Department of Botany & the U.S. National Herbarium

The Plant Press

Smithsonian
National Museum of Natural History

New Series - Vol. 15 - No. 3 July-September 2012

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Botany Profile

Letting the Phylogeny Genie Out of the Bottle

By David Erickson

On April 20-21, the Department of Botany at the Smithsonian Institution convened the 10th Smithsonian Botanical Symposium, hosted by the Department of Botany in collaboration with the United States Botanic Garden. This year's symposium titled "Transforming 21st Century Comparative Biology using Evolutionary Trees," examined the development and application of phylogenetic methods in light of the massive advances in sequencing and genomic technology. Warren Wagner, Chair of the Department of Botany, opened the symposium by welcoming speakers and guests. He then provided an introduction into the Department of Botany and background on symposium subjects in the past. Wagner acknowledged the critical and ever-growing importance that phylogenies play in modern biology.

Jonathan Coddington introduced the scope of investigation at the Smithsonian Institution to the many guests and speakers. He covered tremendous territory highlighting the diversity of research at the Institution with special emphasis on Institution wide projects. These projects include the Global Genome Initiative (GGI) which seeks to collect and curate one representative of all living genera, the Smithsonian Institution Global Earth Observatories (SIGEO) which is a global network of long-term, large-scale forest research plots and an international group of scientists dedicated to the study of tropical and temperate forest function and diversity, and its marine counterpart Marine Geo which seeks to quantify marine diversity through a network of marine research stations.

Following Coddington's whirlwind tour of the diversity of research at the institution, Lawrence Dorr then introduced the recipient of the 10th José Cuatrecasas Medal for Excellence in Tropical Botany. This year's winner was Walter S. Judd, a Professor of Botany at the University of Florida at Gainesville. Judd is one of the world's experts in the Ericaceae, has a strong interest in the Melastomataceae, and has been one of the principals in the "Generic Flora of the Southeastern United States" project. Judd was pleased and honored to accept the award and spoke about his many enjoyable times climbing the mountains of the West Indies.

Smithsonian Botanical Symposium

Kenneth Wurdack then convened the symposium introducing the desire by the organizing committee to showcase how phylogenetic methods have changed, and also how the increasingly powerful phylogenies are being applied to answer hypothesis driven questions. First in the list of speakers was Scott Edwards from Harvard University. Edwards effectively threw down the gauntlet asserting that the traditional methods for analyzing data to infer phylogenies was inadequate to answer the most challenging of questions. Edwards forcefully advocated methods that employ coalescent approaches to investigating multigene phylogenies, particularly as the volume of data vastly expands in the genomic era. This is in contrast to methods that take a "total data" approach and hope the correct phylogenetic signal is contained within as a kind of average among the data. Edwards' presentation served as the perfect introduction to get the audience thinking about how we build phylogenies, and how thinking carefully about data analysis remains a critical question as we may be tempted to assume that genome scale data will intrinsically solve all phylogenetic questions.

Following Edwards was Charles Delwiche from the University of Maryland, whose work has indeed sought to tackle some of those big questions in phylogenetics and plant biology – namely the origin of plants from their algal ancestors. The incredibly deep divergences and the loss of lineages through extinction have made elucidation of the most direct ancestors of plants a challenge. Delwiche, however, showed that modern genomic data has indeed contributed to our understanding of the evolution of modern land plants, particularly by identifying components of land plant physiology that are shared with algae – thus providing a functional genomic link between the groups.

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Travel

Pedro Acevedo traveled to Mayaguez, Puerto Rico (6/22 – 6/29) to participate in a workshop on the red listing of the flora of Puerto Rico and the Virgin Islands.

Walter Adey traveled to Newfoundland, Canada (5/26 – 5/30) to present a paper on corallines and climate archives to the Geological Association of Canada.

David Erickson traveled to Manaus, Brazil (6/4 – 6/12) to attend a workshop on Tropical Amazonian Biodiversity sponsored by the Center for Tropical Forest Science (CTFS).

Robin Everly traveled to Montreal, Canada (6/26 – 6/29) to present a talk and serve as Board President at the 44th Annual Meeting of the Council on Horticultural and Botanical Libraries (CBHL).

Linda Hollenberg traveled to New Haven, Connecticut (6/10 – 6/17) to attend the annual meeting of the Society for the Preservation of Natural History Collections (SPNHC).

Carol Kelloff traveled to Morgantown, West Virginia (4/13 – 4/16) to meet with staff at the West Virginia University Herbarium; to New Haven, Connecticut (6/10 – 6/16) to attend the annual meeting of the Society for the Preservation of Natural History Collections (SPNHC); and to Queens, New York (6/23 – 6/24) to assist the Biological Diversity of the Guiana Shield (BDG) program in getting supplies, equipment, and plants to the US National Herbarium.

W. John Kress traveled to Keshena, Wisconsin (5/2 – 5/4) to meet with collaborators at the College of Menominee Nation to determine the next steps in designing and implementing the Indigenous Global Earth Observatories project for biodiversity and cultural monitoring; to Dominica (5/17 – 5/28) to conduct field work on *Heliconia* and their hummingbird pollinators; and to Bonito, Brazil (6/13 – 6/23) to attend and coordinate the annual meeting of the Association for Tropical Biology and Conservation as Executive Director.

Paul Peterson and **Robert Soreng** traveled to Dar es Salaam, Tanzania (5/1 – 7/11) to collect grasses and other plant materials throughout the country.

