Department of Botany & the U.S. National Herbarium

The Plant Press

Smithsonian
National Museum of Natural History

New Series - Vol. 19 - No. 3 July-September 2016

Special Symposium Issue continues on page 14

Botany Profile

Green Things and Pollinator Wings:
Symposium Explores Pollination Biology

By Gary A. Krupnick

Pollination biology was the focus of the 14th Smithsonian Botanical Symposium, held 20 May 2016 at the National Museum of Natural History (NMNH) and the United States Botanic Garden (USBG) in Washington, DC. Titled, "Bats, Bees, Birds, Butterflies and Bouquets: New Research in Pollination Biology," the meeting featured seven invited speakers, a poster session, and an evening reception. The conference brought together over 340 biologists, ecologists, government officials, horticulturalists, and master gardeners to celebrate the progress of pollination biology and to address issues of pollinator loss and conservation.

The Symposium began with opening remarks by Maureen Kearney (Associate Director for Science, NMNH) and Laurence Dorr (Chair of Botany, NMNH). Kearney praised the partnership between NMNH and USBG, and mentioned how the symposium adds to the intellectual environment of the museum which often exercises an interdisciplinary research approach with a deep organismal focus in systematics, ecology, evolutionary biology, and behavior.

After the opening remarks, Kenneth Wurdack (Curator and Cuatrecasas Committee Chair, NMNH) presented the 14th José Cuatrecasas Medal in Tropical Botany to Kamaljit S. Bawa (see related story on page 14). This prestigious award is presented annually to a scholar who has contributed significantly to advancing the field of tropical botany. Bawa, a Professor of Biology from the University of Massachusetts, was commended for his extensive contributions to tropical biology, international conservation, and pollination biology. In his acceptance speech Bawa expressed his appreciation and gratitude to the Smithsonian Institution and the selection committee. He was delighted to see so many friends and colleagues and gave thanks to all who have inspired him.

Both Laurence Dorr and Seán Brady (Curator of Bees, NMNH) served as conveners.

The first speaker was Sam Droege (USGS Patuxent Wildlife Research Center) who spoke about "Patterns in pollen and plant specialization among native bees in eastern North America." Droege's macro photographs of bee portraits from his online reference catalog provided the backdrop for his talk about pollination from the bee's point of view. First he spoke about the high diversity of bee species in the United States – about 4,000 species. He pointed out that there are nearly as many bee species in Prince George's County, Maryland (249 species) as there are in the United Kingdom (250 species). He explained that 250 million years of evolution has led to complex and varied floral bee designs, nutritious pollen, complex secondary compounds, and complex bee communities that reflect plant diversity.

Droege said that while there are few plant species that are pollinator specialists, there are many bee species that are pollen specialists. Specialist bee larvae often fail to thrive on the pollen of other plants and are often restricted to target plant blooming periods. Population sizes tend to be low for specialists which might lead to conservation concerns. Droege's mid-Atlantic bee collection shows about 20 percent as pollen specialists, with the most common being *Andrena erigeniae* (a Spring Beauty specialist), *Ptilothrix bombiformis* (Hibiscus/Mallow specialist), and *Andrena violae* (Violet specialist). The plant families with the most specialists include Asteraceae, Ericaceae, and Salicaceae. Specialist bees tend to be the most vulnerable due to habitat loss, fragmentation, invasive species, and herbicide usage. Non-native plant species mostly favor generalist bee species, and thus Droege encourages the fostering of native habitat.

David Roubik (Smithsonian Tropical Research Institute) next asked the question, "Whose bees are these? The pollen taxonomy of bee nests and its story in recent decades." Roubik explained that pollen grains are nearly indestructible, taxonomically informative, and open to

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Travel

Vicki Funk traveled to Berlin, Germany (6/16 – 6/26) to be a plenary speaker at the Global Genome Biodiversity Network conference, and to present a workshop on Global Genome Initiative (GGI) - Gardens (co-presented by **Morgan Gostel**).

Erika Gardner, **Carol Kelloff**, **Melinda Peters**, and **Meghann Toner** traveled to Berlin, Germany (6/19 – 6/27) to attend the annual meeting of the Society for the Preservation of Natural History Collections, where Gardner and Toner each presented a talk and Peters presented a poster.

Carol Kelloff and **Mark Strong** traveled to Zuni, Virginia (5/21 – 5/27) to collect rare plants in the Longleaf Pine communities for the Global Genome Initiative (GGI) project.

Nancy Khan traveled to Front Royal, Virginia (5/11 – 5/12) to attend a session of the Emerging Leaders Development Program at the Smithsonian Conservation Biology Institute (SCBI).

W. John Kress traveled to Costa Rica (6/9 – 6/16) to chair the Las Cruces Advisory Committee meeting of the Organization for Tropical Studies.

Gary Krupnick traveled to St. Louis, Missouri (6/27 – 6/30) to present a talk entitled "#EarthOptimism: Success Stories in Plant Conservation" and a poster entitled "A Continental Approach to Orchid Conservation and Restoration" at the Global Partnership for Plant Conservation conference at the Missouri Botanical Garden.

Sylvia Orli traveled to Amsterdam, Netherlands (4/30 – 5/5) with the Smithsonian Digitization Program Office to meet with Picturae and Naturalis to discuss the specimen digitization project.

Jun Wen traveled throughout eastern China (6/23 – 7/22) to conduct field research.

Kenneth Wurdack traveled to Wicomico County, Maryland (6/2) to collect *Litsea aestivalis* (Lauraceae) with Wesley Knapp (Maryland Department of Natural Resources) at Wetipquin Pond Preserve.

Elizabeth Zimmer traveled to Austin, Texas (6/17 – 6/22) to present a talk entitled "DNA sequences identify cryptic species of quillworts (*Isoetes* L.)" at the Evolution 2016 meeting, and to attend an editorial board meeting of *Molecular Phylogenetics and Evolution* as Deputy Editor-in-Chief.

The Plant Press

New Series - Vol. 19 - No. 3

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Visitors

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

Gouri Mahadwar, University of Rochester; Legume phylogenetics internship (9/1/15 - 8/11/16).

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

George Wang, University of Louisiana at Lafayette; Plant-insect interactions (1/7 - 5/31).

Tomas Fer, Charles University, Czech Republic; Zingiberales (2/1 - 6/3).

Joel Cohen, Rockville, Maryland; Plant DNA barcode internship (3/28 - 4/1).

Cassandra Quave, Emory University; Mediterranean ethnobotany (4/1).

Holly Summers, Cornell University; *Oenothera* (Onagraceae) (4/5)

Chris Holder and **Elizabeth Striano**, George Mason University, and **Nancy Rybicki**, U.S. Geological Survey; *Trapa* (Trapaceae) (4/6 - 4/7; 4/12 - 4/13).

Cintia Luz, Universidade de São Paulo, Brazil; *Schinus* (Anacardiaceae) (4/11 - 4/13).

Rowan Schley, Royal Botanic Gardens, Kew; *Brownea* (Fabaceae) (4/11 - 4/14).

Yaling Wang, Xi'an Botanical Garden, China, and **Shouzhou Zhang**, Fairy Lake Botanical Garden, China; Global Genome Initiative Gardens Program partnership meeting, *Magnolia* (Magnoliaceae) (4/12 - 4/14).

Daniel Geiger, Santa Barbara Museum of Natural History; *Oberonia* (Orchidaceae) (4/15 - 4/19).

Marcelo Devecchi, Universidade de São Paulo, Brazil; *Simaba* (Simaroubaceae) (4/21 - 4/22)

Lucas Jordao, Jardim Botanico de Rio de Janeiro, Brazil; *Mimosa* (Fabaceae) (4/21 – 4/22).

Zvezdana Ukropina-Crawford, Berry College; *Crataegus* (Rosaceae) (4/22).

Michele Conrad and 25 students, Mansfield University; Herbarium tour (4/23).

Kate Wagle, University of Oregon; Botanical Art Collection (4/25 - 4/29).

Tom Lovejoy and 9 students, George Mason University; Plant conservation and herbarium tour (5/2).

Marjorie Falanruw, U.S. Forest Service; Micronesian flora (5/3).

Kathleen Kron, Wake Forest University; West Indian Ericaceae (5/11 - 5/12).

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Chair With A View

L.J. Dorr

Taking Stock

It has been an eventful year. Last summer when it became apparent that I would likely become Chair of the Department of Botany I realized that among many other things I would have to organize and orchestrate a spring symposium. A number of ideas floated through my head and suppressing panic, the strongest of all the ideas, I decided that a symposium on pollination biology might be interesting. I had dabbled with the subject early in my career and I knew that even though pollination biology per se is not a focus of research done here in the Museum, a symposium on this topic could easily underscore the valuable systematic and phylogenetic research done by our Botany and Entomology Departments and inform some of our research on the evolution of plants and insects. When I pitched the idea to Susan Pell of the U.S. Botanic Garden, our partner in this enterprise, she agreed and as they say the rest is history. Of course, a good number of Botany staff worked very hard to make this happen and I think we all should be very pleased with the result: an intellectually stimulating day with one of the largest registrations yet for our symposium series.

Another inherited project, which was planned before but inaugurated after I became Chair, is our digitization conveyor project (see *The Plant Press* 19(2): 6, 7. 2016). The scale of the accomplishments here in the last ten months is phenomenal. As of last week, 566,824 herbarium specimens have been digitized, their label data have been or are now being transcribed, and the specimen images and information will soon be fully searchable on our website. This is currently the largest herbarium digitization project in the Western Hemisphere and to put the scale of what has been accomplished into perspective, I need only add that the average size of the 3,200 institutional herbaria in the world is a modest 100,000 specimens! As with the symposium, this project also is a partnership. The Digitization Program Office (DPO) of the Smithsonian Institution has been a driving force, our principal benefactor, and the administrative contact with Picturae, the Dutch company that owns and runs the conveyor belt and that subcontracts the transcriptions being done in Suriname. The very hard work in getting us to this point has been that of not only the contractors employed by Picturae, but also Botany and Museum staff and contractors who planned the project, prepared the specimens for digitization, verified the transcriptions, and who are now importing the data into our collections database.

