



# PLANT SCIENCE BULLETIN

SUMMER 2019 VOLUME 65 NUMBER 2

A PUBLICATION OF THE BOTANICAL SOCIETY OF AMERICA



Botany 2019: A Time to Connect and Collaborate!

## IN THIS ISSUE...



*Report from Congressional Visits Day.... p. 85*



*Fighting plant blindness with monumental trees.... p. 95*



*Two BSA students' paths into botany... p. 122*

# From the Editor

Greetings!

The summer is well underway for most of us. I hope that many of you have carved out some time to attend Botany 2019 in Tucson. In this issue, we have information about events that you don't want to miss!

Lately, I've been busy advising incoming first-year students at Creighton as they prepare to register for their first college classes. So few of them express interest in any aspect of plant or environmental science, even though at least some of them actually will end up pursuing careers in those areas. As botanists, we have our work cut out for us to raise awareness and engage the next generation of plant scientists and science communicators. For this reason, I find the stories about public education that we feature in *PSB*, such as the David Ehret's article about accessing botany through video games (Botany as a State of Flow) in our Spring issue and the Lopes et al. article (Monumental Trees: Guided Walks as an Educational Science Awareness Experience) in this issue so inspiring. I'd love to feature more of these programming ideas in this publication!

In this issue, you will also find the testimonials from this year's Congressional Visit Day. As always, we at *PSB* want to highlight the good and essential work that these folks are doing to raise the profile of plant science in the eyes of the U.S. Legislature.

Don't forget to consider submitting your articles and essays to *Plant Science Bulletin*. We exist to highlight the ideas and concerns of the entire Botanical Community.

See you in Tucson!



*Mackenzie*

## *PLANT SCIENCE BULLETIN* Editorial Committee Volume 65



**Melanie Link-Perez**  
(2019)

*Department of Botany  
& Plant Pathology  
Oregon State University  
Corvallis, OR 97331  
melanie.link-perez  
@oregonstate.edu*



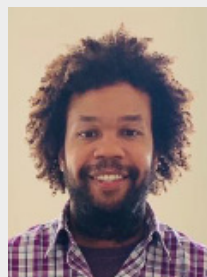
**Shannon Fehlberg**  
(2020)

*Research and Conservation  
Desert Botanical Garden  
Phoenix, AZ 85008  
sfehlberg@dbg.org*



**David Tank**  
(2021)

*Department of Biological  
Sciences  
University of Idaho  
Moscow, ID 83844  
dtank@uidaho.edu*



**James McDaniel**  
(2022)

*Botany Department  
University of Wisconsin Madison  
Madison, WI 53706  
jlmcdaniel@wisc.edu*



# TABLE OF CONTENTS

## SOCIETY NEWS

Botanical Society of America's Award Winners.....	70
Four Members Win Distinguished Fellow Award.....	70
Emily Sessa Wins BSA Emerging Leaders Award.....	73
Public Policy Committee Report from Congressional Visits Day.....	85

## ANNOUNCEMENTS

In Memoriam - William P. Jacobs (1919-2019).....	91
<i>American Journal of Botany</i> Announces New <i>AJB Reviews</i> feature.....	94

## SPECIAL FEATURES

Monumental Trees: Guided Walks as an Educational Science Awareness Experience.....	95
--	----

## SCIENCE EDUCATION

Congratulations to 2019 Bessey Award winner Suzanne Koptur!.....	113
Seeking 20 Graduate Students and Post-Doctorals for Researchers for PlantingScience Master Plant Science Team Online Mentoring Opportunity.....	114
Featured Education Resource.....	115
Education Features at Botany 2019: Sky Islands and Desert Seas.....	118

## STUDENT SECTION

A Journey to the Southwest: A Student's Guide for Botany 2019.....	119
The Path into Botany: Student Stories from Botany Conferences.....	122

## BOOK REVIEWS

Ecological.....	125
Economic Botany.....	130
Systematics.....	135



# SOCIETY NEWS

## Botanical Society of America's Award Winners

### FOUR MEMBERS WIN DISTINGUISHED FELLOW AWARD

*The Distinguished Fellow of the Botanical Society of America is the highest honor our Society bestows. Each year, the award committee solicits nominations, evaluates candidates, and selects those to receive an award. Awardees are chosen based on their outstanding contributions to the mission of our scientific Society. The committee identifies recipients who have demonstrated excellence in basic research, education, public policy, or who have provided exceptional service to the professional botanical community, or who may have made contributions to a combination of these categories.*



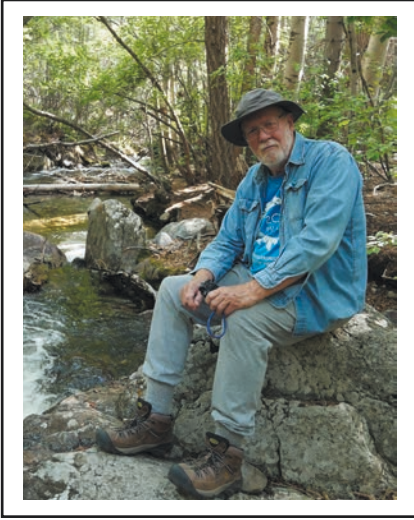
Photo credit: Elaine Simons Lane

**Dr. Sean Graham** (University of British Columbia) is widely recognized as one of world's leading and innovative students of plant systematics and is often on the leading edge in several important areas of plant evolutionary biology. Sean became a full professor at the University of British Columbia in 2012 and since 2016 has served the role as Head of the Department of Botany. He has played a key role in many major initiatives to reconstruct the phylogeny of land plants, using intensive

sampling of genes and species to yield a robust reconstruction of the evolutionary tree of this group. Sean's work has three characteristics worthy of highlighting: (1) it is focused on the broad relationships of major groups, and thus serves as a framework for many subsequent studies; (2) it uses dense sampling of many genes and many species, to provide more robust results than in previous studies; and (3) the data are gathered with great care. His penchant for double- and triple-checking his sequence data produces results that serve as a gold standard for the field.

Sean has also distinguished himself for his record of generous and highly effective service to the botanical community. For example, as BSA's Director-at-Large for Publications over the past six years, he played a leading role in the decision to move to a commercial publisher, and shepherded the Society through the process of selecting a publishing partner and successfully transitioning the BSA journals to publication by Wiley. Sean has also served as an associate editor for the *American Journal*

of *Botany* for many years and has been a key contributing member on the Publications Ethics Committee. He is a caring and skilled teacher of both undergraduate and graduate students and a responsive colleague to all whom request his advice.



