 60 pounds. The species is native to the Seychelles Islands, historically known from five islands but now occurring naturally on only two islands. With a limited distribution, slow growth rate, and illegal harvesting in the wild, this species has been assessed as Endangered in the IUCN Red List.

A palm tree native to the Republic of Seychelles Islands, the Coco de Mer (*Lodoicea maldivica*) produces what are considered to be the largest seeds in the world. The specimen in the exhibition weighs 16 pounds, but seeds weighing over 60 pounds have been recorded in nature.

Another display describes the origin of unique collections in the Museum. In 1961, the Museum received "The Archie F. Wilson Wood Collection," a donation from an enthusiastic wood collector. The blocks of wood on view represent just a small percent of the 4,637 specimens of woody species from the Wilson Wood Collection. Each individually labeled specimen displays the unique grain and color of the species. The exhibit panel describes how the specimens are used today, with purposes ranging from wood identification to research on wood anatomy.

In a creative combination of objects, "What Makes Things Blue" is an exhibit case explaining how pigments, structural colors, and atomic elements give plants, animals, and minerals their intense shades of blue. Situated with *Morpho* butterflies, a tinamou bird egg, Australian opals, and a blue Roman glass vessel dating back to 200 BC – AD 100, is a botanical specimen of *Pollia condensata*'s iridescent bright blue fruit, the most vibrant, intense shade of blue in nature.

Another case uniquely combining specimens tells the story of what happens when a biologist, a conservator, and an anthropologist each share their own perspective on a single object, in this case a Thai offering bowl from 1856. King Mongkut Rama IV of Siam (now Thailand) gave an offering bowl to President Franklin Pierce as a token of friendship

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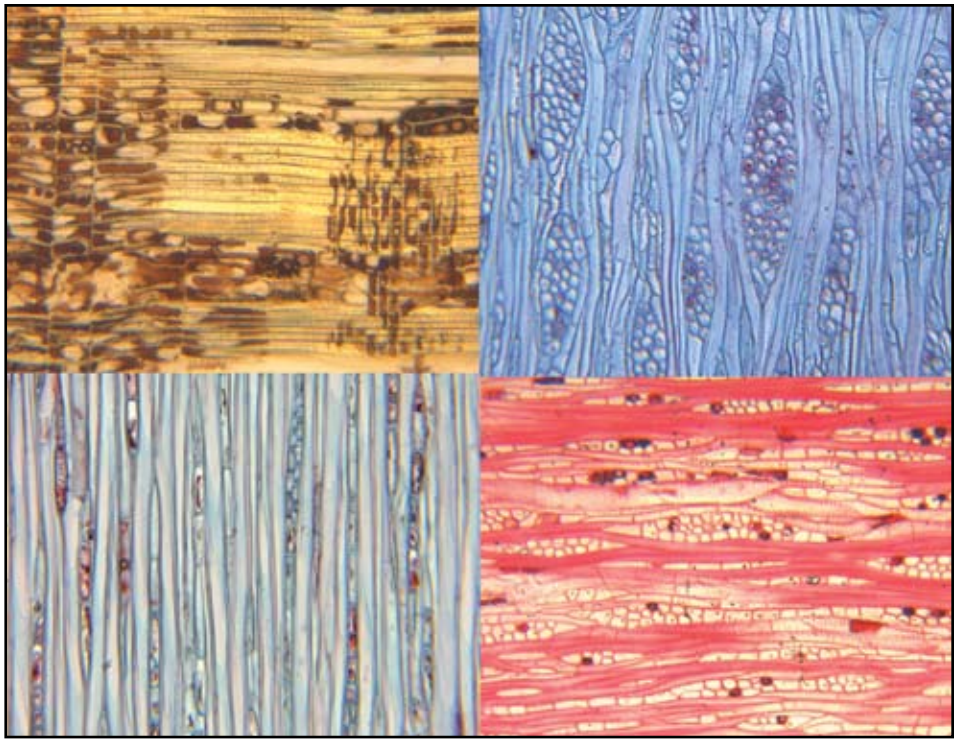
toward all Americans. The bowl is made from wood, lacquer, and shell. The bowl's lacquer coating is made from the sap of the Burmese lacquer tree, *Melanorrhoea usitata*, which grows in the seasonally dry forests of Myanmar and Thailand. Paired with the bowl and the botanical specimen is the animal species which provides the bowl's inlay—a Green Turban snail, *Turbo marmoratus*, a species now overharvested.