Specimens from the United States National Herbarium are placed on a conveyer belt for rapid digitization. (photo by Ingrid Lin)

The past year has also seen a transformation in the U.S. National Herbarium, which although far from complete, augers well for the future. The new cases designed to house our bulky bamboo collections (see *The Plant Press* 19(2): 8. 2016) have been installed and the specimens transferred from the old cases to the new. We are poised as well to order new cases for the ferns and for an area currently used as our specimen sorting center and these will be in place before the end of the year. The sorting center will be relocated and this will provide room for us to expand the Asteraceae. The new cabinetry was purchased with monies awarded by the Smithsonian's Collections Care and Preservation Fund (CCPF) for which we are extremely grateful. A separate CCPF grant is helping us to process a large backlog of grass specimens that will free up space and generate a significant amount of exchange material. A separate, moderately controversial change was the reintegration of the D.C. (District of Columbia) Herbarium into the main collection. Space and the need to focus staff resources on other matters drove this decision. In addition, we also came to the conclusion that the most efficient organization of the U.S. National Herbarium is to have the least number of separate collections possible.

Having taken stock of a few of our major activities where do we go now? There will be another Smithsonian Botanical Symposium in May 2017 and we have initiated a discussion with the U.S. Botanic Garden about the theme. We are continuing the digitization of the herbarium and are beginning to think about how we can use very large data sets to address and answer questions with herbarium specimens that we could not imagine doing before. We are reorganizing the phanerogamic portion of the herbarium as a prelude to converting our filing scheme to a modern one that better reflects our understanding of phylogeny. Finally, you might ask why these things matter. They matter because we are trying to support and improve our research on the systematics and evolution of plants, fungi (i.e., lichens), and algae.

Staff Research & Activities

As a member of the Botanical Art Society of the National Capital Region (BASNCR) **Alice Tangerini** has artwork on display in two of their recent exhibits in the Washington DC area. In the exhibit, "Botanica 2016: The Art & Science of Plants," at Brookside Gardens in Wheaton, Maryland (June 16 - July15), Tangerini has exhibited "Tree Peony" in pen and ink made specifically for an adult coloring book of garden plants. At the opening reception, Tangerini presented a lecture on botanical illustration techniques. In "Off the Beaten Path," which features botanical works in non-traditional presentation and composition at the Strathmore Mansion in Bethesda, Maryland (June 11 - July 31), Tangerini has exhibited a mixed media piece, "Tulips."

New Faces

Manuela Dal Forno joined the Botany Department as a postdoctoral fellow in June 2016, working with **Eric Schuettpelz**. Dal Forno received her Ph.D. in Environmental Science and Public Policy from George Mason University. Her dissertation research focused on the systematics of tropical basidiolichens in the *Dictyonema* sensu lato clade (Agaricales: Hygrophoraceae). Dal Forno was awarded an NSF fellowship for research using biological collections and will be obtaining microbiome data from fresh and historical lichen collections deposited at the U.S. National Herbarium. She will be comparing these data in both space (from different localities) and time (at various ages). Her main objective is to test the hypothesis that microbiome data from specimens deposited in herbaria represent the original bacterial assemblage associated with the living lichen thallus. This opens up a remarkable opportunity to add another data layer to millions of existing collections deposited in museums worldwide.

Bort (Robert) Edwards arrived in January as a Powell Center Postdoctoral Fellow under the guidance of **Vicki Funk**. The Powell Center is a USGS initiative for collaborative analysis and synthesis and Edwards' project brings together data and investigators from SI, USGS, USDA, CSIRO, NSF, and a number of other organizations and universities. They aim to leverage big data in the form of geochemistry and geology, climate, plant distributions, and sequence data to investigate whether the evolution of extreme environmental tolerances has allowed the differentiation and diversification of plant groups in some of the more challenging environments of North America. Edwards has a Ph.D. in phylogenetics and biogeography from The University of Queensland in Australia studying differentiation, niche evolution, and species identity in a recent and complex radiation of monsoon tropical trees, broadleaved paperbarks (*Melaleuca*, Myrtaceae). He is also recovering from two years as a *Drosophila* speciation genetics postdoc at the University of Rochester (identifying the genetic mechanisms of hybrid incompatibility and the large X effect between *D. simulans* and *D. mauritiana*), and is enjoying supra-freezing temperatures, blue skies and dabbling with chlorophyll again. His research can be followed at http://bortedwards.weebly.com/ and on Twitter and Instagram @BortEdwards.

Laura Tancredi is the newest staff member of the Department of Botany. As part of the Information Management team, her main roles will be to enhance the Botany specimen catalog through digitizing, inventorying and imaging specimens, performing quality control for the rapid digitization project, and supervising volunteers and interns who will assist with the improvement of the online records. Before coming to the Smithsonian as a Collections Program Technician (CPT) in 2012, Tancredi worked as an archaeologist at George Washington's Mount Vernon. She therefore comes to Botany with plenty of experience "collecting" in

New faces in the Department of Botany (from left): Manuela Dal Forno, Bort Edwards, Laura Tancredi.

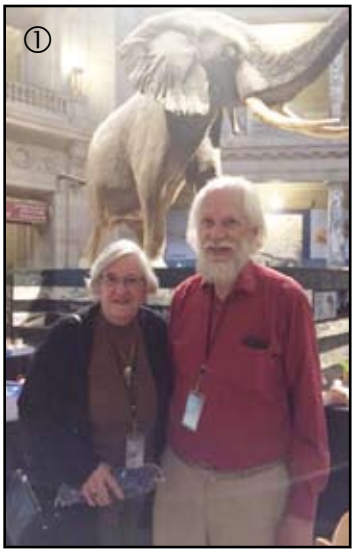
the dirt. Tancredi's first project as a CPT, and first exposure to the world of pressed specimens, was with the National Anthropological Archives, mounting ethnobotanical specimens as part of the Recovering Voices Initiative. She subsequently spent over a year in the Division of Fishes cataloging ~15,000 specimen lots in their fluid collection, and moving and rehousing the osteological collection. She participated in the Department of Entomology's species level inventory, catalogued the Department of Paleobiology's Amber Collection, and spent about eight months last spring and summer with the Department of Botany preparing specimens for the conveyor belt digitization project.

Awards & Grants

The Journal of Systematic Evolution (JSE) recognized the 2015 paper, "A worldwide phylogenetic classification of the Poaceae (Gramineae)," by **Robert Soreng**, **Paul Peterson**, **Kostyantyn Romashchenko**, Gerrit Davidse, Fernando O. Zuloaga, Emmet J. Judziewicz, Tarciso S. Filgueiras, Jerrold I. Davis, and Osvaldo Morrone as one of four JSE Outstanding Papers (2014 and 2015). The 2015 paper, "Expression patterns of *AP1, FUL, FT* and *LEAFY* orthologs in Vitaceae support the homology of tendrils and inflorescences throughout the grape family," by **Ning Zhang**, **Jun Wen**, and **Elizabeth Zimmer**, was recognized as one of four JSE Outstanding Papers by Young Investigators (2014 and 2015). Both papers were nominated by JSE editors and were selected largely based on the citations per year. In addition to a certificate, winners received a cash award.

Volunteer Appreciation in Botany

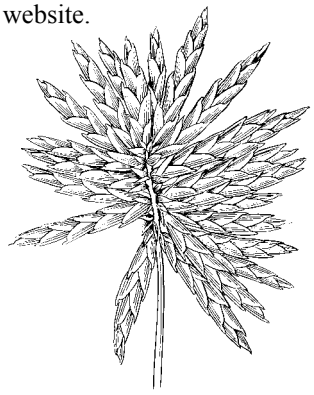
April was designated as Volunteer Appreciation Month at the National Museum of Natural History. The Department of Botany has many dedicated volunteers involved in all aspects of our work. From plant preparation to map curating and data entry, this extraordinary and talented group of volunteers deserves special recognition.



Volunteers from the Department of Botany: (1) Ardith and Jim Harle both volunteer in Botany. Jim manages the map project, which has expanded across the museum, and Ardith works on the plant mounting opportunity. (2) The Monday plant mounting crew (clockwise from top left): Kat Rankin (retired plant mounting coordinator), Irmgard Dugge, Carol Pihstrom, Gwen Petitjean, Jo Ann McCann, and Bayla White. (3) Larry and Alice Owens with Melinda Peters. Larry works on the plant mounting opportunity. (4) Mary Monsma in the studio scanning her fern illustrations.

The museum held a special event in April to honor the volunteers and to give our thanks. During the event a number of Botany volunteers were recognized for their years of service: 5 years (**Ann Cardoni**, **Deanna Crouse**, **Kathleen Griffin**, **Ardith Harle**), 10 years (**Cynthia Ford**, **Rosalie Elliott**, **Bayla White**), 20 years (**Larry Owens**), 25 years (**Margaret Schweitzer**), and 30 years (**Gwen Petitjean**).

Mary Monsma was selected from the Department of Botany for the "Above and Beyond 2016" award. Monsma first worked in Botany in the early 1970s as a contract illustrator drawing ferns for **David Lellinger** and his publication, *The Ferns and Fern-allies of Costa Rica, Panama, and the Choco: Part 1*. In 30 years she completed 582 drawings for that publication, and another 596 drawings for the second volume. Part 2 was never published, as the classification of ferns had changed too much. In 2012 Monsma returned to Botany to begin a long term volunteer project to scan, inventory and organize her fern illustrations from her contract years. With her additional knowledge in Photoshop she has been able to reconstruct, label and optimize the illustrations for future inclusion in Botany's public website.