David Fairchild (*The World as Garden*), through one of photographs and descriptions of the trees of south Florida (*Wayside Trees of Tropical Florida*), to his recent book on leaves (*Nature's Fabric, Leaves in Science and Culture*). David has been a life-long member of the BSA. In addition to his strong record of research and service to the BSA and the public, he has been an excellent teacher and was awarded the BSA Charles Edwin Bessey Teaching Award in 2006 in recognition of his outstanding record in botanical education. He was the first botanist in a fledgling Department of Biological Sciences at Florida International University (FIU), a brand-new public university in Miami, and he worked to develop a robust program in the plant sciences at this young university, initiating hiring of botanical faculty and developing formal collaborations between FIU and other botanical institutions.

**Dr. David W. Lee** (Florida International University) is a plant functional ecologist especially interested in tropical and subtropical plants. He has done pioneering research on the physical basis and functional significance of plant color and has researched light environments in tropical forests, leaf optical properties, structural color in leaves, anthocyanin function (including autumn leaf color), light quality/quantity effects on seedling and plant development, and plasticity, especially in leaves. In addition to his record in basic plant research, he has an outstanding record of public outreach for the botanical sciences, which has included the publication of 11 popular but also scientifically rigorous books on botanical topics. His 2007 book, *Nature's Palette: The Science of Plant Color*, won the Best of Biology and Life Sciences Award from the Association of American Publishers. His other books range from a book presenting the writings of the plant explorer



Photo credit: Spencer Barrett

**Dr. Ann Sakai and Dr. Steve Weller** (University of California, Irvine) have significantly advanced our understanding of the evolution of plant breeding systems while promoting Hawaiian plant conservation and serving the botanical community in numerous important capacities. They have made major contributions to our understanding of the

evolutionary forces that lead to shifts in heterostyly as well as in floral condition, principally in two study systems: the evolution of heterostyly in *Oxalis* (Oxalidaceae) and the evolution of dioecy and wind pollination in *Schiedea* (Caryophyllaceae). The NSF has recognized the value of their work by essentially continually funding it over the last 30 years. As with all great researchers, they have followed research questions wherever they lead, regardless of technique. Very few botanists are as deeply involved with all facets of botany, from systematics to ecology, as are Ann and Steve. Their stellar research careers have been rewarded by election as fellows to the AAAS.

Much of their work has also had direct and tangible impacts on conservation of Hawaiian *Schiedea*, while affording great respect to Hawaiian culture. Their greenhouse collection (which includes 25 of 32 extant species, almost all of which are federally endangered) forms an important reservoir of genetic diversity, and their ongoing research has documented patterns of genetic diversity, demography, and gene flow that are absolutely essential for *Schiedea* species conservation management programs. Much of their recent research has also focused on ways to increase *Schiedea* abundance in Hawaii, in collaboration with the National Tropical Botanical Garden and numerous state and federal agencies across Hawaii.

Ann and Steve have also been deeply involved in service to the BSA and greater botanical community. Throughout their careers they

have made education, outreach, and inclusion central parts of their work. For example, Ann is a co-founder and leader of BSA's highly successful PLANTS (Preparing Leaders and Nurturing Tomorrow's Scientists) program, which is now in its second 5-year NSF grant period. The PLANTS program is designed to increase representation from undergraduate communities who have historically not been represented in botany by bringing 10 to 15 such students to the Botany conference each year. More broadly, Ann has been deeply involved in numerous initiatives at UC Irvine to improve diversity, including initiatives to foster collaboration with historically black colleges and universities, and between Mexican and Californian institutions. Steve was BSA president from 2010 to 2013, where he helped establish the Emerging Leader Award and secured the agreement with the Missouri Botanical Garden that led to the continuation of the current headquarters for BSA. He has also served as BSA Secretary and as a board member. Ann and Steve have also been deeply involved in *AJB* as editors, authors, and reviewers, and they were co-editors for a special issue on Global Biological Change in 2013. They have also distinguished themselves as outstanding and sensitive mentors to generations of students, leading to numerous awards for teaching and mentorship at UC Irvine. They are central figures in the ongoing success of the BSA as an institution that supports research, education, and inclusion.

## EMILY SESSA WINS BSA EMERGING LEADERS AWARD



**Dr. Emily Sessa** (University of Florida) serves as Assistant Professor at the University of Florida where she has developed a well-funded and strong research program. Emily's research is focused on understanding the evolutionary processes that shape plant diversity with a major focus on fern systematics and phylogenetics. To this end, she has published more than 40 peer-reviewed publications on these topics with significant contributions to our understanding of *Dryopteris* phylogenetics and systematics as well as plant biogeography. Emily also studies plant physiology and is among the few researchers to genuinely combine physiology, genomics, and phylogenetics in her analyses of drought tolerance in fern gametophytes and sporophytes. At the heart of her research is the question, "What ecological and evolutionary processes have generated, and help to maintain, fern diversity on Earth?"

Emily has been described as one of the brightest botanical stars of her generation by her colleagues and is already an active leader in the botanical research community. She has served as an editor or associate editor for the *American Fern Journal* and the *American Journal of Botany*, as Communications Coordinator for the American Society of Plant Taxonomists, and was recently elected as the next Director at Large for Publications on the BSA Board. Over the past 24 months, Emily has delivered 13 invited seminars and lectures. She has also mentored more than 12 undergraduate students, four graduate students, and two postdoctoral researchers.

Her latest teaching endeavor is a study abroad course on the Biodiversity of Southern Africa. Emily will be leading a four-week field course in South Africa, Botswana, and Namibia that immerses students in field research and hands-on learning in one of the most botanically and biologically exciting areas on Earth.

## BSA PUBLIC POLICY AWARD

*The Public Policy Award was established in 2012 to support the development of tomorrow's leaders and a better understanding of this critical area. This year's winners are:*

**Audrey Haynes**, Ph.D. Candidate, University of California Berkeley

**Adam Schneider**, Assistant Professor and Herbarium Curator, Hendrix College

## BOTANY ADVOCACY LEADERSHIP GRANT

*This award organized by the Environmental and Public Policy Committees of BSA and ASPT aims to support local efforts that contribute to shaping public policy on issues relevant to plant sciences. This year's winner is:*

**Else Schils**—for the proposal: *Bringing Biocultural Diversity to the forefront of the Political Agenda in Guam*

## DARBAKER PRIZE

*The Darbaker Prize in Phycology is given each year in memory of Dr. Leasure K. Darbaker. It is presented to a resident of North America for meritorious work in the study of microscopic algae based on papers published in English by the nominee during the last two full calendar years. This year the Darbaker Award for meritorious work on microscopic algae is presented to:*

**Dr. Louise Lewis**, University of Connecticut

## ECONOMIC BOTANY STUDENT TRAVEL AWARD

**Emma Frawley**, St. Louis University, St. Louis, MO

**Ksenia Pereverzeva**, Virginia Tech, Blacksburg, VA

## GENETICS STUDENT RESEARCH AWARD

*The Genetics Section Graduate Student Research Award provides \$500 for research funds and an additional \$500 for attendance at a future BSA meeting.*