Rusty Russell traveled to San Francisco, California (5/15 – 5/19) to present at a workshop on citizen science at the California Academy of Sciences; to Gainesville, Florida (5/28 – 5/30) to participate in a workshop on digitization workflows for the iDigBio Program; and to New Haven, Connecticut (6/10 – 6/16) for the annual meeting of the Society for the Preservation of Natural History Collections (SPNHC) to present a paper and moderate a session on archives and special collections.

Laurence Skog traveled to New Haven, Connecticut (5/11 – 5/12) to visit the herbarium at Yale University (YU) to examine and annotate specimens of Gesneriaceae, especially collections of Charles Wright from Cuba.

Alain Touwaide and **Emanuela Appetiti** traveled to Kenmore and Seattle, Washington (5/14 – 5/23) to give seminars, classes, and public lectures on the history of medicine, ethnobotany and ethnomedicine at Bastyr University, to visit the University of Washington (UW) Medicinal Garden and the UW Health Science Library, and to meet with faculty of the UW Department of Classics.

Kenneth Wurdack traveled to Georgetown, Guyana (5/5 – 6/23) to collect plants; and to Davis, California (6/27 – 7/4) to conduct Euphorbiaceae research related to the University of California at Davis herbarium collections and the work of the late Grady Webster.

The Plant Press

New Series - Vol. 15 - No. 3

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Visitors

Carlos García-Robledo, Smithsonian Fellow; Plant-herbivore interactions (7/20/10-7/20/12).

Ying Meng, Kunming Institute of Botany, China; Polygonaceae (1/9/11-8/31/12).

Iliana Lang, Bethesda, Maryland; Plant conservation internship (9/12/11-5/18/12).

Liu Qiuqun, Huazhong Agricultural University, China; Vitaceae (9/15/11-9/15/12).

Yoomi Park, Konkuk University South Korea; Pacific *Peperomia* (Piperaceae) (10/1/11-8/31/12).

Suzanne Nagi, University of Illinois at Urbana-Champaign; *Trientalis* (Myrsinaceae) (11/1/11-6/30/12).

Rubens Coelho, State University of Campinas, São Paulo, Brazil; Sapindaceae (11/14/11-11/14/12).

Audrey Wilde, McLean, Virginia; DC Flora internship (1/9-8/1).

Colleen Allen, University of Durham, United Kingdom; U.S. Exploring Expedition (3/20-4/19).

Rodrigo de Stefano, Centro de Investigación Científica de Yucatán, Mexico; *Pithecellobium* (Fabaceae) (4/1-4/8).

Thomas Haug, U.S. Coast Guard; Herbarium tour (4/6).

Dean Papavassiliou, World Bank; Ancient Greek medicine (4/10).

Xiuqin Ci, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences; DNA barcoding internship (4/10-6/10).

Andrew Henderson, New York Botanical Garden; Arecaceae (4/13).

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Getting Better All The Time

Editor's Note

On a 100 degree Monday afternoon in D.C. this summer, Lauren Scangarella is comfortably ensconced in a fifth floor office inventorying and curating Hawaiian specimens. Emmie Miller and Julia Quigley are in the Botany Library researching historical expeditions. Kelly Friend is peering into a microscope to collect character data on *Commelina*. And Catherine Cox is leaning over the Zeutschel scanner making digital images of Ray Fosberg's field books. However, beating the heat is the last thing on their minds.

Every year, hundreds of college undergrads and graduate students apply to participate in activities in the Department of Botany that are aimed at every aspect of our collections, research and outreach programs. Choosing among them may be one of the most difficult things we do. These students are consistently competent, highly intelligent, and motivated. They bring a youthful enthusiasm that is lacking most of the rest of the year. For three months every year, the energy level in the Department spikes to unreal heights. And by the end of the summer, the cumulative product of their work contributes to Botany's goal of "getting better" vs. "getting by"—in every program. But this doesn't happen by chance.

In 1986, the Department of Botany developed the first organized intern program in the Museum by recruiting students to assist with collections projects. Eventually, this model was adopted by the Museum for both collections and research projects and today it supports all the Museum's research, collections, education, exhibits and administration functions. In Botany, intern projects are proposed, and students are recruited, by research and collections staff, collaborators—even volunteers (thanks, Jim Harle!). Many of these projects are "advertised" online by Mary Sangrey, the Museum's coordinator of intern activities and a former Botany intern. Others are the result of serendipitous connections made with Botany staff because these students are self-selecting. That is, they possess the drive to seek out and secure opportunities that will support their career objectives.

But internships in Botany are not examples of indentured servitude. They are also about learning and developing new skills. I've always been impressed that Botany staff members take the time to ensure that students actually learn and grow through their time here. And, in my experience, the learning is reciprocal when you take the time to check in, listen, and provide personal guidance. The knowledge that we have been a positive influence on hundreds of students over the years is a great legacy and personal reward. Indeed, Lauren Scangarella says "everyone tells me Botany is the best place to intern." And the results are impressive. Some interns have gone on to doctoral programs, some have found their way in museum careers, and some are currently employed by the Smithsonian!

We welcome and celebrate the summer interns of 2012!