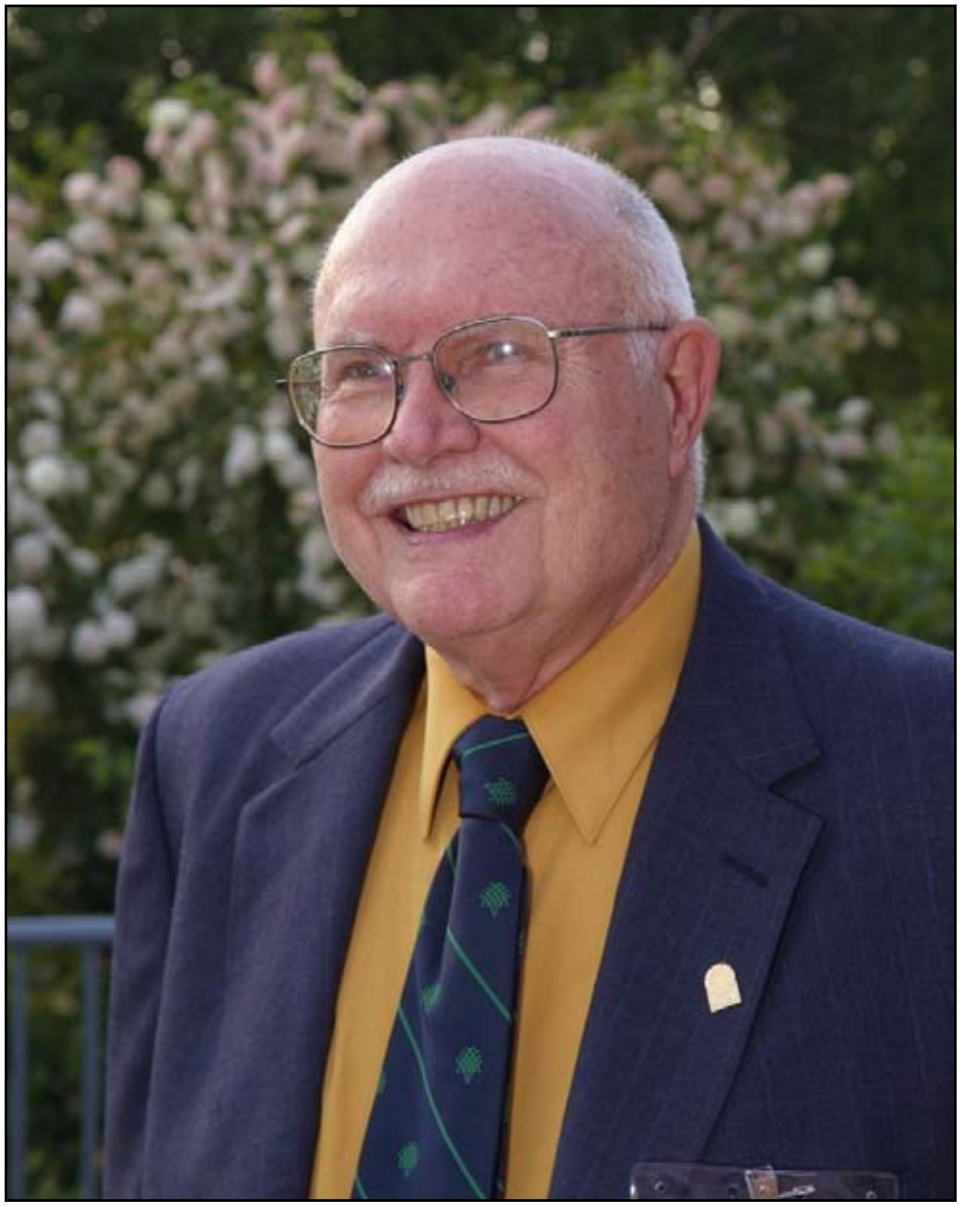


Dan Henry Nicolson (1933-2016)

Dan Nicolson was born on 5 September 1933 in Kansas City, Missouri and grew up in Shenandoah, Iowa where his parents ran the Henry Field's Seed and Nursery Company, which was then one of the largest mail order seed companies in the country. After graduating from Shenandoah High School (1951) Nicolson enrolled in Grinnell College, Grinnell, Iowa. Four years later, not only did he graduate with a B.A. (1955) but he also published his first botanical paper: a revision of the genus *Asclepias* (milkweed) in Iowa. Evidently there was an expectation that he would take over the family business and he dutifully pursued a M.B.A. (1957) at Stanford. Botany, however, proved to be more alluring than business and rather than return to Shenandoah, he moved further east to pursue graduate study in Botany at Cornell University (M.S., 1959 and Ph.D., 1964).

While studying at Cornell, Nicolson met and married Alice (Allie) Black Crawford. The newly wedded couple attended the 1959 International Botanical Congress in Montreal for their honeymoon. This unorthodox destination must not have bothered his wife too much because they remained married for 57 years. While in graduate school Dan and Allie spent almost two years (1960-62) in Malaysia and Southeast Asia where he did the field work that led to a monograph of the genus *Aglaonema* (Araceae), the subject of his dissertation.

In 1964 Nicolson was hired by the Smithsonian Institution to fill a vacancy created when Richard (Dick) Cowan was promoted to Assistant Director of the U.S. National Museum (now National Museum of Natural History). During his first year on the job Nicolson attended the International Botanical Congress in Edinburgh and spent three months collecting on the island of Dominica in the Caribbean. The following year as the junior curator in the department, he was tasked with organizing the move of the U.S. National Herbarium from the Castle to its current location in the West Wing of the Natural History Building. Several years later he organized the Herbarium Services Unit (now Core Collections Management) and was also instrumental in recruiting Ruth Schallert to serve as the first librarian for what is now the Botany and Horticulture Library.



Nicolson continued his focus on Asian botany and spent a year (1966-67) collecting plants in Nepal as a Senior Fulbright Fellow. This was followed by work in India (1968-74) where he spent three months of each year in Bangalore (now Bengalaru) collaborating with Father C.J. Saldanha on the flora of the Hassan District, which was published in 1975. He also spent a month in Sri Lanka in 1979 and later contributed a treatment of the Araceae to the multi-volume *A revised handbook of the flora of Ceylon*, which was then being published for the Smithsonian Institution and the National Science Foundation. A three-month long trip to Yunnan, China in 1983 was Nicolson's last extensive foray into the field.

In the 1970s Nicolson became deeply involved in botanical nomenclature and in the International Association for Plant Taxonomy (IAPT) so much so that for close to a generation Dan Nicolson and Botanical nomenclature were almost synonymous. He served (1979-99) as nomenclature editor of the journal *Taxon* and was (1981-2006) also a member of the editorial committee for the *International Code of Botanical Nomenclature* helping to prepare five separate editions. He held numerous offices in the IAPT including president (1993-99). In conjunction with his interest in nomenclature, Nicolson also delved deeply into Botanical bibliography and history. His most important contributions to these last fields were *An interpretation of Van Rheede's Hortus Malabaricus* (1988), *The Forsters and the botany of*

the second Cook Expedition (1772-1775) (2004), and the final two supplements to *Taxonomic Literature,* ed. 2 (2008, 2009). All four of these books were published with an IAPT imprint.

Nicolson liked to quip that his scientific work could be divided into three areas: 1, Monographic work in Araceae (knowing a lot about little); 2, Floristic work in India and the West Indies (knowing a little about a lot); and 3, Nomenclature (knowing a little about really nothing). He was perhaps a little too self-effacing. His contributions to Botany were important and he received recognition for them: a Science Achievement Award (2004) from NMNH, the Stafleu Medal (2005) from the IAPT, and the Secretary's Research Award (2009) from the Smithsonian Institution.

In 2005 Nicolson attended the International Botanical Congress in Vienna, his ninth and final congress. He retired in December of the same year and initially devoted his time to bringing the monumental IAPT-sponsored project *Taxonomic Literature* to a conclusion. Health issues, however, prevented him from taking on additional projects.

In addition to his wife Allie, Nicolson's immediate survivors are his three children, John, Sally, and David. David works in the Natural History Building as a Data Development Coordinator for the Integrated Taxonomic Information System (ITIS), which is part of the USGS.

The Department of Botany plans to hold a Memorial Service for Nicolson in the early Fall.

Opposite page: Dan Nicolson, recipient of the Distinguished Career in Science Award given by the Washington Academy of Sciences, in 2008.

This page, top to bottom: Nicolson supervises the move of the Department of Botany and the assembled collections to the new west wing of the Museum of Natural History, in 1965.
Nicolson displays a specimen during the blooming of *Amorphophallus titanium* at the United States Botanic Garden, in 2003.
Nicolson receives the Stafleu Medal from Pieter Baas during the 17th International Botanical Congress in Vienna, Austria, in 2005.

Smithsonian Scientists Participate in National BioBlitz

In celebration of the Centennial of the National Park Service (NPS), the Smithsonian Institution joined NPS and the National Geographic Society on May 20-21 to participate in the 2016 National BioBlitz. The event included all-taxa rapid biological surveys, in which teams of volunteers, each led by subject matter experts, found and identified as many species as possible in national parks throughout the country. A concurrent Biodiversity Festival with hands-on learning activities took place on the National Mall at Constitution Gardens.

This two-day event centered around a 24-hour BioBlitz inventory period in which teams of scientists, teachers, children, and other community members worked together on a series of different inventories to discover and document as many species of plants, animals, microbes, fungi, and other organisms as possible. The primary data collection tool for all BioBlitzes was iNaturalist <http://www.inaturalist.org>, a digital application hosted by the California Academy of Sciences.

***Amorpha fruticosa* (left) and *Persicaria arifolia* (right) were both observed at Dyke Marsh Wildlife Preserve in Virginia during the 2016 National BioBlitz. (photo by Nancy Khan)**

Over nine thousand species in different taxonomic groups, and over 85,000 observations were documented, and tens of thousands of public participants were engaged in our national parks. Among the taxonomic groups, 40,378 plant observations were made and 4,735 plant species were documented. About 20 Smithsonian scientists led inventories in the Greater Washington area. Representing Smithsonian's Department of Botany was **Nancy Khan** who led a plant survey of Dyke Marsh Wildlife Preserve, and **Manuela Dal Forno** who led a lichen inventory on Theodore Roosevelt Island.

Nancy Khan (right) and fellow observers take a break during a BioBlitz of Dyke Marsh Wildlife Preserve. (photo by Suzanne Dingwell)

Khan and Suzanne Dingwell (Virginia Native Plant Society) led a group of seven observers in Dyke Marsh Wildlife Preserve, a tidal wetlands on the west bank of the Potomac River. Since over 360 species of plants have already been documented in the park, they focused their efforts on unique plant species or new populations. Of the 25 plant records that they uploaded to iNaturalist, their favorite discovery was the striking racemes of small purple flowers belonging to the native species *Amorpha fruticosa.* Despite the steady drizzle and heavy overgrowth of *Toxicodendron radicans*, *Ampelopsis brevipedunculata*, *Lonicera japonica*, and *Celastrus orbiculatus*, they surveyed a few pockets of palustrine forest and emergent wetland areas. In the forest understory two ferns, *Botrychium dissectum* and *Onoclea sensibilis* were fairly common. At the water's edge, two sedges with dramatic spiky perigynia, *Carex intumescens* and *C. squarosa*, formed large patches among other common wetland species. Perhaps their most significant records were two vining *Persicaria*; one being the native tearthumb, *Persicaria arifolia,* which may not have previously been documented and

the second, two small patches of an invasive species, *Persicaria perfoliata* (mile-a-minute vine). To their knowledge, the presence of this additional invasive species had not been specifically documented within the boundaries of the Dyke Marsh preserve, although it is known along the George Washington Memorial Parkway.