**Adriana Hernandez**, Cornell University, Ithaca, NY



## GENETICS STUDENT TRAVEL AWARD

**Alan Yocca**, Michigan State University, East Lansing, MI

## THE GRADY L. WEBSTER AND BARBARA D. WEBSTER STRUCTURAL BOTANY PUBLICATION AWARD

*This award was established in 2006 by Dr. Barbara D. Webster, Grady's wife, and Dr. Susan V. Webster, his daughter, to honor the life and work of Dr. Grady L. Webster. After Barbara's passing in 2018, the award was renamed to recognize her contributions to this field of study. The American Society of Plant Taxonomists and the Botanical Society of America are pleased to join together in honoring both Grady and Barbara Webster. In odd years, the BSA gives out this award and in even years, the award is provided by the ASPT.*

**William B. Sanders and Asunción de los Ríos.** 2017. Parenchymatous cell division characterizes the fungal cortex of some common foliose lichens. *American Journal of Botany* 104: 207-217. doi:10.3732/ajb.1600403

### ***Honorable Mention:***

**Dan Johnson, Phoebe Eckart, Noah Alsamadisi, Hilary Noble, Celia Martin, and Rachel Spicer.** 2018. Polar auxin transport is implicated in vessel differentiation and spatial patterning during secondary growth in *Populus*. *American Journal of Botany* 105: 186-196. doi:10.1002/ajb2.1035

## THE BSA DEVELOPING NATIONS TRAVEL GRANTS

*The goal of the Developing Nations Travel Grants is to encourage international collaboration and foster connections within our international botanical community by extending financial help to those in need of assistance to attend Botany conferences. This year's winners are:*

**Oyedapo Ololade Adesomi**, Obafemi Awolowo University, Ife, Nigeria

**Sekinat Okikiola Azeez**, Obafemi Awolowo University, Ife, Nigeria

**John Chau**, University of Johannesburg, South Africa

**Eliezer Cocoltzi**, Universidad Veracruzana in Xalapa, Veracruz, Mexico

**Ana Andruchow Colombo**, Universidad de Buenos Aires and Museo Paleontológico Egidio Feruglio, Argentina

**Facundo De Benedetti**, Egidio Feruglio Paleontological Museum, Trelew, Argentina

**Ethiéne Guerra**, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

**Alison Gonçalves Nazareno**, Federal University of Minas Gerais, Belo Horizonte, Brazil

**Nora Oleas**, Universidad Tecnologica Indoamerica in Machala y Sabanilla, Quito, Ecuador

**Shabir Ahmad Rather**, University of Delhi, New Delhi, India

## THE BSA PROFESSIONAL MEMBER TRAVEL GRANTS

*The Professional Member Travel Grants aim to increase attendance of scientists who lack grant or institutional support for travel to the annual BSA meeting as well as to increase diversity among the annual meeting attendees. This year's winners are:*

**Laura Frost**, Louisiana State University

**Jordan Metzgar**, Virginia Tech

**Carlos J. Pasiche-Lisboa**, University of Manitoba, Memorial University of Newfoundland, Canada

**Ayobola Sakpere**, Obafemi Awolowo University, Ile-Ife Nigeria

**Carolina Moriani Siniscalchi**, University of Memphis

**Kevin Weitemier**, Oregon State University

**Dustin Wolkis**, National Tropical Botanical Garden

**Cheng-Chiang Wu**, Harvard University

## THE BSA GRADUATE STUDENT RESEARCH AWARDS, INCLUDING THE J. S. KARLING AWARD

*The BSA Graduate Student Research Awards support graduate student research and are made on the basis of research proposals and letters of recommendations. Within the award group is the Karling Graduate Student Research Award. This award was instituted by the Society in 1997 with funds derived through a generous gift from the estate of the eminent mycologist, John Sidney Karling (1897-1994), and supports and promotes graduate student research in the botanical sciences. The 2019 award recipients are:*

### THE J. S. KARLING GRADUATE STUDENT RESEARCH AWARD

**Jennifer Ackerfield**, Colorado State University—for the proposal: *Unraveling the link between hanging garden and alpine thistles (Compositae: Cirsium): A phylogeographic study of Cirsium rydbergii and C. ownbeyi of the Colorado Plateau*

### THE BSA BILL DAHL GRADUATE STUDENT RESEARCH AWARDS

**Steven Augustine**, University of Wisconsin—Madison—for the proposal: *Quantifying Environmental Tolerances of Wisconsin's Southern Hardwoods for Effective Oak Savanna Restoration*

**Dylan Cohen**, Claremont Graduate University—for the proposal: *Illuminating Loasa (Loasaceae) diversity in Chile using next generation sequencing*

**Michelle D'Aguillo**, Duke University—for the proposal: *Habitat tracking through germination phenology in two southern Appalachian Phacelia (Boraginaceae) species*

**Michael D'Antonio**, Stanford University—for the proposal: *Ontogeny and structure of Late Paleozoic arborescent lycopsids*

**Maria Beatriz de Souza Cortez**, University of Florida—for the proposal: *Elucidating the floristic history of Brazil's campos rupestres to help preserve its future*

**Sonal Gupta**, University of Michigan—for the proposal: *Deconstructing the sweetpotato: How influential is leaf shape on fitness and what is the role of environmental variation?*

**Adriana Hernandez**, Cornell University—for the proposal: *Revealing the Evolutionary History and Ecological Niches of a Highly Polymorphic Lily, Calochortus venustus: An Integrative Approach to Conservation*

- Cody Coyotee Howard**, Florida Museum of Natural History—for the proposal: *The progression of aridity in Africa and its effects on plant evolution*
- Rachel Lyman**, Washington University in St. Louis—for the proposal: *The Biogeography of the Central Tennessee Basin Glade Endemics*
- Yesenia Madrigal Bedoya**, University of Antioquia (Colombia)—for the proposal: *Gene evolution and characterization of genes that promote flowering in Neotropical orchids*
- Cheyenne Moore**, Bucknell University—for the proposal: *The conservation challenge of linear populations: Using field surveys and herbarium collections to inform the populations genetics of a Pennsylvania rare plant, Baptisia australis var. australis*
- OJO Funmilola Mabel**, Obafemi Awolowo University—for the proposal: *Genetic and Cytogenetic studies of the Andropogon gayanus – Andropogon tectorum complex in South Western Nigeria*
- Maria Pimienta**, Florida International University—for the proposal: *Diurnal and nocturnal pollination of Guettarda scabra (Rubiaceae), an advantage to surviving in South Florida's disappearing pine rocklands*
- Sébastien Rivest**, University of Ottawa—for the proposal: *Evolutionary and ecological causes and consequences of pollen defense*
- Amanda Salvi**, University of Wisconsin - Madison—for the proposal: *Determining the roll of nitrogen loss on non-stomatal photosynthetic limitations to water stress in greenhouse and common garden experiments*
- Karla Sosa**, Duke University—for the proposal: *Escaping Australia: The role of ploidy and reproductive mode in the dispersal of Australasian Cheilanthes (Pteridaceae)*
- Jordon Tourville**, SUNY-ESF—for the proposal: *The Potential Influence of Mycorrhizal Mutualists on Tree Elevational Range Expansions Under Future Climate Change*
- Daniel Turck**, University of Idaho—for the proposal: *Identifying cryptic diversity and modeling future distributions of North American temperate rainforest plants, using comparative phylogeography and machine learning*
- Cecilia Zumajo**, The New York Botanical Garden—for the proposal: *Origin and evolution of the seed coat in gymnosperms*