- Rusty Russell, guest contributor
  Collections Manager

A partial list of the 2012 summer interns hosted by the Department of Botany (listed by supervisor and project):

Pedro Acevedo
Classification of *Paullinia*
- Joyce Cherry, Cornell University

Deborah Bell
Herbarium Curation
- Andrea Hall, Bowling Green State Unviersity
- Mahima Iyengar, University of Michigan

Andrew Clark
Seeds of Success
- Chantal Cough-Schulze, Oregon State University
- James Hancock, Roger Williams University
- Leah Isaman, Northwestern University
- Gaia Khairina, Clark University
- Meghan Studer, Lynn University

Robert Faden
Anatomy of Commelinaceae
- Kelly Friend, Adrian College

Jim Harle
Maps
- Eleonore Dixon-Roche, Carleton College
- Benjamin Durham, University of Massachusetts
- Amanda Lee Magoffin, Logan College
- Zenya Molnar, Mt. Holyoke College
- Megan Wilmes, Northern Virginia Community College

Elaine Haug
Informatics
- Bryan Piatkowski, Roanoke College

Linda Hollenberg
Herbarium Curation
- Alanna Coogan, Marist College
- Ellen Danford, Stanford University

Nancy Khan
Flora of Hawaii
- Lauren Scangarella, New York

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Staff Research & Activities

Walter Adey and Karen Adey were principal players in the development of the Phycological Society of America's booth at the Science and Engineering Fair in Washington, DC, on 27-29 April. Visitors to the booth received algae book marks, participated in alginate-based gel making, and interacted with a team of 12 scientists. The purpose of the PSA booth was to inform students and the public about the critical roles algae play in the Earth's ecosystems and the ways micro and macro algae are being and could be used by industry. A centerpiece of the PSA Booth was a 35-minute video produced by Karen Adey that brought together a wide range of video segments describing a range of algal research emphasizing some of the exciting applied work on food, biofuels and water clean-up currently underway. Walter Adey's climate archive and Algal Turf Scrubbing research were among the video clips included.

On 9-11 May, **Emanuela Appetiti** met with independent scholar Andrew Bray (Canberra, Australia) to show him the U.S. National Herbarium specimens collected during the *American-Australian Scientific Expedition to Arnhem Land* (AASEAL, 1948). Bray is the son of John E. Bray, one of the members of the AASEAL. Andrew is editing his father's journal, which he hopes to publish by 2013. Appetiti has been involved in the study and analysis of this expedition for several years, working closely with her Australian colleagues. During the week, Bray visited the U.S. National Herbarium, the Mammal division at the Museum, the Reptile and Amphibian Collections at the SI Museum Support Center (MSC), and the National Anthropological Archives, which all preserve specimens and documents related to AASEAL. Bray also delivered a lecture on 11 May.

On 18 May, **Gary Krupnick** participated in the Endangered Species Day Fair at the U.S. Botanical Garden (USBG). The event, hosted by USBG, the U.S. Fish & Wildlife Service, and the Endangered Species Coalition, included tours of USBG's endangered and native plants, visits with exhibitors from federal agencies and conservation organizations, and demonstrations about what can be done at home to protect native plants. Krupnick hosted a booth displaying U.S. National Herbarium specimens of rare and endangered species from the U.S. and abroad.

On 23 April, the Smithsonian Institution hosted "Smithsonian Day" for the 2012 State Teachers of the Year. The Teachers of the Year represent all grade levels and disciplines and come from each of the 50 states, the District of Columbia, and U.S. territories. As part of their week-long program, these 56 outstanding educators come to the Smithsonian for a day-long in-service to learn more about the educational resources provided by the Smithsonian and to take part in behind-the-scenes activities which highlight the research, exhibition development, and interpretation that take place throughout the Institution. The Department of Botany, teaming with Smithsonian Environmental Research Center (SERC), offered a break-out session: "A Study of Plants & Trees: Collection, Collaboration and Conservation." The event, led by Josh Falk (SERC), **Gary Krupnick, Hilary Cochard, Deborah Bell**, **Greg McKee**, and **Alice Tangerini**, engaged the teachers with stories about specimens from the U.S. National Herbarium, demonstrations of specimen pressing and mounting, insight into the art of botanical illustration, and an introduction to the Smithsonian Institution's Tree Banding Project, a citizen science program that is the first global observatory of how trees respond to climate.

The 2012 Biodiversity Academy took place at the National Museum of Natural History during the week of 25 June. The program is conducted annually to join teachers from across the US in activities to enhance teacher understanding of plant and animal biodiversity concepts. During the week, the teachers participated in hands-on activities and presentations to strengthen their own curriculum in the schools they teach. On 27 June, **Gary Krupnick** presented a lecture on plant conservation and a tour of the U.S. National Herbarium.

Alain Touwaide delivered a lecture on 4 April at St. John's College, Annapolis, Maryland, on the tradition of medicinal plants knowledge in the Mediterranean.

Awards & Grants

Walter Adey was awarded the Darbaker Prize by the Botanical Society of America and the Phycological Society of America. The award was established by Leasure K. Darbaker who bequeathed funds to the Botanical Society in 1952 to recognize individuals working in the area of "Microscopical Algae."

Botany Round-Up

By Emily Hunter and Rusty Russell
Adapted from the Field Book Project Blog <http://nmnh.typepad.com/fieldbooks/>

Last summer, Field Book Project staff and interns began to catalog the hundreds of field books that are in the care of the Department of Botany. This summer, the Field Book Project has reached a significant milestone. As of this writing, the final collection of Botany field books is being cataloged – at least for now. "*At least for now*" because while the current cache of Botany field books has been documented they, like all of the collections at the National Museum of Natural History, grow and diversify. Field books are still being "found", and some day current staff will contribute their own field books. For now, the Field Book Project only catalogs the field notes of inactive collectors.