Dal Forno and Brenda Wasler (NPS) led a group of 22 observers on Theodore Roosevelt Island. During the inventory they educated the observers on the biology and natural history of lichens and how to identify them. Dal Forno made a guide, "Lichens of Theodore Roosevelt Island" <http://www.inaturalist.org/guides/3038>, and provided the observers with a dichotomous key of lichens. They identified 27 lichen species.

At the Biodiversity Festival the Smithsonian hosted two booths. One booth was hosted by the National Museum of Natural History (NMNH) which featured three projects: Biocube, eMammal, and Leafsnap. Staff from the Department of Invertebrate Zoology hosted the Biocube project which examines how much life can be found in one cubic foot. Staff from the Office of Education & Outreach hosted eMammal, a project where citizen scientists work in collaboration with researchers to document mammal distribution and abundance using camera traps. During the event, eMammal displayed wildlife images from cameras set in Rock Creek Park. **Ida Lopez**, **Monica Carlsen**, **Caroline Puente**, and **George Wang** (Department of Botany) hosted Leafsnap, a mobile app that uses visual recognition software to help identify tree species from photographs of their leaves.

The other Smithsonian booth was hosted by Smithsonian Libraries and Biodiversity Heritage Library (BHL) and featured hands-on activities including coloring projects, online exhibitions, and a plant ID challenge that demonstrated how BHL can help visitors identify nature around them. Booth volunteers interacted with over 320 people during the course of the two-day event, and had a unique opportunity to expose young people (K-12) to the rich variety of free resources that NMNH and BHL has to offer.

At the festival's closing ceremony, Gary Hevel, a scientist emeritus from Smithsonian's Department of Entomology, was interviewed. Hevel has been the only scientist to have participated in all 10 NPS/NGS BioBlitz events.

Manuela Dal Forno assembled an educational display of lichens to assist with the inventory of Theodore Roosevelt Island.

The 2016 National Parks BioBlitz is the culmination of a 10-year series of BioBlitzes co-hosted by the National Park Service and the National Geographic Society at different national parks across the country, leading up the centennial of the National Park Service. The first in the series took place at Rock Creek Park in 2007. Other BioBlitz locations have included Biscayne National Park, Rocky Mountain National Park, Jean Lafitte National Historical Park and Preserve, and Hawai'i Volcanoes National Park. This year 19 parks in Greater Washington and more than 100 national parks across the country hosted BioBlitz events. A long-time partner of the National Park Service, the National Geographic Society helped draft legislation to establish the NPS in 1916. The Society has given many grants to create and sustain national parks across the United States, and has extensively covered the parks in its media for nearly a century.

Common and Conspicuous Trees of Yasuni, Ecuador

On May 12, 2016, Gorky Villa, on behalf of Finding Species, Inc., presented a copy of *Common and Conspicuous Trees of Yasuni* to **Robin Everly**, Librarian of the Botany Library. The book represents a culmination of years of botanical work in the Yasuni Biosphere Reserve in Ecuador. Finding Species is a non-profit organization whose mission is to uniquely contribute to the resolution of critical environmental, conservation, and biodiversity issues through aesthetically beautiful and scientifically significant photographs." Finding Species has been a collaborator of the Department of Botany's Leafsnap app project from the project's inception. Finding Species' beautiful high-resolution images of the tree species' characters enable the Leafsnap app user to make an informed species identification.

Gorky Villa presents Robin Everly with a copy of *Common and Conspicuous Trees of Yasuni.* (photo by Ida Lopez)

Quillwort Type Gets Visitors

Michael and Sharon Rosenthal stopped by the Department of Botany on June 17 to see the type specimen of the quillwort *Isoëtes viridimontana* M.A. Rosenthal & W.C. Taylor (Isoëtaceae). Sharon was hiking the Appalachian Trail at the time, and their visit was a brief diversion from the Virginia section of the trail, as well as a brief respite from all of the rain that Washington, DC, had been receiving lately. Several years ago Michael discovered this quillwort along the margins of Haystack Pond in southcentral Vermont. He and Sharon described the new species with assistance from Botany Laboratory Technician **Gabe Johnson**, Research Associate **Carl Taylor**, and Curator **Elizabeth Zimmer** (see *Amer. Fern. J.* 104: 7-15. 2014). The discovery of this new species, including a photograph of Michael collecting in Haystack Pond, is featured in the display, "Botany in a New Era of Discovery," near the West Wing elevator lobby of the National Museum of Natural History. Michael told us that he continues to discover new records of ferns (and other organisms) for Vermont and New England. It is an excellent way to spend one's retirement!

Sharon and Michael Rosenthal show the type specimen of the quillwort *Isoëtes viridimontana.* (photo Ken Wurdack)

Visitors

Continued from page 2

Erika Gonzalez, Smithsonian Conservation Biology Institute; *Quercus* (Fagaceae) (5/12)

Mirinda Martin and 8 students, Brigham Young University - Idaho; Herbarium and L.A.B. tour. (5/12).

Prabha Amarasinghe, Florida Museum of Natural History; *Memecylon* (Melastomataceae) (5/16 - 5/19).

Diego Paredes B., San Marcos University, Peru; Northern Peruvian *Miconia* (Melastomataceae) (5/16 - 5/21)

Harlan Svoboda, Ohio University; *Passiflora* (Passifloraceae) (5/19 - 5/20).

Rafaela Jorge, Universidade Estadual de Campinas, Brazil; *Kielmeyera* (Clusiaceae) (5/20)

Ellen Dean, University of California - Davis; *Lycianthes* (Solanaceae) (5/23 - 6/3).

Jef Mancera, California Academy of Sciences; *Astronia* (Melastomataceae) (5/23).

Karen Muscat, University of Melbourne, Australia; Hawaiian *Dianella* (Asphodelaceae) (5/24 - 5/25).

L.L. Gaddy, Independent researcher; *Quercus* (Fagaceae) (5/25).

Daniel Vance, The College of William and Mary; Compositae (5/31 - 8/5).

Katherine Wu, Mount Saint Mary's College; Natural History Research Experiences summer internships (5/31 - 8/5).

Declan Cooper, University of Sheffield, United Kingdom; Morphometrics internship (6/1 - 8/11).

Kelly McLeod, Glasgow School of Art, United Kingdom; Legume systematics internship (6/1 - 8/11).

Grant Godden, Michigan State University; Lamiaceae (6/3).

Dillon Davis, Wilkes University; Plant DNA barcode project internship (6/6 - 7/15).

Wesley Knapp, Maryland Natural Heritage Program; Maryland flora checklist (6/23 - 6/24).

Lyra Morina, University of Maryland, College Park; Plant DNA barcode project internship (6/6 - 8/19).

Bethany Nowviskie and 14 students, University of Virginia; Herbarium tour (6/8).

Kirsten Schuler, Fairfax, Virginia; Herbarium assistance (6/9 - 6/14).

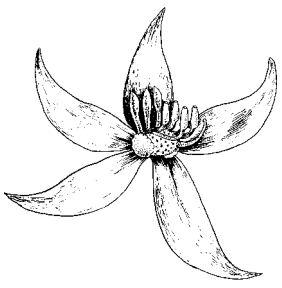
Xi Chen, Morton Arboretum and Yunnan University, China; *Lithocarpus* (Fagaceae) (6/13 - 6/17).

Nirasha Abeysekera, Fairfax, Virginia; Herbarium curation internship (6/27 - 8/12).

Kristen Halper, Fairfax, Virginia; Herbarium curation internship (6/27 - 8/17).

Dylan Cohen, Rancho Santa Ana Botanic Garden; *Loasa* (Loasaceae) (6/29 - 7/1).

Jessie Tchapda and **Esi Tyree**, Washington, DC; Youth Engagement through Science (YES!) internship (6/29 - 8/5).



Celebrating Pollinators and Plants

National Pollinator Week 2016 was celebrated June 20-26 in an effort to raise awareness of the decline in important pollinator populations. The National Museum of Natural History held a number of events throughout the week, including "Expert is In!" programs throughout the museum and a Pollination Party in the Pollinator Garden. Many of the events moved beyond simply raising awareness, giving participants opportunities to contribute towards pollinator protection.

On June 20, Smithsonian experts came out to the museum galleries to talk about unique pollinators. Visitors of all ages swarmed their tables to learn about the behavior of plant pollinators. **Gary Krupnick** explained to visitors the importance of "Trees for Bees," a topic highlighted in the 2016 Pollinator Week poster issued by the Pollinator Partnership. With their profusion of flowers, trees are a convenient food source for bees and other pollinators. Krupnick displayed specimens of tulip tree (*Liriodendron tulipifera*), staghorn sumac (*Rhus typhina*), flowering dogwood (*Cornus florida*), and eastern redbud (*Cercis canadensis*), and shared stories of their natural history and importance to pollinators. Krupnick was one of the scientific advisors on the poster design.

The 2016 Pollinator Week poster, "Trees for Bees."

During the program, Krupnick also provided museum visitors information on how to join the Million Pollinator Garden Challenge, a way to register public and private gardens and landscapes to support pollinators. The Million Pollinator Garden Challenge was launched by The National Pollinator Garden Network, an unprecedented collaboration of national, regional, conservation and gardening groups, including Smithsonian Gardens and the National Museum of Natural History, to support the President's Executive Strategy to "Promote the Health of Honey Bees and Other Pollinators."

On June 21, Smithsonian Gardens hosted its third annual Pollination Party. The event was kicked off by the unveiling of the newly renamed Pollinator Garden outside the National Museum of Natural History. The original Butterfly Habitat Garden was renamed to reflect the growing importance of supporting pollinator health championed by the formation of a task force by President Obama in 2014 and the implementation of the Million Pollinator Garden Challenge. Smithsonian Gardens' reinterpretation of this space educates visitors on the wide diversity of pollinators and the types of plants that support them. The garden display also shows what can be done to create beautiful pollinator-friendly gardens.