## VERNON I. CHEADLE STUDENT TRAVEL AWARDS

### (BSA IN ASSOCIATION WITH THE DEVELOPMENTAL AND STRUCTURAL SECTION)

*This award was named in honor of the memory and work of Dr. Vernon I. Cheadle. This year's winners are:*

**Alexander Bippus**, Oregon State University (Advisor: Ruth A. Stockey)—for the proposal: *Uncovering Mesozoic polar bryophyte diversity: A permineralized haplolepideous moss gametophyte from the Late Cretaceous of the north slope of Alaska*  
Co-authors: Ruth Stockey, Ger Rothwell

**Megan Nibbelink**, Humboldt State University (Advisor: Mihai Tomescu)—for the proposal: *Exploring zosterophyll diversity in the Emsian (Early Devonian) permineralized assemblages of the Battery Point Formation (Québec, Canada)*  
Co-author: Alexandru Tomescu

**Annika Smith**, University of Florida (Advisors: Pamela and Douglas Soltis)—for the proposal: *How many ways are there to make a nectar spur? Studies in the nasturtiums (Tropaeolum)*  
Co-authors: Lena Struwe, Kurt Stenn, Douglas Soltis, Pamela Soltis

**Zebadiah Yoko**, North Dakota State University (Advisor: Dr. Jill Hamilton)—for the proposal: *Teasing apart the scale of quantitative trait differences for restoration across heterogeneous landscapes*  
Co-authors: Kate Volk, Jill Hamilton

## THE BSA YOUNG BOTANIST AWARDS

*The purpose of these awards is to offer individual recognition to outstanding graduating seniors in the plant sciences and to encourage their participation in the Botanical Society of America.*

**Emma Baker**, Creighton University (Advisor: Dr. Mackenzie Taylor)

**Susan Eiben**, Ohio University (Advisor: Dr. Harvey Ballard)

**Sophie Everbach**, Oberlin College (Advisor: Dr. Michael J. Moore)

**Chlöe Fackler**, McGill University (Advisor: Dr. Frieda Beaugard)

**Blake Fauskee**, Duke University (Advisor: Dr. Kathleen Pryer)

**Linnea Fraser**, Oberlin College (Advisor: Dr. Michael J. Moore)

**Evan Gallagher**, University of Missouri–Columbia (Advisor: Dr. J. Chris Pires)

**Ava Heller**, Ohio University (Advisor: Dr. Harvey Ballard)

**Claire Jorgensen**, Willamette University (Advisor: Dr. Susan Kephart)

**Melissa Kosty**, UCLA (Advisor: Dr. Ann M. Hirsch)

**Elizabeth Ladyzhets**, Barnard College - Columbia University (Advisor: Dr. Hilary S. Callahan)

**Hailee McOmber**, Fort Lewis College (Advisor: Dr. Ross A. McCauley)

**Jocelyn Navarro**, Connecticut College (Advisor: Dr. Chad Jones)

**Sofia Ocampo**, Florida International University (Advisor: Dr. Suzanne Koptur)

**Simone Oliphant**, Florida International University (Advisor: Dr. Suzanne Koptur)

**Asa Peters**, Connecticut College (Advisor: Dr. Chad Jones)

**Emily Swindell**, Fort Lewis College (Advisor: Dr. Ross A. McCauley)

**Helene Tiley**, Oberlin College (Advisor: Dr. Michael J. Moore)

## THE BSA PLANTS GRANT RECIPIENTS

*The PLANTS (Preparing Leaders and Nurturing Tomorrow's Scientists: Increasing the diversity of plant scientists) program recognizes outstanding undergraduates from diverse backgrounds and provides travel grants and mentoring for these students. This year's winners are:*

**Austin Betancourt**, San Jose State University (Advisor: Benjamin Carter)

**Talbrett Caramillo**, Fort Lewis College (Advisor: Ross McCauley)

**Marco Donoso**, University of Central Oklahoma (Advisor: Chad King)

**C.J. Cooper**, College of the Redwoods (Advisor: Maria Friedman)

**Lisa Danback**, Webster University (Advisor: Nicole Miller-Struttman)

**Ana Flores**, Florida International University (Advisor: Jennifer Richards)

**Mari Irving**, University of Central Florida (Advisor: Chase Mason)

**Chazz Jordan**, Georgia State University (Advisor: Lauren Eserman)

**Cristina Raya**, University of Texas Rio Grande Valley (Advisor: Rupesh Kariyat)

**Rachael Snodgrass**, Gonzaga University (Advisor: Stephen Hayes)

**Tatyana Soto**, Mills College (Advisor: Sarah Swope)

**Emily Swindell**, Fort Lewis College (Advisor: Ross McCauley)

**Dannielle Waugh**, University of Central Florida (Advisor: Chase Mason)

**Danielle Weaver**, CSU-Fullerton (Advisor: Joshua Der)

## AWARDS FOR STUDENTS - GIVEN BY THE SECTIONS

### DEVELOPMENTAL & STRUCTURAL SECTION STUDENT TRAVEL AWARDS

**Ana Andruchow Colombo**, Museo Paleontológico Egidio Ferugio (Advisor: Ignacio Escapa)—for the presentation: *Anatomical studies of two Chilean Podocarpaceae species: insights to the seed cone and leaf morphological evolution of the family*

**Molly Edwards**, Harvard University (Advisor: Elena Kramer)—for the presentation: *Exploring the developmental and genetic basis of complex petal morphologies in bee- and hummingbird-pollinated Aquilegia (columbine)*

**Asia Hightower**, Wayne State University (Advisor: Edward Golenberg)—for the presentation: *Sculpting an imperfect flower: The study of KNUCKLES in primordia regulation*

### ECOLOGICAL SECTION STUDENT TRAVEL AWARDS

**Natalie Love**, University of California, Santa Barbara (Advisor: Dr. Susan Mazer)—for the presentation: *A new phenological metric for use in pheno-climatic models: a case study using herbarium specimens of Streptanthus tortuosus*

**Kristin Peach**, University of California, Santa Barbara (Advisor: Dr. Susan Mazer)—for the presentation: *Rethinking floral attraction: sexual dimorphism in Clarkia unguiculata*

**Meera Lee Sethi**, University of Washington, Seattle (Advisor: Janneke Hille Ris Lambers)—for the presentation: *Higher, Faster, Hungrier: Complex Dynamics of a Subalpine Plant-Insect Herbivore Interaction*