The numbers are far greater than the original estimates. To date the Field Book Project has cataloged **1,018 botanical field books** created by **168** field biologists. Many of these field books have received special conservation attention from experts at the SI Archives, and now exist in a more controlled environment. We've created consistent records and access points that ultimately make the field books and their content more accessible to researchers. The short version? You will have an easier time finding and using these field books.

In 1980 former Botany Librarian Ruth Schallert prepared an inventory of field books being stored in the Botany Library. For more than two decades, this listing was the only electronically available field book resource on the NMNH website. In the course of cataloging, however, we have found that some of the field books were missing. Their current storage in the Natural History Library improves our ability to maintain and preserve the Botany

field books. The task of digitally scanning field books has begun, and soon researchers will be able to locate field book items through the catalog by several access points (dates, creator, locality, and others) *and* be able to see and read the individual field book pages.

Field books are the original source of information for collecting activities and the resulting collections. They are, therefore, even more important than specimen labels. The impact of reaching this milestone in Botany is significant in terms of improved access to this critical data, all of which bodes well for research and collections programs in the Department.

Field Book Project and YES!

The Field Book Project welcomed 25 students from the Smithsonian YES! (Youth Engagement through Science) summer program into the National Museum of Natural History Main Library stacks to view field books from the Department of Botany. During their internships, YES students will create their own field notes while working with a variety of Smithsonian scientists.

Field Book Project field book lesson plan served as one major resource for Forensic Anthropology Lab Educator Nicole Webster, who developed an introduction to the concept of field notes for the students and activities involving photocopied examples of exemplary field notes. The purpose of the YES students' visit was to now see original examples of field notes that reinforced the concepts they had learned in their introduction from the previous day.

Students explored nine original field books created between 1897 and 1946, each field book highlighting different aspects of note taking such as format (journals, lists, photos) and types of information like physical characteristics, localities, environmental and contextual information, co-occurrence, and cultural. Botanists whose field books were on view included Charles Boynton, Raymond F. Fosberg, David Griffiths, William J. Fisher, Edmund Sheldon, Edward Palmer, and André Goeldi.

2012 Cuatrecasas Travel Fellowships

This year the Department of Botany was fortunate to be able to offer support to six Latin American students to come and use the U.S. National Herbarium for their research between now and May 2013. The award is intended to support work in the spirit of the research of José Cuatrecasas and it is open to all who would benefit from studying tropical plants in the collection. The following six students were selected this year:

Italho Coutinho, Federal University of Viçosa, Brazil, "Leaf anatomy as an additional tool to the taxonomy of the genus *Chamaecrista* (Leguminosae – Caesalpinioideae)"

Bruno Amorim, Federal University of Pernambuco, Brazil, "*Myrcia* (Myrtaceae) of the Atlantic Forest in northeastern Brazil"

Fabián Medina, National University of Colombia, Colombia, "*Ficus* subgenus *Urostigma* (Moraceae)"

Jorgé Pérez-Zabala, University of California at Davis, "The diversification of the New World evergreen species of *Prunus*: Linking form, function and environment through evolutionary time"

Jefferson Carvalho-Sobrinho, Feira de Santana State University, Brazil, "Systematics and biogeography of *Bombax*-group and taxonomic revision of *Pseudobombax* Dugand (Bombacoideae, Malvaceae)"

Carolina Guerreiro, Darwinion Botany Institute, Argentina, "New insights on woody bamboos from southern South America"

Visitors

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Ana Luiza Cortes, Universidade Estadual de Feira de Santana, Brazil; Acanthaceae (4/16-4/19).

Melissa Islam, Denver Botanic Gardens; *Corispermum* (Amaranthaceae) (4/17).

Yota Batsaki, **Sarah Burke** and **Jan Ziolkowski**, Dumbarton Oaks; *Historia Plantarum* Collection (4/19).

Maria Wanderley, Instituto de Botânica, São Paulo, Brazil; Bromeliaceae and Xyridaceae (4/30-5/4).

Koray Durak, Boğaziçi University, Turkey; Byzantine medicine (5/4).

Lynn Bohs, University of Utah; *Solanum* (Solanaceae) (5/7-5/9).

Andrew Bray, Independent scholar, and **Georgia Bray**, Department of Education, Employment and Workplace Relations (DEEWR), Australia; American-Australian Scientific Expedition to Arnhem Land specimens (5/9-5/11).

Italo Coutinho, Universidade Federal de Viçosa, Brazil; Caesalpinoideae (5/21-6/18).

Thiago Cosen, Universidade Federal do Rio de Janeiro, Brazil; Bromeliaceae (5/21-5/28).

Valdnea Dalvi, Universidade Federal de Viçosa, Brazil; Gentianaceae (5/21-5/28).

Cecily Marroquin, George Washington University; Medical traditions (5/24-7/1).

Francine Costa Assis, Universidade Federal de Minas Gerais, Brazil; *Pecluma* (Polypodiaceae) (5/28-6/8).

Donald MacKenzie, Jerold Panas, Linzy & Partners, Chicago, Illinois; History of Greek medicine (5/29).

Pei-Luen Lu, University of Hawaii-Manoa; Asparagaceae (5/30-6/2).

Katie Dykgreve, Colorado State University; San Jacinto collections (6/4/-8/30).

Sonia Vougioukalou, King's College, United Kingdom; Greek archaeobotany (6/8).