On June 22, the White House released the Pollinator Partnership Action Plan (PPAP), building on Federal actions to improve pollinator health by facilitating additional state and private-sector engagement. The PPAP furthers President Obama's June, 2014, memorandum that focused the attention of Federal agencies on the plight of the pollinators—honey bee colony mortality rates that impact the viability of commercial beekeepers and agricultural pollination services; monarch butterfly declines that threaten its iconic continental-scale migration; and other pollinator species quietly slipping toward extinction. The PPAP highlights ways in which state, local, and tribal governments; the private, academic, and non-profit sectors; and the general public can contribute to achieving the goals of the national *Strategy to Promote the Health of Honey Bees and Other Pollinators*. Among the highlights in the PPAP is how the Smithsonian Institution is working to recruit

Gary Krupnick displays plant and bee specimens and talks about the importance of trees for native bees during an "Expert is In" session at the National Museum of Natural History.

volunteers to help make biodiversity data more accessible by transcribing label information from museum specimens.

Krupnick, who represented the Smithsonian Institution on the Pollinator Health Task Force, worked hard to ensure that the Smithsonian is well-represented in the Strategy, which draws attention to the pollinator research, education, and landscapes at the National Museum of Natural History, Smithsonian Conservation Biology Institute, National Zoological Park, Smithsonian Environmental Research Center, Smithsonian Tropical Research Institute, Smithsonian's Forest Global Earth Observatories, and Smithsonian Gardens.

Rising CO_2 Depletes Pollen's Nutritional Potency, Bees Suffer

-Adapted from Smithsonian Insider

Unless you've been living under a rock for the last few years, you've doubtless caught at least a passing reference to the plight of the beleaguered bee. Bees of all types pollinate an estimated 75 percent of our fruit, nut and vegetable crops, and they've been suffering population declines in recent years from a variety of suspected

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Pollen

Continued from page 11

sources. These die-offs are a major concern to farmers and hobby beekeepers, as well as anyone who likes to eat.

Bees like food too, but a new study led by the U.S. Department of Agriculture's Agricultural Research Service has found that recent increases in carbon dioxide emissions over the last several decades have made a key autumnal food source less nutritious than in the past. This adds one more potential factor to the cocktail of stressors making bees vulnerable to attack by pests, pathogens and pesticides.

USDA Agricultural Research Service plant physiologist Lewis Ziska, together with colleagues from Purdue University, Williams College and the Smithsonian, compared the protein content of pollen from historic specimens of Canada goldenrod (*Solidago canadensis*) from the U.S. National Herbarium collection at the Smithsonian's National Museum of Natural History with pollen from field trials simulating varying levels of atmospheric carbon dioxide. They found that as CO_2 levels increased, the protein content of the pollen decreased. The study was published in the journal *Proceedings of the Royal Society B* (283: 20160414; 2016).

Goldenrod, which blooms from July through October across most of North America, is one of the most widely available sources of pollen for late-year foraging. Though nectar is the bees' main food source during the warmer months, bees need the fats, vitamins and minerals from pollen protein to make it through the winter. Because they only store small amounts of it, fluctuations in the amount or quality of the pollen itself can directly affect bee health.

"Goldenrod was the focus because it's the last source of pollen for bees before they overwinter," Ziska says. "Whatever happens to goldenrod in the fall can be a harbinger of overall bee health and their ability to survive until spring."

How rising CO_2 affects insects' food sources has never been investigated in much depth, despite more than 100 such studies on human food sources suggesting the same kind of impact, Ziska said. Using Smithsonian herbarium samples dating from 1842 through to 1998, as well as more recently collected samples from other sources, Ziska found that pollen protein content has declined by about one third since 1960, from 18 to 12 percent.

Three of the many historical goldenrod records kept in the U.S. National Herbarium. These plants were collected in Arizona, Florida and Alabama (left to right). Goldenrod samples in this herbarium were used to measure how rising atmospheric CO_2 has impacted protein in pollen.

A field experiment that simulated a similar range of CO_2 exposures, but included future CO_2 concentrations up to 500 parts per million (ppm), confirmed the herbarium results. Still, as Ziska pointed out, it's not clear if there's an upper limit to the effect, or if the protein content will eventually stabilize regardless of the CO_2 concentration in the atmosphere.

The silver lining to the study, he said, is that commercial and hobby honeybee keepers may be able to counteract any nutritional deficiencies by supplying additional protein late in the fall. How to ameliorate the impact on wild, solitary bees is, however, unclear.

"We wanted to conduct a robust study by looking at both the historical record and field experiments," Ziska says. Though he started out by visiting herbariums around the world, including in Australia, the Smithsonian's herbarium "has by far the best and most diverse set of herbarium samples for studying long term climate effects," he adds.

Andrew Clark, who now works for the USDA but at the time of the study was a Smithsonian herbarium collections specialist guiding Ziska through the *Solidago* specimens, says that the use of goldenrod in this way is a fairly novel approach to the kinds of research typically conducted with herbariums. Pollen studies, for example, aren't done very often any more, and typically focus on the structure of the pollen itself to aid in plant family classification.

"The Smithsonian herbarium goes right to the heart of America's past, because when it started our first collections were from people like Lewis and Clark, frontiersmen who were identifying what was unique to America. No European had seen what was there," Clark said. "It's a very clear snapshot of what our natural environment looked like at that time."

Whether or not the bees will be able to adjust to a degraded pollen source is still unclear.

"As with most biological organisms, there is some capacity for adaptation, but how much is an open question," Ziska paused, then continued. "I often read where 'CO_2 is plant food', but that simple meme falls short of understanding the complexity of CO_2 in plant biology. I suspect that plant pollinators are just the tip of the iceberg—or flower."

Publications

Appelhans, M.S., S. Krohm, S. Manafzadeh and **J. Wen**. 2016. Phylogenetic placement of *Psilopeganum*, a rare monotypic genus of Rutaceae (the citrus family) endemic to China. *J. Syst. Evol.* http://dx.doi.org/10.1111/jse.12208

Carlucci, M.B., G.D.S. Seger, D. Sheil, I.L. Amaral, G.B. Chuyong, L.V. Ferreira, U. Galatti, J. Hurtado, **D. Kenfack**, D.C. Leal, S.L. Lewis, J.C. Lovett, A.R. Marshall, E. Martin, B. Mugerwa, P. Munishi, Á.C.A. Oliveira, J.C. Razafimahaimodison, F. Rovero, M.N. Sainge, D. Thomas, V.D. Pillar and L.D.S. Duarte. 2016. Phylogenetic composition and structure of

tree communities shed light on historical processes influencing tropical rainforest diversity. *Ecography* http://dx.doi.org/10.1111/ecog.02104

Costion, C.M., A.J. Lowe, M. Rossetto, R.M. Kooyman, M.F. Breed, A. Ford and D.M Crayn. 2016. Building a plant DNA barcode reference library for a diverse tropical flora: an example from Queensland, Australia. *Diversity* 8(1): 5. http://dx.doi.org/10.3390/d8010005

Culley, T.M., C.D. Huebner and **A. Novy**. 2016. Regional and local genetic variation in Japanese stiltgrass (*Microstegium vimineum*). *Invasive Plant Sci. Manag.* 9(2):96-111. http://dx.doi.org/10.1614/IPSM-D-15-00055.1

Fernández-Alonso, J.L., P.A. Fryxell and **L.J. Dorr**. 2016. Malvaceae, pp. 1535-1570. In R. Bernal, S.R. Gradstein and M. Celis (eds.). *Catálogo de Plantas y Líquenes de Colombia 2.* Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogota.

Feuillet, C. 2016. Two new combinations in *Euploca* Nutt. (Heliotropiaceae, Boraginales) and a conspectus of the species of the Guiana Shield area. *PhytoKeys* 61: 101-124. http://dx.doi.org/10.3897/phytokeys.61.6260

Feuillet, C. 2016. Lectotypifications of six taxa in the Boraginales (Cordiaceae and Heliotropiaceae). *PhytoKeys* 62: 95-100. http://dx.doi.org/10.3897/phytokeys.62.6259

Harris, A.J., C. Fu, Q.Y. Xiang, L. Holland and **J. Wen**. 2016. Testing the monophyly of *Aesculus* L. and *Billia* Peyr., woody genera of tribe Hippocastaneae of the Sapindaceae. *Mol. Phylogenet. Evol.* 102: 145-151. http://dx.doi.org/10.1016/j.ympev.2016.06.001

Henkel, T.W., **C.L. Kelloff**, **S.N. Alexander** and **V.A. Funk**. 2016. Smithsonian plant collections, Guyana: 1992–2014, Terry W. Henkel. *Smiths. Contrib. Bot.* 104: vi-206. http://dx.doi.org/10.5479/si.1938-2812.104

Howard, M.G., W.J.F. McDonald, P.I. Forster, **W.J. Kress**, **D. Erickson**, D.P. Faith and A. Shapcott. 2016. Patterns of phylogenetic diversity of subtropical rainforest of the Great Sandy Region, Australia indicate long term climatic refugia. *PloS One* 11(4): e0153565. http://dx.doi.org/10.1371/journal.pone.0153565

Katinas, L., M.P. Hernández, A.M. Arambarri and **V.A. Funk**. 2016. The origin of the bifurcating style in Asteraceae (Compositae). *Ann. Bot.* 117(6): 1009-1021. http://dx.doi.org/10.1093/aob/mcw033

Li, R. and **J. Wen**. 2016. Phylogeny and diversification of Chinese Araliaceae based on nuclear and plastid DNA sequence data. *J. Syst. Evol*. 54(4): 453-467. http://dx.doi.org/10.1111/jse.12196

Martin, M.D., M.T. Olsen, J.A. Samaniego, **E.A. Zimmer** and M.T. Gilbert. 2016. The population genomic basis of geographic differentiation in North American common ragweed (*Ambrosia artemisiifolia* L.). *Ecol. Evol.* 6(11): 3760-3771. http://dx.doi.org/10.1002/ece3.2143

McManus, K.M., G.P. Asner, R.E. Martin, K.G. Dexter, **W.J. Kress** and C.B. Field. 2016. Phylogenetic structure of foliar spectral traits in tropical forest canopies. *Remote Sens.* 8(3): 196. http://dx.doi.org/10.3390/rs8030196

Ochyra, R. and **R.R. Ireland**. 2016. *Isopterygium tenerifolium* (Hypnaceae, Bryophyta) - one more Afro-American disjunct. *Herzogia* 29(1): 72-78.