**Tanisha Williams**, University of Connecticut (Advisor: Dr. Kent Holsinger)—for the presentation: *Using species distribution models to assess the impacts contemporary and forecasted climate change has on the distribution patterns of Pelargonium species throughout South Africa*

## PTERIDOLOGICAL SECTION & AMERICAN FERN SOCIETY STUDENT TRAVEL AWARDS

**Helen Holmlund**, University of California, Santa Cruz (Advisor: Jarmila Pittermann)—for the presentation: *High-resolution computed tomography reveals dynamics of desiccation and rehydration in a desiccation-tolerant fern.*

**Alaina Petlewski**, Cornell University (Advisor: Fay-Wei Li)—for the presentation: *Using sequencing technologies to investigate evolutionary questions in Lycopodiaceae*

**Lindsey Riibe**, University of Florida (Advisor: Dr. Emily Sessa)—for the presentation: *Morphology and sequence data resolve the Diplazium praestans mystery*

**David Wickell**, Cornell University (Advisor: Fay-Wei Li)—For the presentation: *CAM photosynthesis in the aquatic lycophyte Isoetes taiwanensis*



# TRIARCH “BOTANICAL IMAGES” STUDENT TRAVEL AWARDS

*This award provides acknowledgement and travel support to BSA meetings for outstanding student work coupling digital images (botanical) with scientific explanations/descriptions designed for the general public.*

1<sup>ST</sup> PLACE  
ROSEMARY GLOS  
CORNELL UNIVERSITY

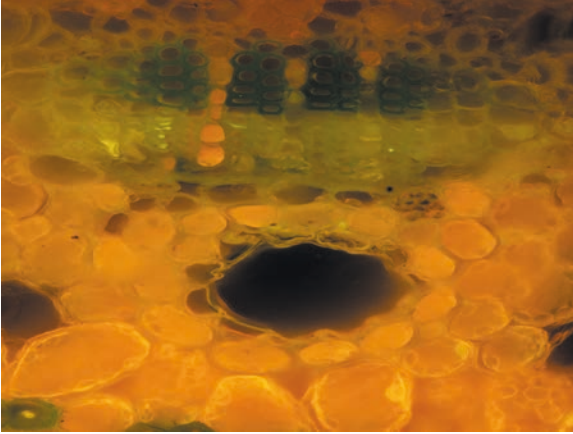


*LOASA NANA*

The Loasaceae are a small, predominantly New World family known colloquially as the “chili nettles,” “stickleafs,” or “blazing stars.” Members of the family bear a morphologically diverse layer of trichomes (hairs), some of which are similar to those found in nettles (*Urtica*) and likewise impart a painful sting. *Loasa nana* is a diminutive member of the Loasaceae that grows in alpine Patagonia. This specimen was photographed at Cerro Catedral, Argentina, at an elevation of approximately 6000 feet. Many members of the Loasaceae, including this taxon, exhibit induced (thigmonastic) stamen movements. If you look closely at the boat-shaped petals (yellow), you can see bundles of stamens, which spring out and release a shower of pollen when triggered by a potential pollinator. A few stamens, the anthers of which are visible in the center of the flower, have already been triggered.

2<sup>ND</sup> PLACE

ANA ANDRUCHOW COLOMBO  
UNIVERSITY OF  
BUENOS AIRES



VASCULAR BUNDLE AND RESIN  
CANAL OF SAXEGOTHAEA LEAF  
UNDER EPIFLUORESCENCE  
LIGHT MICROSCOPY

In this image a detail of the central portion of a leaf of *Saxegothaea conspicua* in cross section can be observed. *Saxegothaea conspicua* is a conifer from Southern Chile and Argentina that belongs to the family Podocarpaceae. Leaves of *S. conspicua* have a single central vascular bundle (or vein) associated with a resin canal. Above, the vascular bundle can be observed comprising the xylem (above, in darker green) and the phloem (below, in lighter green). Three parenchyma rays, which are one-cell thick, can be observed crossing both the xylem and phloem; the one on the left is more easily distinguishable, as the cell content shines in yellow. Below the vascular bundle a single resin canal can be observed. This picture was taken with an epifluorescence light microscope, without previous dyeing the plant tissues. Therefore the different colors observed in this picture are the result of the different chemical composition of each cell type.

3<sup>RD</sup> PLACE

ANNIKA SMITH  
UNIVERSITY OF FLORIDA



THE EGG-BEATER HAIRS OF  
THE WATER FERNS

Much like ducks use their body oil to keep their feathers from becoming waterlogged, water plants also employ various defenses to protect themselves from the water in which they live. *Salvinia* (water ferns) float on the water, and the upper surfaces of their leaves are coated with dense hairs. Any water that is dripped on the top of the leaf forms a bead and runs off quickly, never reaching the surface of the leaf. Looking closely, we can see that the shape of the hairs is incredibly unusual—each individual hair is shaped like an egg beater. In the photograph, we can see the water-repellant properties of the egg-beater shaped hairs in action.

# Public Policy Committee Report from Congressional Visits Day

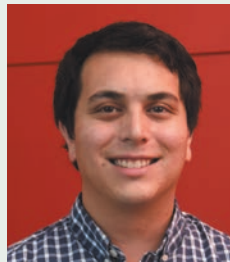
*This year, the BSA awarded the Public Policy Award to two BSA members: Audrey Haynes and Adam Schneider. Each of them---in addition to Jenny Mullikin, who won the award from American Society of Plant Taxonomists (ASPT)---traveled to Washington, DC to participate in this annual policy event sponsored by American Institute of Biological Sciences (AIBS) on March 26 and 27, 2019 to advocate on behalf of federal funding from National Institutes of Health (NIH) and National Science Foundation (NSF) for basic research. Their experiences follow here.*

## AUDREY HAYNES' EXPERIENCE

Science is not insular. Whether we scientists like it or not, there is a reciprocal relationship between science and society. One fundamental influence politics has on science is through research funding. The federal government has historically funded around 60-70% of basic research in the U.S.—but in the last decade that number has shrunk to 44% (Mervis, 2017). This decrease is partly due to increased

investment by pharmaceutical corporations, but primarily to a flattening of the federal science budget. In botany, many researchers are acutely familiar with this through decreased National Science Foundation (NSF) funding rates (currently ~20% [NSF, 2018a]) and the suspension of programs like the Doctoral Dissertation Improvement Grant (NSF, 2018b). Scarce federal funding threatens the future of basic biological science, which may not turn a short-term profit but is vital to solving challenges such as food security, sustaining biodiversity, and combating emergent diseases.

This March I had the honor of attending a Congressional Visits Day in Washington D.C. aimed at addressing this funding deficiency. My first day I gathered with a group of scientists from all over the country and at all career stages at the American Institute of Biological Sciences headquarters for a science communication training. In preparation for our visit to Congress we divided into regions. As a graduate student at UC Berkeley I was part of the California group, which was fittingly a large and diverse group of scientists studying everything from Alzheimer's to mountain lion movement. We practiced telling our unique stories of how federal funding has impacted our work and how that work benefits society.