The intertwined fates of a butterfly and a plant are on display to tell the story of near-extinction and recovery due to human activities. Atala butterflies**,** *Eumaeus atala*, lay their eggs exclusively on the coontie plant, *Zamia floridana*, a species native to Florida. The caterpillars eat the coontie's leaves, incorporating the plant's toxins into their bodies as a defense against predators. Seminole tribes in Florida had harvested the plant for its thick starchy stems so much that by the 1930s, industrial starch production had nearly wiped out the plant and the butterfly along with it. Fortunately, the coontie became a favorite of landscapers and gardeners in Florida because it tolerates drought and salty soil. As the plant made a comeback, so did the butterfly.

Some collected specimens serve as biological indicators of environmental change. In one display case are specimens of coralline algae, *Clathromorphum compactum*, from Labrador, Canada. These specimens tell us of the world's rapidly changing climate. Coralline algae are long-lived and preserve a record of their environmental conditions (light and temperature) as tree-ring like growth bands. Recent research using these specimens shows that sea ice has been rapidly declining in the past 150 years relative to any period since the 14th century.

A display that will be rotated on a regular basis is "Eureka! New Discoveries in the Museum." The first story to be featured is that of a 2012 plant collecting expedition to Kamakusa Mountain, a remote tabletop mountain in Guyana (featured in *The Plant Press* 16: 8-10; 2013). Smithsonian botanist Kenneth Wurdack teamed up with American and Guyanese researchers to document this poorly-mapped region's plant diversity. As the collections get identified, at least



Wood has long been prized for its beauty and variety—beauty and variety that extends to a microscopic level. This sampling of one of the world's largest collections of wood shows the amazing cellular structure of wood. Clockwise from top left: *Quiina negrensis*, *Cornus controversa*, *Colubrina arborescens*, and *Cornus stolonifera*. (Image by Stanley Yankowski)

***Pollia condensata*, native to Africa, uses structural coloration instead of pigments to produce the most intense color of blue ever studied in biological tissue. (photo by James Di Loreto)**

Coralline algae of the genus *Clathromorphum* are specific to the Arctic and Subarctic, and they have critically important stories to tell about their ocean and how it has changed over the centuries. (photo by James Di Loreto,)

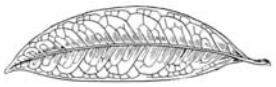
five new species have come to light in four families including a new *Raveniopsis* (Rutaceae). An isotype specimen and the scientific illustration of the species accompanying its scientific publication (see back page, this issue) are currently shown in the exhibit.

The second new exhibition to showcase botany in the Museum is "Plants on the Move," a cozy space designed to give wary tourists a chance to give their feet a rest and to recharge their mobile devices. Scheduled to open in November 2017, the tentative plans for the exhibition include artistic visual representations of how plants disperse their seeds and spores, such as wind, water, force, and animal. The space will feature two large, living cycads in planters and a central display of ferns crowned by a hanging staghorn fern. The text panels will describe stories about plant reproduction, informative descriptions of seeds and spores, and case studies about moss, fern, orchid, cycad, and bromeliad reproduction and dispersal. Information about the National Seed Strategy for Restoration and Rehabilitation will also be featured.

We are excited that these two new exhibitions feature excellent examples of botany on display in the Museum. These exhibits can help mitigate "plant blindness," a syndrome pervasive throughout our culture. Plant blindness is the inability to see or notice plants in one's own environment, leading to the inability to recognize their importance, to underappreciate their aesthetic and unique biological features, and to rank plants as inferior to animals and as unworthy of consideration (Wandersee and Schussler 1999 *Am. Biol. Teacher* 61: 82-86). Put simply, plants are often overlooked when paired with animals.