Osuri, A.M., J. Ratnam, V. Varma, P. Alvarez-Loayza, J. Hurtado Astaiza, M. Bradford, C. Fletcher, M. Ndoundou-Hockemba, P.A. Jansen, **D. Kenfack**, A.R. Marshall, B.R. Ramesh, F. Rovero and M. Sankaran. 2016. Contrasting effects of defaunation on aboveground carbon storage across the global tropics. *Nature Commun.* 7: 11351. http://dx.doi.org/10.1038/ncomms11351

Peterson, P.M. and **R. Soreng**. 2016. A revision of *Poa* subsection *Aphanelytrum* (Poaceae, Pooideae, Poaeae, Poinae); and a new species, *Poa auriculata*. *PhytoKeys* 63: 107-125. http://dx.doi.org/10.3897/phytokeys.63.8198

Rabeler, R.K. and **W.L. Wagner**. 2016. New combinations in *Odontostemma* (Caryophyllaceae). *PhytoKeys* 63: 77-97. http://dx.doi.org/10.3897/phytokeys.63.8181

Rojas-Sandoval, J., E.J. Meléndez-Ackerman and D. Anglés-Alcázar. 2016. Assessing the impact of grass invasion on the population dynamics of a threatened Caribbean dry forest cactus. *Biol. Conserv.* 196: 156-164. http://dx.doi.org/10.1016/j.biocon.2016.02.015

Seberg, O., G. Droege, K. Barker, J.A. Coddington, **V.A. Funk**, **M. Gostel**, G. Petersen and P.P. Smith. 2016. Global Genome Biodiversity Network: saving a blueprint of the Tree of Life – a botanical perspective. *Ann. Bot.* http://dx.doi.org/10.1093/aob/mcw121

Shi, W., **J. Wen** and B. Pan. 2016. A comparison of ITS sequence data and morphology for *Calligonum pumilum* and *C. mongolicum* (Polygonaceae) and its taxonomic implications. *Phytotaxa* 261(2): 157-167. http://dx.doi.org/10.11646/phytotaxa.261.2.5

Strong, M.T. 2016. Three new Cyperaceae from the Cuyuni-Mazaruni Region of Guyana (South America). *Novon* 24(4): 401-407. http://dx.doi.org/10.3417/2015032

Thornhill, A.H., B.D. Mishler, N.J. Knerr, C.E. González-Orozco, **C.M. Costion**, D.M. Crayn, S.W. Laffan and J.T. Miller. 2016. Continental-scale spatial phylogenetics of Australian angiosperms provides insights into ecology, evolution and conservation. *J. Biogeogr.* http://dx.doi.org/10.1111/jbi.12797

Zhang, K.M., Y. Shen, X.Q. Zhou, Y.M. Fang, Y. Liu and L.Q. Ma. 2016. Photosynthetic electron-transfer reactions in the gametophyte of *Pteris multifida* reveal the presence of allelopathic interference from the invasive plant species *Bidens pilosa*. *J. Photochem. Photobiol. B:* 158: 81-88. http://dx.doi.org/10.1016/j.jphotobiol.2016.02.026

Zhang, N., **J. Wen** and **E.A. Zimmer**. 2016. Another look at the phylogenetic position of the grape order Vitales: Chloroplast phylogenomics with an expanded sampling of key lineages. *Mol. Phylogenet. Evol.* 101: 216-223. http://dx.doi.org/10.1016/j.ympev.2016.04.034

Ziska, L.H., J.S. Pettis, J. Edwards, J.E. Hancock, M.B. Tomecek, **A. Clark**, J.S. Dukes, I. Loladze and H.W. Polley. 2016. Rising atmospheric CO_2 is reducing the protein concentration of a floral pollen source essential for North American bees. *Proc. R. Soc. B* 283(1828): 20160414. http://dx.doi.org/10.1098/rspb.2016.0414

Smithsonian
Botanical Symposium

Bawa Receives 14th 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. Highlights from past presentations to the recipients are available at <http://botany.si.edu/cuatrecasas/cuatrecasasMedal.cfm>.

Kenneth Wurdack presents Kamal Bawa with the 14th José Cuatrecasas Medal in Tropical Botany. (photo by Tomas Fer)

Kamaljit [Kamal] S. Bawa is the 14th recipient of the José Cuatrecasas Medal for Excellence in Tropical Botany. He was educated at Punjab University in Chandigarh, India, where he received his bachelor's, master's and Ph.D. degrees. After receiving his Ph.D. in 1967, he came to the United States for postdoctoral appointments, first at the University of Washington and then at the Gray Herbarium of Harvard University. In 1974 he joined the faculty of the University of Massachusetts, Boston, where he has remained and presently is a Distinguished Professor of Biology. He has been a Guggenheim Fellow, Pew Scholar in Conservation and the Environment, Giorgio Ruffolo Fellow in Sustainability Science, and in 2012 was the first laureate of the Gunnerus Sustainability Award from the Royal Norwegian Society of Sciences and Letters. He is a fellow or officer in many scientific societies, including a past president of the Association for Tropical Biology and Conservation (ATBC).

The Cuatrecasas Medal selection committee took special note of Bawa's extensive and often pioneering contributions to tropical biology and international conservation. Of special relevance to this Symposium is his research in reproductive ecology (including pollination biology) and population genetics in both the Old and New World tropics. His more recent contributions have addressed the challenges of biodiversity conservation and sustainability, especially for India and its centers of biodiversity in the Western Ghats and Himalayas. In 1996 he founded the Ashoka Trust for Research in Ecology and the Environment (ATREE), which has developed research and education programs to address key environmental problems in India. He has authored, coauthored, and edited over 200 scholarly articles and 11 books that span a remarkable array of breadth from basic biology to environmental policy in a changing world.

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); and Paulo Günter Windisch from Universidade Federal do Rio Grande do Sul, Brazil (2015).

Abstracts from the Speakers at the 14th Smithsonian Botanical Symposium

The 14th Smithsonian Botanical Symposium, "Bats, Bees, Birds, Butterflies and Bouquets: New Research in Pollination Biology," was held 20 May 2016. The invited keynote speakers explored a variety of topics, from bee diversity and pollen grain evolution to the importance of unseen floral attractants and pollinator response to climate change. Below are the abstracts from the papers that were presented by the keynote speakers.

Speakers, conveners, and award recipients of the 2016 Smithsonian Botanical Symposium at the National Museum of Natural History (from left): Ken Wurdack, Laurence Dorr, Kamal Bawa, Robert Raguso, Tatyana Livshultz, David Roubik, Seán Brady, Candace Galen, Matthew Koski, and Nathan Muchhala. (photo by Tomas Fer)

Sam Droege
USGS Patuxent Wildlife Research Center

"Patterns in pollen and plant specialization among native bees in eastern North America"

The long co-evolution of flowering plants and their insect pollinators has created an abundance of strategies on both sides of the plant/insect equation. Many insects are visitors to flowers and their role as floral visitor from the plant perspective varies from outright thievery to obligate pollinator. Of those insect visitors, native bees are almost entirely unique in that they purposefully gather pollen and nectar to provision nests for their young. The 800 species of native bees east of the Mississippi River in North America have greatly compartmentalized their plant interactions. About 20 to 25 percent are highly specialized, using pollen from at times only one species or genus of plant. Other species are less restrictive in the pollen they use, but still may largely focus on gathering pollen from a single plant family and have only a brief, six-eight week period of flight activity. A smaller number of species, but often the most dominant in terms of individuals present, visit a wide range of plant families, often are social or colonial in life history strategy (but never to the extent that the introduced honeybee has taken social living) and are active throughout the flowering season. Specialized structures in both plants and their bee counterparts are abundant and will be illustrated in this talk along with illuminating broadscale geographic patterns in bee specialization, brief mention of conservation implications for both plants and bees, and presentation of a number of examples of specialized bee/plant pairings.

Candace Galen
University of Missouri

"Shifting baselines and changing partners: Ecological and evolutionary responses to climate change in alpine bumble bees and their host plants"

Bumble bees (*Bombus*) are a key pollinator guild in North America with multiple species in decline. Globally, bumble bees are moving upward in altitude, suggesting alpine regions represent potential thermal refugia from climate change in lower, southern regions of their range. Yet our research over four decades in the Rocky Mountains indicates that as warming continues, these high altitude refugia are themselves likely to be imperiled. In central Colorado (USA), encroachment of woody vegetation near timberline (tundra greening) and reduced flowering of tundra plant communities near the krummholz ecotone has led to landscape scale declines in historically preferred resources for bumble bee foragers. Only in small habitat patches near alpine summits are bees shielded from these negative effects of warming. Over a 500 m altitudinal gradient on Pennsylvania Mountain (CO), past bumble bee host species flower for only 33% of the time span observed in the 1970s. Advancement of flowering phenology with warming is especially pronounced in historically late season host plants, leading to increased flowering overlap among species, causing temporal mismatches between bumble bee colony production and resource availability, and favoring generalized foraging in two long-term resident bumble bee species. Results from pollination experiments suggest that a positive feedback loop links generalized foraging in bumble bees to foreign pollen contamination and impaired seed set of alpine host plants. Using herbarium specimens to reconstruct past trajectories of pollination quality we can test this idea, addressing broad scale impacts of global warming on pollination services.

Matthew Koski
University of Virginia, USA

"The evolutionary ecology of ultraviolet floral pigmentation at micro- and macroevolutionary scales"

The tremendous diversity in flower color has fascinated biologists for decades. Because pollinators are visually perceptive of ultraviolet (UV) color, flower

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Sam Droege (USGS Patuxent Wildlife Research Center) speaks about North American pollen-specialized bees. (photo by Ken Wurdack)

Abstracts

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color patterns in the UV spectrum have particularly sparked interest in pollination biologists. A common UV 'bullseye' floral phenotype has long been held to function as a nectar guide for pollinators, increasing pollination efficiency. I experimentally test how variation in floral UV pigmentation phenotype affects pollinator behavior using phenotypic manipulation, and then address whether pollinators may contribute to UV floral variation in nature using the common plant, *Argentina anserina* (Rosaceae). Pollinators preferentially visit flowers with a distinct UV bullseye pattern, however UV pattern variation does not affect their alighting, or foraging behavior. There is pronounced variation in the size of the UV bullseye in nature, and geographically shifting pollinator preference can contribute to patterns of floral variation across space. While UV pigmentation patterns are variable within species, they also differ substantially among taxa, potentially owing to pollinator-mediated trait divergence. I test whether pollinators may drive phenotypic variation among taxa in the Potentilleae (Rosaceae) tribe using a biogeographically-informed sister taxon analysis. Interestingly, species that co-occur have more similar UV pigmentation phenotypes than those that grow in spatially distinct regions, suggesting a lack of reproductive character displacement for UV pigmentation. Instead, I present data that suggest how selection via abiotic factors (in conjunction with pollinators) may drive variation in UV floral pattern.