**By BSA PPC Co-Chairs Krissa Skogen** (*Chicago Botanic Garden*) **and Kal Tuominen** (*Metropolitan State University*) **and ASPT PPC Chair Andrew Pais** (*North Carolina State University*)

The next morning we met up in a cafeteria in the basement of Congress to down some coffee and collect ourselves. Our schedule was packed

with meetings with offices of six members of the House and both California senators. For each meeting, we designated a lead depending on who was a constituent of the policymaker. I was the lead with Barbara Lee and Dianne Feinstein's offices. This was particularly special since, as a Berkeley native, these women have been my representatives for as long as I can remember.

Our ask was at least \$9 billion for NSF and \$41.6 billion for the National Institutes of Health (NIH) in the upcoming fiscal year (FY 2020), a slight increase in funding from the previous year. In contrast, the White House requested to decrease funding for science across the board, including by ~12% for both NSF and NIH (OMB, 2019). The proposed FY 2020 budget is an alarming signal of the president's goals. Ultimately, however, Congress controls the federal budget, so reaching out to policymakers is an important step toward an adequate budget for NSF and NIH.

In our meetings I illustrated the importance of plant ecology research through my experience. My lab has received federal funding to study fire ecology and I study plant water relations. Given California's recent uptick in drought and highly destructive wildfires, this research is essential, something I understand both professionally and personally having almost lost my grandmother's home to the Tubbs Fire in 2017. Federal funding for plant ecology research will help predict, mitigate, and prepare for future extreme events brought on by climate change. I also mentioned that as a recipient of the NSF Graduate Research Fellowship (GRFP), I know how federal funding has directly enabled my career. Since its inception in 1952, the GRFP has supported over 55,000 students (NSF, 2018a). This investment in early-career scientists is key to building our scientific research community and

keeping the U.S. a global leader in scientific innovation. In addition, funding graduate students can reduce financial barriers for young scientists, resulting in a more diverse and inclusive scientific community.

Our California delegation happened to meet only with Democrats who largely supported our request. Intuitively this may seem ineffective, but politics is about priorities. Simply registering support for an issue is not enough to create change; our representatives need to actually prioritize and fight for it. Without the scientific community actively telling our stories, communicating results, and contacting our representatives, science funding will fall to the bottom of the priority list. In the inevitable showdowns over the budget, it's our responsibility to keep federal science funding at the forefront. Science is too important to be collateral damage.



*Audrey Haynes at the U.S. Capitol during Congressional Visits Day.*

## REFERENCES

Mervis, J. Data Check: US government share of basic research funding falls below 50%. *Science Magazine*. March 2017.

<https://www.sciencemag.org/news/2017/03/data-check-us-government-share-basic-research-funding-falls-below-50>

National Science Foundation. NSF FY 2019 Budget Request to Congress. April 2018a. <https://www.nsf.gov/pubs/2018/nsf18022/nsf18022.pdf>

National Science Foundation. DDIG Update. May 2018b. [https://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=245500&org=NSF&from=news](https://www.nsf.gov/news/news_summ.jsp?cntn_id=245500&org=NSF&from=news)

Office of Management and Budget. A Budget for a Better America – President’s Budget FY 2020. March 2019. <https://www.whitehouse.gov/omb/budget/>

## ADAM SCHNEIDER’S EXPERIENCE

“Keep us informed” was a key message I heard repeatedly from lawmakers when asking what I can do to help them support science policy during the 2019 Congressional Visits Day (CVD) last March. At this event, organized by the American Institute of Biological Sciences (AIBS), I joined about 30 other biologists from academia, public agencies, and nonprofit organizations in Washington, DC for training at the AIBS headquarters followed by meetings with members of Congress and their staffs to advocate for federal investment in the biological sciences.

Additional support from the Hendrix College Biology Department allowed me to also participate in the AIBS Communications Training Boot Camp for Scientists, held during the two days preceding the CVD. I learned strategies for communicating to non-specialists the importance of my research and that of others to non-specialists, which I immediately applied to my conversations with lawmakers and their staffs. For example, during the opening morning of the boot camp, we organized our message using the “Communications Triangle”: develop three key messages united by a common and concise big idea, and prepare effective transitions to pivot among these messages in any order. Depending on what best engages your audience, these messages might take the form of a story, statistic, or a memorable example. One Senate staffer I met with pointedly asked the return on investment in NSF funding, although others were most interested in hearing about our specific research projects, or what a scholarship program supported by an NSF grant to some of my colleagues had made possible for their students.

The afternoon session of the first day focused on how science journalism works and how to interact with different types of media. Though various media outlets operate in different ways (hint: know your audience!), much of the advice was broadly applicable, such as “don’t bury the lede”; also, when correcting false information, it’s best to lead with a fact so as not to reinforce the myth.

On the second day, the focus of the workshop pivoted to more directly preparing us to meet with lawmakers. We got an overview of the federal appropriations process, both in general

and specific differences between the Senate and House. Depending on the federal agency involved, several committees are responsible for shaping appropriation bills and then forwarding them to the floor. March and April are when budget resolutions are developed in Congress for the following year (FY2020), so we were asked to specifically request funding increases for the National Science Foundation (to \$9 billion) and National Institutes of Health (to \$41.6 billion) during our meetings from current FY2019 spending levels of \$8.1 and \$39 billion, respectively. These figures were mutually agreed upon by a number of science organizations to provide a strong common message. During our meetings on Capitol Hill, it was a challenge to balance relationship-building with expressing a firm, concrete, and timely “ask.” One of the major benefits of these meetings is developing an opportunity for future dialogue. For example, the staffer interested in my colleague’s NSF grant to support scholarships to Pell-eligible students asked me to connect the two of them after our meeting. At the same time, sometimes the requested funding levels were the only thing that the legislative assistant wrote down from the meeting.

During the last session of the boot camp, we were divided into groups based on geography and received schedules for our meetings the next day on Capitol Hill. I worked with Amrita Banerjee (Vanderbilt University, TN) and Jenny Mullikin (St. Louis University, MO) to hone our message and prepare for a busy day on Capitol Hill.

We had a total of nine meetings, eight of which were scheduled ahead of time. The ninth was an impromptu meeting with a legislative assistant for my representative, French Hill (R - AR). While walking past his office on the way to lunch, I decided it couldn’t hurt to introduce ourselves and leave a couple of handouts.



*Adam Schneider during Congressional Visits Day stopping by to visit Arkansas State Representative French Hill.*

While I was talking to the receptionist, I asked if someone could talk to us, and next thing I knew I was talking to the staffer! Another highlight was having a legislative assistant to Rep. Jim Cooper (D - TN) chase us down in the hallway after our meeting to gleefully follow up (in the affirmative) on my question as to whether Rep. Cooper was a co-sponsor of the Botany Bill (HR1572, <https://botanybill.weebly.com>).