Valentina Savo, University of Rome, Italy; Mediterranean ethnobotany (6/8).

Xianzhou Kan, Anhui Normal University, China; Vitaceae (6/15).

Bruno Amorim, Universidade Federale de Pernambuco, Brazil; Brazilian *Myrcia* (Myrtaceae) (6/18-7/17).

Jorge Mario Velez Puerta, Universidad Nacional, Colombia; *Solanum* (Solanaceae) (6/18- 7/13).

Leah Isaman, Northwestern University; Seeds of Success internship (6/18-9/7).

Fred Gibbs, George Mason University; *Historia Plantarum* Collection (6/19).

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Interns

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University

Gary Krupnick
West Indies Plant Conservation
- Clara Monsma, Oberlin College
- Gideon Wolf, Columbia University

Ida Lopez
Heliconia Insect-Herbivore
- Liam Ackerson, Virginia Tech University

Plant DNA Barcode
- Grace Anderson, Smith College
- Wenna Chen, South China Botanical Garden

Zingiberales
- Jennifer Cruz, Smithsonian YES Program
- Erika Rodriguez, Smithsonian YES Program

Sonoe Nakasone
Field Book
- Blair Bailey, American University
- Janelle Batkin, Fashion Institute of Technology
- Catherine Cox, George Mason University
- Alice Doolittle, University of Pittsburgh
- Cherie Edmonds, University of Michigan
- Richard Jerome, Catholic University
- Alison Pinches, University of Calgary

Sylvia Orli
F.R. Fosberg Collection
- Sean Schifano, Johns Hopkins University

Flora of DC
- Georgina Warren, Christopher Newport University

Rusty Russell
U.S. Exploring Expedition
- Chelsea Frankel, Bard College
- Kendra Hay, University of Wisconsin

Historical Expeditions
- Emmie Miller, Colorado State University
- Julia Quigley, University of Chicago

Treasures
- Katharine Woods, SUNY-Geneseo

Alice Tangerini
Illustration
- Marilyn Foehrenbach, Moore College of Art and Design

Alain Touwaide
Medical Traditions
- Jaishri Atri, George Washington University
- Tatiana Bozhich, St. John's College
- Nils Niemeier, University of Richmond
- Alexandra O'Neill, Georgetown University
- Baxter Sapp, St. John's College
- Sabine Thomas, Bastyr University
- Tanya Volansky, Randolph-Macon College
- Daniel Woolridge, Georgetown University

Visitors

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Panya Vij, Alexandria, Virginia; *Silene caroliniana* (Caryophyllaceae) (6/22/12-1/19/13).

Gareth Belton, University of Adelaide, Australia; *Caulerpa* (Caulerpaceae) (6/26-6/28).

Rainbo Dixon, Murdoch University, Australia; *Sargassum* (Sargassaceae) (6/26-6/28).

Kostantinos Gergakopoulos, University of Athens, Greece, and **Achilles Perry**, Independent scholar; History of Greek botany and medicine (6/27).

James Colbert, Iowa State University; Lichens (6/28).

Publications

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Smithsonian Botanical Symposium

Judd Receives 10th 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 three botanists on the staff of 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 on the Symposium Archives at http://botany.si.edu/events/sbsarchives/.

Walter S. Judd is the 10th recipient of the 2012 José Cuatrecasas Medal for Excellence in Tropical Botany. Judd, a Professor of Botany at the University of Florida at Gainesville, was selected for this honor as he has made many important contributions to tropical Botany through his research, field work, and teaching. He received a B.S. (1973) and M.S. (1974) from Michigan State University and a Ph.D. from Harvard University (1978). His doctoral dissertation was a revision of the genus *Lyonia* (Ericaceae) and field work in Hispaniola undertaken in support of this research first introduced him to the high mountain flora of the Caribbean. Since then Judd has established himself as one of the world's experts in the Ericaceae, a family well-known in temperate and boreal regions but also well-represented in the tropics. Judd's trips to the Caribbean also incited an interest in the almost exclusively tropical Melastomataceae, and the species-rich Miconeae of this plant family has been another long-standing focus of his systematic research. Not all of his research contributions, however, are restricted to these two families as Judd also made general collections in Hispaniola and prepared a number of floristic inventories for national parks in Haiti. For many years he has been one of the principals in the "Generic flora of the Southeastern United States" project. Although focused on a more or less temperate flora, this project does treat tropical elements that occur in southern Florida and generally requires knowledge of tropi-

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Walter Judd, Professor of Botany at the the University of Florida at Gainesville, accepts the 2012 José Cuatrecasas Medal for Excellence in Tropical Botany from Laurence Dorr (Chair of the Cuatrecasas medal selection committee). (Photo by Ken Wurdack)

Abstracts from the Speakers at the Smithsonian Botanical Symposium

The 10th Smithsonian Botanical Symposium, "Transforming 21st Century Comparative Biology using Evolutionary Trees," was held 20-21 April 2012. The invited speakers covered a wide range of organisms and topics to illuminate how molecular phylogenetics can be used to understand evolutionary and ecological processes. Below are the speakers' abstracts from the papers that were presented.