Tatyana Livshultz
Drexel University

"Putting milkweeds in context: The evolution and function of pollen aggregation in Apocynaceae"

Pollination is an inefficient process. On average, less than 1% of exported pollen grains are deposited on conspecific stigmas. Pollen transfer is an order of magnitude more efficient (ca. 25% on average) in species with pollen packaged into pollinia, yet pollinia have evolved in only two families, Orchidaceae and Apocynaceae, indicating strong fitness costs under most ecological conditions. I develop the hypothesis that pollinia and elevated pollen transfer efficiency are adaptations to conditions of strong mate-finding Allee effects and high levels of interspecific competition for pollination, allowing plants to continue outbreeding, but at the cost of drastic reduction in the number of mates. Apocynaceae, with ca. 5000 species, have a diversity of floral morphologies and degrees of pollen aggregation, including monads, tetrads, and pollinia, making them an ideal lineage to investigate the evolution of pollen aggregation and its adaptive value using the comparative method. By placing both direct measures of pollen transfer efficiency and a correlated trait (pollen-to-ovule ratios) in a phylogenetic context, I show that pollinia evolved in an ancestral flower that already had functionally aggregated and highly efficient pollen transfer. However, power analysis indicates that the sample size is not yet adequate to detect if Apocynaceae with pollinia (milkweeds) have significantly more efficient pollen transfer than those without. Comparative climate niche analysis links the origin of pollinia to ecological conditions generated by the aridification of Africa during the Cenozoic, consistent with the hypothesis that ecological adversity has selected for the evolution of efficiency.

Nathan Muchhala
University of Missouri – St. Louis

"Bats, birds, and bellflowers: The evolution of specialized pollination systems in the Neotropics"

Animal pollination is thought to have played a central role in angiosperm diversification, especially in the tropics, where over 98% of plants are animal-pollinated. Research in my lab combines experiments and theory to explore the ecology and evolution of plant-pollinator interactions, with a focus on bat pollination in the Neotropics. In this talk I begin by discussing research on an unusual species of nectar bat which can launch its tongue 1.5 times its body length, an extension more than double that of other bats and longer than any other mammal. Unique adaptations allow it to store its tongue in its rib cage. Experiments suggest that this bat is involved in a coevolutionary race with long-tubed flowers; tongue elongation allows bats to reach more nectar, while flower elongation maximizes pollen transfer. In the second part of the talk, I present evidence for two cases of character displacement in response to competition for pollination. The first involves overdispersion in flower morphology: co-occurring *Burmeistera* were found to place their pollen in different regions of bats heads', thus maximizing conspecific pollen transfer despite sharing bats as pollinators. The second involves overdispersion in flower color: co-occurring *Iochroma* were found to differ significantly in color, as perceived by their primary pollinators (hummingbirds and bees), relative to random expectations. I end the talk with a brief

overview of other ongoing projects in the lab. Together, this research shows some of the ways that coevolution and competition have shaped the highly specialized pollination systems found in the tropics.

Robert Raguso
Cornell University

"Floral scent: The dark matter of plant-pollinator interactions"

Flowers are not merely objects of aesthetic beauty; they serve as engines of biological diversity, lynchpins of ecological stability and fonts of human ecosystem services from agriculture and floriculture to cosmetics. Botanists have long been dazzled by the visual aspects of floral display (color, shape and pattern). In contrast, the chemical aspects of floral function, from the scents that guide pollinator attraction and learning to the composition of the nectars, resins and oils that reward their visits, somehow remain peripheral to the central bodies of ecological and evolutionary theory concerning pollination. However, recent technological and conceptual advances have made it easier to analyze and manipulate floral chemistry, particularly floral scent, and a growing body of evidence points to more central roles for scent in mediating floral isolation, constancy, gene flow and defense. I will highlight several recent manipulative studies, in which visual signals were tracked and controlled, to illustrate the unexpected roles played by scent in otherwise well-studied model systems. Floral scent provides critical mechanisms that explain conditional reproductive isolation among sympatric *Ipomopsis aggregata* and *I. tenuituba*, balance floral defense and pollinator-mediated selection on floral form in *Polemonium viscosum*, and dictate the network structure of floral visitors to generalized pollinator hubs such as *Cirsium arvense* and *Achillea millefolium*. In addition, I will explore our current knowledge of geographic variation in floral scent - the potential for local scent dialects - in the context of the Geographic Mosaic Theory of Coevolution, with reference to an ongoing study on the genus *Oenothera*.

David W. Roubik
Smithsonian Tropical Research Institute, Panama

"Whose bees are these? The pollen taxonomy of bee nests and its story in recent decades"

We need to know more about why the populations of our bees go up and down, and a good deal more about what makes those bees in the first place. Making a pollen reference collection to a particular flora is both time-consuming and rewarding. For bee ecology, there is no greater source of detailed information. We have characterized honey origins from its pollen content, and pollen in orchid bee and solitary bee nests—without barcoding—but with replicated work. Our studies can, in contrast to all but a very small number of places that have established molecular reference libraries to the local flora, usually identify pollen grains to species. Armed with this insight, we can begin to picture the consumer's dilemma (for a bee) and plant community efforts to obtain pollination service and reproduce.

An early question that motivated our building of two reference pollen libraries, one for Panama and one for the Yucatán Peninsula of Mexico, was the escape and explosive range extension of African honeybees in the Neotropics. What do they eat, and which plants are primarily responsible for sustaining them? By quantifying their pollen taken to hives, and also pollen ingredients of their honey, we saw striking evidence that many primary forest resources of the invasive honeybees are trees, and often not pollinated by bees, but yielding huge surpluses of nectar and pollen for "cleanup" organisms, such as social bees and their colonies. Much of their food was "leftovers" from nocturnal flowers designed to feed and attract larger animals, like bats or moths. We documented the decline of native bee resource use when displaced by the invasive honeybee, but saw rapid 'resource partitioning', as local bees escaped food competition with the invader. We also witnessed subsequent growth of tree populations pollinated by the honeybees, and a boom in native bee resources that were offered via honeybee pollination services. Some solitary bees, on the other hand, did not respond to the Africanized bee invasion, but maintained their broad relationship with flowering plants that sustain them, in remarkably flexible fashion, and in the face of long-term climate changes and hurricanes. Our primary conclusion is that the wide diversity in native vegetation, particularly in the tropics (and also in the Washington, DC area), insures that flower visitors can adjust to and survive the tests of floral resource availability and other challenges.

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creativity and curiosity. His research on Barro Colorado Island, a 1,560-hectare island in the Panama Canal, makes use of botanical knowledge, reference collections, photographs, and field and laboratory work. Among his studies are orchid bees, honey bees, Africanized honey bees, *Centris* bees, and megachilids.

Roubik's pollen research has also included studies of honey bee competition with native bees. A 17-year study from the Yucatan Peninsula in Mexico shows the impact of invasive Africanized honey bees on solitary megachilid bees. He found honey bees may have forced the native bees to switch their food plants. Pollen from plants in the families Euphorbiaceae and Anacardiaceae were present in lower amounts in megachilid nests after honey bee invasions, while Sapotaceae, Fabaceae, and Rubiaceae pollen were present in great amounts in the same nests.

Tatyana Livshultz (Drexel University) continued the focus on pollen with her talk, "Putting milkweeds in context: The evolution and function of pollen aggregation in Apocynaceae." Livshultz studies the structural and functional diversity of

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pollen. The most common type of pollen aggregation are tetrads, 4 pollen grains dispersed as a unit. Orchidaceae and Apocynaceae have pollinaria, two or more pollinia (entire pollen content of an anther sac fused into a mass) attached at a translator. Livshultz showed that aggregated pollen and translators evolved three times independently within Apocynaceae.

Livshultz demonstrated how aggregation affects pollen performance through measures of pollen transfer efficiency (PTE), the fraction of exported pollen grains that reach conspecific stigmas. She discussed how milkweed pollinarium evolved in an ancestor that already had functionally aggregated pollen and high PTE. The evolution of the pollinarium further elevated PTE. She explained that current evidence does not indicate that evolution of the gynostegium nor tetrads and translators in Apocynum and Periplocoideae elevated PTE. Finally, Livshultz put milkweeds in a paleoecological context and explained that drought-induced mortality of plants and pollinators during early Oligocene aridification of Africa may have created the selective pressure for evolution of increased PTE and pollinaria in milkweeds.

The next two speakers spoke about unseen floral attractants—scent and ultraviolet pigmentation. First was Robert Raguso (Cornell University) who discussed "Floral scent: The dark matter of plant-pollinator interactions." Raguso explained that in studies of the structure of plant-pollinator networks, floral scent is almost never mentioned, yet it can be just as important as visual and tactile patterns. He showed how scent can affect seed fitness and structure floral networks through attraction and repellence. In one study floral fragrances of *Cirsium arvense* and *Achillea millefolium* were swapped, and the links between insect visitors to the two plant species were restructured until the scents dissipated. In *Penstemon digitalis*, where the corolla limb is scentless and the nectar tube has volatiles, Raguso showed how floral scent emission and floral display were under selection, and flower size and color were not. This suggests that smelling stronger benefits reproductive success in this flowering species.

Raguso also explained how scent can help integrate complex floral phenotypes and mediate reproductive isolation through attraction, preference and constancy. *Dracula lafleurii*, an orchid species from Ecuador, is pollinated by flies that breed in mushrooms, and *Dracula* flower parts resemble mushrooms. In a study using 3d-printed silicon models of *Dracula* flowers, Raguso was able to tease apart visual, olfactory, and tactile responses in which a combination of the three gets the best response by flower visitors. A study examining visitation by *Hyles lineata* hawkmoths to scent-augmented and color-swapped *Ipomopsis* flowers demonstrated that moths require both scent and high visual contrast to feed on flowers at dusk. He concluded by stressing the importance of scent combined with visual traits in pollination studies.