After lunch we had six back-to-back meetings at various Senate offices. One difference between the houses of Congress is that Senate staffs are much larger and more specialized, which was apparent from the much more specific and technical questions posed by the Senate staffers with whom we met. Our last meeting of the day was our only direct meeting with an elected official, Sen. John Boozman (R - AR).

Overall, I highly recommend this experience to all. The communication and civics training provided by AIBS was impactful for me, and I have plans to implement some of the communication strategies to improve my

classroom teaching. From the visits on Capitol Hill, my most lasting takeaways include:

***Decreased cynicism about our government and political process.*** Our visits were nearly universally well received. Washington DC is full of smart people working hard to solve problems and do the right thing, as well as groups of ordinary citizens from many walks of life (and sometimes in colorful t-shirts) participating in our democracy.

***Empowerment*** to set up meetings with lawmakers in the future.

***The importance of citizen activists to support government scientists.*** After a budget is proposed by the president, federal employees are legally bound to support their boss and not criticize or endorse the proposal even though they may be the most informed on those issues.

***Always start with your bottom-line message because you never know how much time you'll have.*** Provide handouts and visual aids. Listen. Dialogue.

***If you are a constituent, mention this in your interactions.*** Your presence will carry more weight.

***In-person meetings in local offices in your home district or state are nearly equally effective*** as travelling to Washington, D.C.

***Build relationships.*** You never know where they will lead.

In summary, I really appreciate AIBS for hosting and organizing this event, as well as the Botanical Society of America and my biology colleagues at Hendrix College

for financial support for my participation in both the Congressional Visit Days and the Communications Training. I am very thankful for this experience!

## JENNY MULLIKIN'S EXPERIENCE

I have been interested in science policy issues ever since I started working as an environmental consultant, conducting biological surveys for use in Clean Water Act and Endangered Species Act permitting. It is a field that I could not continue in long-term, because seeing beautiful Midwestern forests become suburban neighborhoods was a weekly occurrence. Now that I am a graduate student again, I miss being involved in environmental policy. Thanks to ASPT, I was able to attend a Congressional Visits Day (CVD) in Washington, D.C., coordinated by the American Institute for Biological Sciences (AIBS). Finally, my interest in policy and passion for science were reunited.

When I arrived in Washington, my first thought was, "Am I too early for the cherry blossoms?" I was, but I did see tiny pink buds emerging from the trees. My second thought was that I was going to be talking to actual policy makers on issues that matter. I was excited to meet other biologists and learn about their experiences with policy and science, and how they might incorporate that into their careers as scientists. There hasn't been a large push to be involved in policy as a scientist, so it is nice to see other examples of scientists incorporating policy into their careers.

On the first day of the trip, AIBS conducted a communication bootcamp for the participants

in the CVD. We honed our message to our national representatives and met like-minded scientists from across the country. The skills we learned are valuable for communicating science not only to policymakers, but also other non-technical audiences that we interact with daily. We were divided into groups based on geographic location; being from St. Louis, Missouri, I was in the Midwest group with Dr. Adam Schneider from Arkansas and Dr. Amrita Banerjee from Tennessee. It was our job to talk to our collective senators and representatives to advocate for increased funding for both NIH and NSF, the powerhouse funders of science research.

I started the day solo at a Missouri “Coffee with Constituents” event with Senator Roy Blunt. He was very familiar with the importance of science funding to many Missouri institutions, so that was a positive way to start a long day. Afterwards, I met my Midwest group and we raced from buildings on either side of Capitol Hill to nine meetings—two senators and one representative from all three states. We somehow fit in a visit to the National Botanic Gardens over lunch, which was a tropical oasis amid the bustling city outside.

What surprised me is that out of the nine senate and representative meetings we had that day, all but one was receptive to supporting science funding and hearing about our experiences. I talked about the role of science in my hometown of St. Louis or in shaping mine and my colleagues’ careers. However, I also found myself talking about how female bees have long leg hair to hold onto pollen grains, and how that is both adorably cute and important. In the end, I realized that the staffers and representatives are just like friends and family who want to hear about the anecdotes of discovery and silly quirks that make doing science so stimulating and rewarding. Personalizing



*Congressional Visits Day with Jenny Mullikin, Adam Schneider, Sen. John Boozman (R - AR), and Amrita Banerjee.*

and anthropomorphizing our science is not something to be encouraged normally. It’s a delicate balance of engaging non-scientists to care about what is really happening, but also not misinform or misrepresent the results. However, what is vital to spreading the importance of science is to ignite the same interest and passion that we have for science to others. We can drone on about the return on investment that we get from science funding, or how important science is to our daily lives. Those are important deliverables. But really relating to someone on the aspects of science that are interesting to them, and encouraging their curiosity, is what gets them onboard with our message.

I am grateful for the opportunity to participate in CVD. The experience not only stimulated conversation with policymakers on the importance of science funding, but I gained insight into their side of the table as well. It is easy to sit back and talk about what is happening with science and policy and think that it is out of our control. In reality, it takes all of us constantly sharing our stories and passions with legislators to slowly change their minds and make a difference.





# ANNOUNCEMENTS

## In Memoriam

Photo from Princeton University archives



### WILLIAM P. JACOBS (1919-2019)

With great sadness, I have learned that William P. Jacobs, a professor emeritus at Princeton University, passed away on March 3, 2019 in Princeton, New Jersey. He was 99.

Jacobs was born on May 25, 1919, in Boston. He served in the U.S. Army Medical Corps (1942-1944). Jacobs received his Ph.D. in 1946 from Harvard University. He joined the Princeton faculty in 1948 and taught at the University for more than four decades before transferring to emeritus status in 1989.

Jacobs' courses included introductory botany and biology, as well as advanced studies of

plant development. His interest in pedagogy led him to serve on a committee studying the role of botany in college curricula for the Botanical Society of America and another on innovation in lab instruction for the revision of high school biology curricula under the aegis of the American Institute of Biological Sciences.

Jacobs was a world-class biologist who had a huge impact on the understanding of the hormonal control of vascular differentiation and development in plants. His pioneering study published in 1952 in the *American Journal of Botany* opened the field of auxin research in vascular differentiation, by revealing that auxin produced in young leaves induces and controls xylem regeneration around a wound (Jacobs, 1952). Since then, numerous papers used this basic information to explore the role of auxin in vascular differentiation of plants. Jacobs also wrote many pioneering excellent publications on the role of other hormonal signal, like cytokinin and gibberellin, and published more than 170 publications, including his book: "Plant Hormones and Plant Development," published in 1979.

Among his many awards, Jacobs received the Dimond Prize from the Botanical Society of America in 1975 and a Guggenheim Fellowship in 1967. In 1998, he was presented with the American Society of Plant Biologists' Charles Reid Barnes Life Membership Award for achievement in plant physiological research and teaching.