Kenneth Wurdack (symposium convener; left) and Warren Wagner (Chair of Botany; second to left) join the speakers of the 2012 Smithsonian Botanical Symposium (left to right): Scott V. Edwards, James W. Horn, Charles F. Delwiche, Richard Ree, David D. Ackerly, Karen Osborn, and Michael Donoghue. (Photo by Elaine Haug)

Scott V. Edwards
Harvard University

"Resolving the Tree of Life through Phylogenomics and the Multispecies Coalescent Model"

As phylogenomics makes available ever-increasing numbers of loci for phylogenetic analysis, the diversity of gene histories due to incomplete lineage sorting and other factors increases as well. Concatenation of multilocus data sets into supermatrices has proven an effective way of increasing phylogenetic signal for the Tree of Life. However, when analyzed by standard methods that ignore gene tree heterogeneity, theory suggests that concatenation yields inconsistent estimates of phylogenetic relationships when gene tree heterogeneity is high. Here I illustrate an empirical example of this inconsistency using phylogenomic data from 447 loci and 37 species of placental mammals and outgroups. Remarkably, these loci yield 440 topologically distinct gene trees, indicating that virtually every locus has a distinct phylogenetic history. As expected, standard Bayesian and maximum likelihood analysis of these loci yields a tree with full support on every node, yet, unexpectedly, analysis of concatenated subsamples of the data yield equally strong relationships that often conflict with each other. By contrast, analysis of complete and subsampled data sets using so-called "species tree" methods – a family of methods that accommodates gene tree heterogeneity through the multispecies coalescent model – yields trees with consistent and increasing support with increasing numbers of loci. Additional examples from birds confirm that gene tree heterogeneity is not confined to recently radiating clades, but is also present at deeper phylogenetic levels. Species tree methods invariably require more loci to achieve significance than concatenation, but they appear to be consistent and less erratic with genome-scale data sets.

Charles F. Delwiche
University of Maryland

"Illuminating the Origin of Land Plants with Algal Genomes"

The close relationship between green algae and land plants (embryophytes) was recognized prior to Linnaeus, and by the end of the 19th century it was understood that the land plants are younger than, and probably derived from, green algae. Ultrastructural studies in the second half of the 20th century refined the problem, revealing two great lineages of green algae, the true chlorophytes and the charophytes, the latter including land plants. However, it was only with the rise of molecular systematics at the end of the millennium that the relationships among these organisms could be fully appreciated. Paleobotanical studies indicate that green algae originated deep in the Precambrian, probably on the order of 2 Ba, while land plants arose late in the Ordovician, about 450 Ma, and diversified through the Silurian and Devonian. Consistent with the evidence from the fossil record, in molecular analyses land plants are deeply embedded in green algal biodiversity, and the individual lineages of charophytes (traditionally classified as orders) are each comparable in age to the land plants. This illustrates the vast, understudied biological diversity found not only in green algae, but throughout the basal lineages of eukaryotes (the "protists"). By applying state-of-the-art DNA sequencing technologies we have been able to identify in charophyte algae components of fundamental biological processes that were previously believed to be unique to land plants. Studies targeted on the basis of evolutionary relationships hold the promise of shedding new light on the origin, evolution, and function of fundamental plant processes.

James W. Horn
Smithsonian Institution

"Diversification and Structural Innovation in Euphorbia"

Euphorbia—with over 2,000 recognized species of protean habit, and with a nearly global distribution—has long been considered one of the most challenging clades of flowering plants to untangle. Yet manifest in these complexities is the potential of *Euphorbia* as a system

to address fundamental issues in plant evolutionary biology. A newly developed and robustly supported molecular phylogeny for the genus provides a framework with which we are achieving a synthesis of structural evolution, evolutionary tempo, and diversification in *Euphorbia*. Outstanding are the many examples of extreme parallelism in trait evolution, including at least 14 origins of xeromorphic growth forms. The evolution of growth form and inflorescence position is significantly correlated, and a pathway of evolutionary transitions is supported that has implications for the evolution of *Euphorbia* CAM xerophytes of large stature. Such xerophytes total more than 400 species and are dominants of vegetation types throughout much of arid Africa and Madagascar. Divergence dating estimates indicate these xerophyte lineages rapidly radiated in the late Miocene to early Pliocene (~8–4 Ma), subsequent to aridification of these regions and lowered atmospheric CO_2 levels. We test these and other traits as correlates of diversification in *Euphorbia* to shed further light on the evolution of this remarkable angiosperm clade.

Karen Osborn
Smithsonian Institution

"Discoveries in the Deep and Their Usefulness for Studies of Invertebrate Evolution"

The deep, open ocean is the largest habitat on earth by volume and supports a huge diversity and biomass of invertebrates. Most animal groups have representatives living in the open ocean but many of these pelagic animals have dramatically different morphology, behavior and ecology in relation to their closest relatives. By studying the differences between these animals and their relatives in shallow water or on the sea floor, we learn how the pelagic environment changes and shapes the many animals that survive there. Additionally, we learn about the constraints and possibilities for various animals groups and how open ocean communities functions. Because of the difficulty studying this habitat, the delicate nature of many of the animals, new ways to explore this habitat, and molecular tools exciting discoveries and new understanding of the evolutionary history of numerous invertebrate groups are now possible. I will introduce a recent discoveries and talk about how they are useful in study of the evolution of pelagic invertebrates and the communities those animal are part of.

David D. Ackerly
University of California, Berkeley

"Traits, Communities, and History: What Do We Learn from Phylogenies?"