Matthew Koski (University of Virginia) followed with a talk on "The evolutionary ecology of ultraviolet floral pigmentation at micro- and macroevolutionary scales." Ultraviolet (UV) pigmentation leading to a bullseye pattern has been found in at least 23 of 62 angiosperm orders. Koski's research focused on how UV bullseye mediates pollinator behavior and if pollinators or abiotic factors contribute to UV variation. He showed that insects are more attracted to UV bullseye in *Potentilla anserina*, that the UV pattern, not the reflection, increases attractiveness, and that the bullseye does not serve as a nectar guide.

The pollinator communities of *Potentilla anserina* change with altitude (bees predominantly at lower altitudes and flies at higher altitudes), as does the bullseye size (larger bullseye at higher altitudes). Koski found that by manipulating the size of the bullseye at low and high altitude sites, both bee and fly preference for bullseye shifted with altitude. Plants with larger bullseyes received more visits and pollen by both pollinators at higher altitudes, while plants with smaller ones received more pollen at lower sites. In terms of abiotic factors, he found that larger bullseyes protect pollen from UV-damage. Looking at macroevolutionary patterns of diversity in the genus *Potentilla*, Koski explained that the UV bullseye is larger in more alpine species which experience higher UV-irradiance and cooler temperatures. He concluded that while pollinators are important in driving variation among populations of *Potentilla*, it is the abiotic factors that drive diversity at both micro- and macroevolutionary levels.

Moving the discussion from insect to vertebrates, Nathan Muchhala (University of Missouri-St. Louis) discussed "Bats, birds, and bellflowers: The evolution of specialized pollination systems in the Neotropics." To examine bat-flower coevolution, Muchhala examined the efficiency of bat tongue at extracting nectar and the ability of bats to transfer pollen. He showed how tongue length varies among three bat species, with *Anoura caudifer* and *A. geoffroyi* having short tongues (3.7 cm and 3.9 cm, respectively) while *A. fistulata* have long tongues (8.5 cm). The diet of *Anoura fistulata* includes many plant species, but not the short corolla *Burmeistera*. In pollen transfer experiments in the field, Muchhala showed how angle and depth are more important than duration and force –bats lift their heads for deeper feeding which led to greater transfer of pollen. He argued that *Anoura fistulata* appears to have evolved its incredibly long tongue through coevolutionary races with long-tubed flowers.

Muchhala also spoke on interspecific competition (plants competing for pollinators), floral character displacement,

Acknowledgements

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

Organizers
- Laurence J. Dorr,
- Seán Brady
- Gary Krupnick
- Sue Lutz
- Ari Novy
- Sylvia Orli
- Susan Pell
- Eric Schuettpelz
- Holly Shimizu
- Warren L. Wagner
- Kenneth Wurdack
- Elizabeth Zimmer

Support
- Mary Ann Apicelli
- Carol Youmans

Photographer
- Kenneth Wurdack

And many others who had helped in a myriad number of ways.

and evolution. He discussed his research on overdispersion of color in *Iochroma*, a hummingbird- and bee-pollinated genus of 33 species of shrubs and small trees throughout the Andes. Looking at color differences, phylogenetic distances, and differences in plant morphology (lengths of petiole, leaf, and pedicel), Muchhala asked whether coexisting communities of species differ more than expected by chance. He found that hummingbird and bee pollinators are driving the difference in color among the species, and that there is ongoing selective pressure among the plant species to be different in color as much as possible to reduce the costs of receiving pollen from close relatives.

The talks concluded with a presentation by Candace Galen (University of Missouri) who spoke about "Shifting baselines and changing partners: Ecological and evolutionary responses to climate change in alpine bumble bees and their host plants." To examine the impacts of global climate change on plant-pollinator relationships, Galen conducted field studies at three sites in the Colorado Rocky Mountains where overnight lows are on average 2°C warmer and flower production has seen a 60 percent decrease since the 1970s. Galen examined whether *Bombus* species are broadening their food choices. She found that the foraging breath of bumble bees has more than doubled, and that flower shape of host plants has also broadened—many short-tubed flowers are now among those they visit.

Since bees with shorter tongue (proboscis) lengths have a wider breath of food choices, Galen hypothesized an evolutionary shortening of tongue length due to warmer summers and reduced host plant flower abundance. She showed that among museum specimens of *Bombus balteatus* and *B. sylvicola*, tongue length has decreased by 25 percent, demonstrating strong selection and rapid evolution within 40 generations of these species. Galen explained that the silver lining to global climate change is that these pollinators have been able to adapt rapidly to changing resources. However, reproductive success of host plants still need to be measured. As diets of these bumble bees have broadened, Galen asks how the change in vegetation will impact pollinator dynamics and whether pollen contamination will be a result of competing bee species visiting competing plant species.

Poster presenters and guests interact at the opening reception of the Smithsonian Botanical Symposium. (photo by Ken Wurdack)

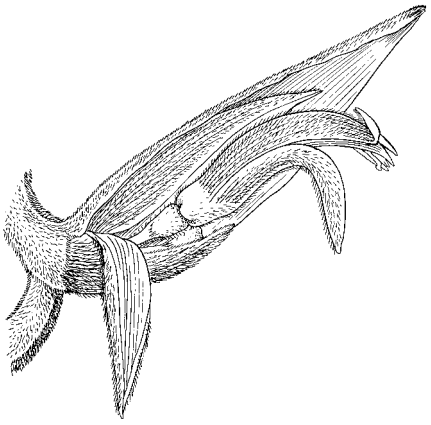
The Symposium ended with a reception and poster session in the Conservatory of the United States Botanic Garden. A group of 14 presenters displayed their posters and spoke about their research ranging in topics from floral rewards and the diet of hummingbirds and bats to honey bee health and the conservation of endangered species.

Next year's 15th Smithsonian Botanical Symposium will take place on Friday, May 21, 2017, with a theme yet to be determined. Be sure to check the symposium website at <http://botany.si.edu/sbs> for updates.

Supplementary Symposium Links on the Web

The website to the 14th Smithsonian Botanical Symposium <http://botany.si.edu/events/sbsarchives/sbs2016/> has many links and documents related to the conference. Included on the website is the full program, abstracts of the talks, links related to the speaker's presentations, and selected images from the various events. Additional items related to the Symposium can be added to the list of links and documents by sending an e-mail to sbs@si.edu.

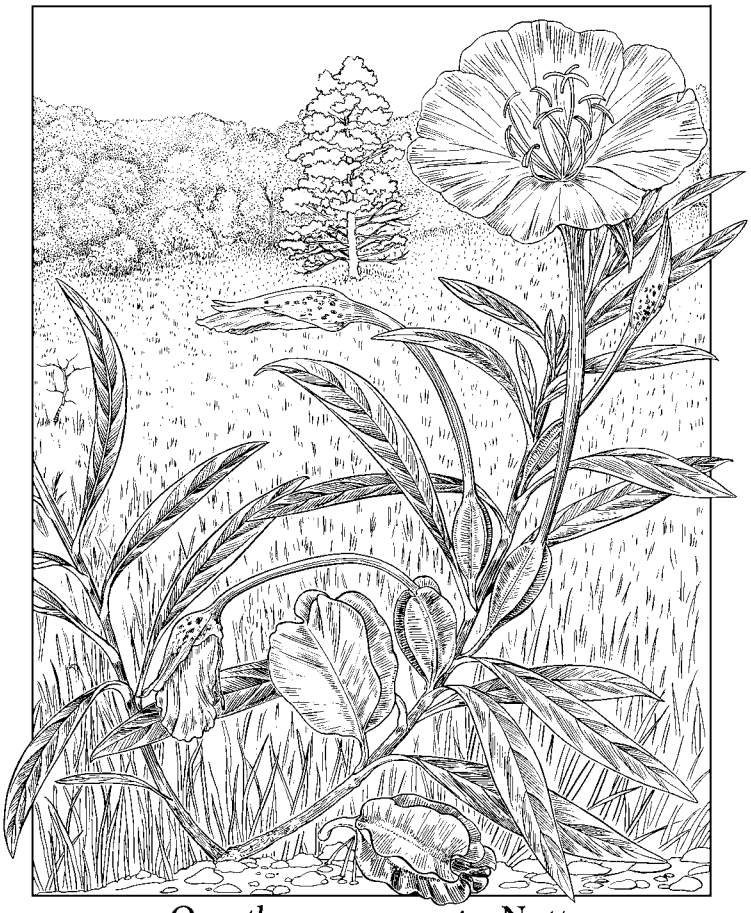
The Symposium archive page <http://botany.si.edu/events/sbsarchives/> also includes programs, abstracts and images from the past 13 symposia: "Linnaean Taxonomy in the 21st Century" (2001); "The Convention on Biological Diversity" (2002); "Botanical Frontiers in Southeast Asia" (2003); "Botanical Progress, Horticultural Innovations, and Cultural Changes" (2004); "The Future of Floras: New Frameworks, New Technologies, New Uses" (2005); "Island Archipelagos: Cauldrons of Evolution" (2006); "Partners in Evolution: Interactions, Adaptations, and Speciation" (2008); "Genes, Genomics and Genome Evolution in Plants" (2009); "Food for Thought: 21st Century Perspectives on Ethnobotany" (2010); "Transforming 21st Century Comparative Biology using Evolutionary Trees" (2012); "Avoiding Extinction: Contemporary Approaches to Conservation Science" (2013); "Location, Location, Location... New Advances in the Science of Biogeography" (2014); and "Next Generation Pteridology: An International Conference on Lycophyte & Fern Research" (2015).



Art by Alice Tangerini

Oenothera macrocarpa Nutt.

At the 2016 Smithsonian Botanical Symposium, speaker Sam Droege (U.S. Geological Survey) talked about pollen specialist bees which have evolved obligate associations with flowering host plant genera. *Oenothera* is a recurrent host plant genus associated with specialist bee species in the United States. *Oenothera macrocarpa* is a known host plant for the sweat bee, *Lasioglossum oenotherae*. Alice Tangerini illustrated *O. macrocarpa* for a T-shirt design for the Botany 2011 conference in St. Louis, Missouri. The type locality for this species is along bluffs along Meramec River near the Shaw Nature Reserve of the Missouri Botanical Garden. This species was selected for the shirt since the meetings were in St. Louis, and Missouri Botanical Garden director Peter Raven and his students worked on Onagraceae. The drawing began as a pen and ink illustration based on US herbarium specimens and field photographs. Digital color was added for the shirt logo.



Oenothera macrocarpa Nutt.

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