Plant blindness is most evident in newspapers and magazines where a photo of a giraffe feeding on an *Acacia* tree will mention the animal but not the plant in the caption. So if a museum exhibit features a photograph of a bat pollinating a banana flower or a frog sitting atop a lotus leaf, the opportunity exists to give both plant and animal equal weight by naming both species in the title and caption.

The two new exhibits, "Objects of Wonder" and "Plants on the Move" offer a fantastic foundation for advancing our understanding of the importance of plants to life on earth. It is with hope moving forward that plant blindness can be alleviated by featuring botany prominently and with purpose in future exhibitions in the Museum



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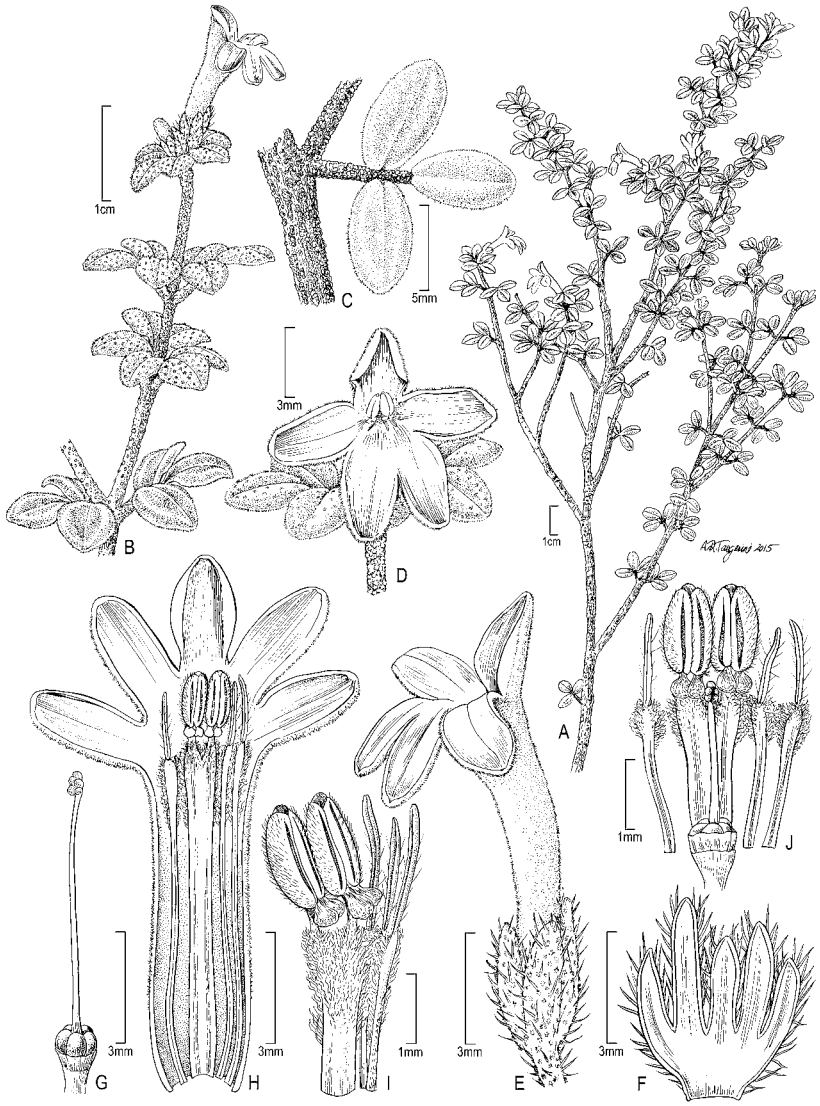
Art by Alice Tangerini

Raveniopsis sp. nov.

In the new exhibition, "Objects of Wonder" at the National Museum of Natural History, new discoveries by museum scientists will be given a spotlight. Rotating on a regular basis, the display case debuts with a new plant species described by botanist Kenneth Wurdack. During a 2012 plant collecting expedition to Kamakusa Mountain, Guyana, an unusual shrub was discovered and subsequently identified by Wurdack to the genus *Raveniopsis* (Rutaceae). Alice Tangerini drew a scientific illustration of this species, and both illustration and plant specimen are currently displayed in the exhibition.



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