The use of phylogenetics as a tool and a conceptual framework reflects a significant shift in ecology thinking in recent years. I will highlight three aspects of this synthesis, and specifically ask, what has ecology learned from phylogenetics? 1) In community ecology, phylogenetic approaches are widely used to test hypotheses about the role of abiotic and biotic influences on community assembly. The key question is: if we knew all the traits of species in a community, and the mechanisms of interaction, would phylogenetics still be useful? 2) At a larger scale, phylogenetic methods provide unique insights into the influence of biogeographic and bioclimatic history on patterns of regional and local diversity. The deep history of many lineages is evident in the environmental tolerances and traits of organisms observed in modern-day communities, yet the underlying ecological and evolutionary processes remain obscure. 3) Comparative methods provide a phylogenetic approach to examine the tempo and mode of evolution. The bulk of evidence suggests that ecological traits exhibit modest, but not strong, phylogenetic signal, based on patterns of similarity among close relatives. Increased understanding of the evolutionary fate of lineages with extreme-trait values (e.g., the tallest trees or the smallest seeds) will be critical to distinguish among alternative evolutionary models. Drawing on these three areas, I will identify research priorities to fill major gaps in the continuing synthesis of phylogenetics and ecology.

Richard Ree
The Field Museum

"Phylogeny and the Evolution of Floral Diversity in Pedicularis (Orobanchaceae)"

In China's Hengduan Mountains, over 350 species of *Pedicularis* exhibit spectacular variation in floral form and color, and often co-occur and flower synchronously. However, all are pollinated solely by bumblebees. Phylogenetic analysis of trait evolution and community structure reveals evidence that a geographic mosaic of pervasive reproductive interference between co-occurring species of *Pedicularis* may accelerate the evolution of floral traits and elevate rates of both speciation and extinction, and explain the preponderance of species in the Hengduan hotspot. These results motivate finer-scale analysis of *Pedicularis* phylogeny at and below the species level, and I will present some preliminary results on how reduced-representation genomic tools can be used not only to confidently infer relationships, but also reveal patterns of historical introgression.

Michael Donoghue
Yale University

"Adventures in Plant Phylogeny and Prospects for the Future"

Progress in understanding plant phylogeny has exceeded our wildest dreams, but there is still much to be done. I will briefly review some of the most extraordinary advances of the last few decades and the corresponding insights into plant evolution. Having established a solid phylogenetic backbone, the next step will be

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Acknowledgements

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

Organizers
- Kenneth Wurdack
- Laurence J. Dorr
- Nancy Khan
- Gary Krupnick
- Sue Lutz
- Sylvia Orli
- Warren L. Wagner
- Jun Wen
- Elizabeth Zimmer

Support
- Mary Ann Apicelli
- Patricia Davis

Photographers
- Elaine Haug
- Kenneth Wurdack

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

Abstracts

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to fill in the details. But, far from being a pedestrian exercise, I predict that the most important findings are yet to come. As I hope to illustrate with concrete examples from *Viburnum*, a more comprehensive coverage will enable truly compelling analyses of character evolution, biogeography, and diversification.

Symposium

Continued from page 1

James Horn, a post-doctoral fellow at the Smithsonian Institution, introduced his research collaboration with Wurdack, examining the structural and functional diversity of the spurges (*Euphorbia*, Euphorbiaceae). As one of the most species rich genera among all plants, investigation of this clade provides an insight into the general processes by which evolution and speciation occur. One of the key insights is the extent to which similar traits have evolved in the group, such as the frequent parallel origin xeromorphic adaptations to drought and desert conditions. Such rapid adaptation to novel environments may have lead to the dramatic speciation as functional novelty leads to invasion of novel geographic habitats. The use of a molecular phylogeny further allowed them to date the radiations of these xeromorphic clades, and showed that they corresponded to late Miocene and early Pliocene times where rapid desertification was known to have occurred. Thus the diversity of the clade appears tightly linked to its ability to evolve with the environment.

In contrast to Horn and his work using well-developed and time calibrated molecular phylogenies, was the next presentation by Karen Osborn, a curator in Invertebrate Biology at the Smithsonian Institution. Her work in marine exploration demonstrated both the vast numbers of living species waiting to be discovered, but also provided a glimpse into the use of molecular phylogenies to try and correctly describe the many cryptic, novel species waiting to be discovered. She described how on nearly every collection trip – using sophisticated deep sea robots – entirely new species were encountered, where it was nearly impossible to classify them with morphology, but then became tractable with the use of molecular phylogenetics.

David Ackerly, from the University of California at Berkeley, then gave an excellent presentation regarding the role of phylogeny in ecology. Ackerly is one of a founding set of ecologists to use the evolutionary relationships present in phylogenies to answer questions in ecology. He asserted that phylogenies have been profitably used by ecologists to evaluate the relative role of biotic (competition among species) versus abiotic (adaptation to the environment), but then challenged the audience to consider that if we knew all trait and physiological data about the organisms in an environment, would we still need phylogenies to answer questions. The answer to that question is *yes*, since we can never know or measure all the traits that may enable adaptation. Ackerly further demonstrated how phylogenies enable us to examine the biogeographic patterns of the evolution of traits believed to facilitate adaptation, and the way in which phylogenies facilitate comparative studies that can quantify the rate at which different lineages diversify in critical functional traits. The end conclusion is that many important functional traits relevant in adaptation show some phylogenetic conservation, and that use of phylogenies will continue to empower ecological studies that use time or relatedness as a critical factor.

The last set of talks was from Richard Ree from the Field Museum and his former dissertation advisor Michael Donohue from Yale University. Ree focused on the processes leading to the unusually high rates of species diversification seen in among *Pedicularis*, a genus in the parasitic broomrape family (Orobanchaceae). The key to the high rates of diversification relate to floral evolution, and Ree was able to use phylogenies of the group to better understand why the group evolved so many species so quickly. His conclusion was that the high levels of geographic diversification in conjunction with the rapid floral evolution produced a system that supported novel species. His conclusion was similar in many respects to the presentation of Horn who demonstrated that the high species diversity in *Euphorbia* is similarly attributable to their ability to invade novel habitats – but the *Pedicularis* story differs in that the speciation occurs in closely adjacent habitats compared to *Euphorbia* that have radiated to geographically distant and widespread habitats. Ree's results show that microevolutionary processes of gene flow and pollinator behavior can play an important role

Symposium participants enjoying the reception at the U.S. Botanic Garden (Photo by Elaine Haug)

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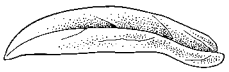
in rapid speciation, and that phylogenetic analysis can show how these traits evolve with species and thus which traits – as well as biogeographic factors – accelerate evolution.

To conclude the symposium, Donohue spoke of how phylogenies have shed light on a variety of issues in plant evolution such as the relationships of the earliest plant species, how phylogeographic patterns inform our expectations of the evolution of a clade of species, as well as how we can now assemble larger and larger phylogenies that can capture increasing amounts of information about large scale patterns of diversification. One fascinating example of this was the observation of the variability in rates of molecular evolution among different classes of plants – thus herbaceous species are observed to have a faster rate of evolution than long-lived woody plant species. A critical conclusion of Donohue's talk was the role of capturing all species and the extent to which missing taxa can dramatically change our inferences of the evolution of related organisms. His example with *Viburnum* (Adoxaceae) in the context of the biogeographic origins of the genus showed that a strongly supported conclusion which was wrong can be observed when some species are not in the phylogeny. Thus he said that although the effort to collect all species was a huge challenge, the rewards would be proportionate to the challenge.

The range of the presentations was impressive but a few points could hold the talks together. The first is that constructing the phylogenies correctly in the genomic age may require new methods, which is the double edged sword of working with the new and vast quantities of data that are being generated. A second theme is that use of phylogenies to tell us how rapidly different clades are evolving and how the traits they carry (particularly those which promote adaptation or reproductive isolation) change with them. This can tell us about the roles of competition, geographic diversification, and functional novelty in promoting and maintaining species diversity. All of these questions rely upon our understanding of the tempo and structure of evolution, which are directly drawn from phylogenetic reconstructions.

The next Smithsonian Botanical Symposium will be held April 19-20, 2013. The theme will be announced in the fall.



Supplementary Symposium Links on the Web

The website to the 10th Smithsonian Botanical Symposium <http://botany.si.edu/sbs/> 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 pages <http://botany.si.edu/events/sbsarchives/> also includes programs, abstracts, and images from the past nine 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); and "Genes, Genomics and Genome Evolution in Plants" (2009); and, "Food for Thought: 21st Century Perspectives on Ethnobotany" (2010).

The Symposium dinner in the Rotunda of the National Museum of Natural History provided a wonderful setting for lively discussions. (Photo by Elaine Haug)

Cuatrecasas Medal

Continued from page 7

cal relatives of temperate genera.

Judd has always incorporated phylogenetic considerations into his revisionary work and with several co-authors he has incorporated these ideas into one of the most widely used text books in our discipline, *Plant Systematics: A Phylogenetic Approach* (1999-2008). The text book, translated into at least five languages and now in its third edition, is utilized in over 150 universities world-wide. Judd has had a strong influence on tropical Botany through his teaching and he has supervised more than 30 graduate students at the University of Florida. Many of these students have made and continue to make their own contributions to tropical Botany. Additionally, Judd has for many years taught a summer course in "Tropical Botany" in suburban Miami, utilizing the extensive living tropical plants found at Fairchild Tropical Botanic Garden, The Kampong of the National Tropical Botanical Garden, and the Montgomery Botanical Center.

Past recipients of the Cuatrecasas Medal are Rogers McVaugh of the University of North Carolina at Chapel Hill (2001); P. Barry Tomlinson of Harvard University (2002); John Beaman of the Royal Botanic Gardens, Kew (2003); David Mabberley of the University of Leiden, The Netherlands, and the Royal Botanic Gardens, Sydney (2004); Jerzy Rzedowski and Graciela Calderón de Rzedowski of Instituto de Ecología del Bajío, Michoacán, Mexico (2005); Sherwin Carlquist of Rancho Santa Ana Botanic Garden and Pomona College (2006); Mireya D. Correa A. of the University of Panama and Smithsonian Tropical Research Institute (2008); Norris H. Williams of the Florida Museum of Natural History and the University of Florida, Gainesville (2009); and Beryl B. Simpson of the University of Texas at Austin (2010).

Art by Alice Tangerini

Pedicularis furbishiae S.Watson

The diversity of *Pedicularis* (Orobanchaceae) in China's Hengduan Mountains was the focus of Richard Ree's talk at the 10th Smithsonian Botanical Symposium. Alice Tangerini illustrated the North American endangered Furbish lousewort (*Pedicularis furbishiae*) for the cover of *Endangered and Threatened Plants of the United States* by E.S. Ayensu and R.A. DeFilipps (1978; Smithsonian Institution and World Wildlife Fund, Inc.). This critically imperiled species is endemic to the Saint John River Valley of northern Maine and adjacent New Brunswick, where threats include ice scouring, flooding, gravel extraction, forestry, and invasive species.

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