Jacobs will be remembered for his elegant, quantitative, and creative research work on high plants, especially on xylem and

phloem differentiation in his model plant system *Coleus blumei*, as well as his research on the alga *Coulerpa*, which is the world's largest single-cell organism. He used to collect the alga in various sea locations and used to practice his swimming skills during lunchtime at the Princeton University's swimming pool. I always enjoyed joining him for swimming and fruitful research discussions. He had a lifelong love of dancing and therefore arranged and attended countless dance parties.

Jacobs conducted research in a range of laboratories around the world, including the Bahamas, Cuba, England, Italy, and Switzerland.

I remember Bill Jacobs as a very fine human being and an excellent scientist with the highest standards in his work. I feel that I have lost both my knowledgeable mentor and a very good friend. I will always remember him with love for the two productive PostDoc years (1974-76) spent in his laboratory.

He is survived by his wife, Jane Jacobs; two children, Mark and Anne; and five grandchildren.

--Roni Aloni, Tel Aviv University, Israel

## FROM THE *PSB* ARCHIVES

**60 years ago:** Emanuel D. Rudolph of Wellesley College writes about how the concepts of evolution may be brought into beginning Botany courses.

“The value to the students of information about plant evolution, even if it is very incomplete—a prodding indication that botanists are still actively interested in and actively working on evolutionary problems—should be well worth the effort on our parts.”

--Rudolph, Emanuel D. “Evolution in Beginning Botany Courses - The Mid Twentieth - Century Dodo Bird?” *PSB* 5(3): 7-8

**50 years ago:** Irving Knobloch of Michigan State University describes innovative use of visual aids.

“Not wishing to be out of the mainstream of innovation, we have examined the possibility of utilizing some sort of aid not ordinarily used in a plant anatomy course. Heeding the advice of certain psychologists that most of our knowledge is imported to us via our visual organs, we set up units in our laboratory best described as ‘The tri-visual unit.’ This system consists of a rear-view projector, a microscope and a laboratory manual. We use the COC Rotator projectors now made by the Graflex Corporation, as seen in the illustration. This type has an inclined viewing screen which can, if necessary, be used for tracing. The entire projector folds down into a small suitcase-sized unit for easy carrying.

--Knobloch, Irving W. “The Use of Visual Aids in a Plant Anatomy Course” *PSB* 15(2): 4-5

**LI-COR®**

# LI-180 Spectrometer

Capture the spectral composition  
of your light sources  
with a single click.

[www.licor.com/180](http://www.licor.com/180)



# *American Journal of Botany* Announces New *AJB Reviews* feature

The *American Journal of Botany* is pleased to announce the start of *AJB Reviews*, a new article type launching in 2020. These reviews will expand the coverage and reach of the journal by providing timely syntheses of a major issue, and new insights or perspectives to guide future research.

*AJB Reviews*, headed by Dr. Jannice Friedman (Queen's University, Kingston, Ontario, Canada), place topics in context while being forward-thinking and insightful. They can develop new hypotheses and propose general models that help move the field forward. Original interdisciplinary syntheses and articles that cover newly emerging fields are welcomed. Authors can express a personal perspective while maintaining a balanced view of the field.

Anyone interested in submitting an *AJB Reviews* should provide a preliminary summary of up to 250 words. A decision on whether to invite a full review rests with the Editorial Board. All contributions will be fully peer-reviewed, in line with other *AJB* manuscripts.

For more information, go to <https://bit.ly/2LvM1BE> or e-mail the Review Editor at [reviews@botany.org](mailto:reviews@botany.org).





# SPECIAL FEATURES

## Monumental Trees: Guided Walks as an Educational Science Awareness Experience

### ABSTRACT

To reduce “plant blindness” and improve well-being, a new approach has been designed and implemented. The method combines botany and mindfulness activities, developed as a proactive learning experience during guided walks, to positively influence families regarding plant science through the exploration of monumental trees located in different urban gardens of Coimbra, Portugal. This short-term program, developed for

non-formal learning settings, was performed during a Summer Science Program promoted by “Ciência Viva”, the Portuguese Agency for Scientific and Technological Culture. During the botanical and mindfulness activities carried out, public awareness about monumental trees was enhanced through the “Tree of Emotions” activity performed at the end of the botanical guided walk. We measured the effect of this activity by assessing the categories through which participants relate to trees. An open-ended questionnaire was enacted, and content analysis was

**By Raquel Pires Lopes<sup>1</sup>, Cláudia Sintra Vieira<sup>2</sup>, Catarina Schreck Reis<sup>3</sup>, Paulo Renato Trincão<sup>4</sup>, and Amadeu M. V. M. Soares<sup>5</sup>**

<sup>1</sup> Department of Biology and Research Center “Didactics and Technology in Education of Trainers” (CIDTFF), University of Aveiro, University Campus, 3810-193 Aveiro, Portugal, +351 966504315, raquellopes@ua.pt, orcid.org/0000-0003-0499-4850

<sup>2</sup> Psychologist at “Oficina de Psicologia”, 1050-179 Lisbon, Portugal, +351 967 536 075, claudia.sintravieira@gmail.com

<sup>3</sup> Centre for Funcional Ecology, Life Sciences Department, University of Coimbra, 3001-455 Coimbra, Portugal, +351 239 703 897, catarina.reis@exploratorio.pt

<sup>4</sup> Centre for Funcional Ecology, Life Sciences Department, University of Coimbra, 3001-455 Coimbra, Portugal, +351 239 703 897, paulo.trincao@exploratorio.pt

<sup>5</sup> Department of Biology & Center for Environmental and Marine Studies (CESAM), University of Aveiro, 3810-193 Aveiro, Portugal, + 351-234 370 792, asoares@ua.pt

used. The analysis can be broken down into seven categories: ornamental and aesthetic; subjective, affective, and well-being; cultural; dendrometric; morphological; biological and environmental; and anthropomorphic. The most categories identified by participants are subjective, affective, and well-being experiences, revealing the scientific aspects explored. The results suggest that botanical guided walks combined with mindfulness exercises can be an efficient tool for the general public to establish affective links with trees and their surrounding spaces as well gain botany awareness, recognizing its importance in daily life.

### Key words

botanical activities; Trees of Public Interest; people–plant interaction; non-formal learning; outdoor programs; mindfulness.

### Acknowledgements

Raquel Pires Lopes and Catarina Schreck Reis are financially supported by scholarships from the Portuguese Foundation for Science and for Technology, respectively SFRH/BD/91905/2012 and SFRH/BPD/101370/2014. The authors would like to thank the “Exploratório Science Center of Coimbra,” “Oficina de Psicologia,” and “Ciência Viva” for the working partnership, as well as all of the participants in the Summer Science programs. The authors would like to thank all the participants who agreed to collaborate in this study by completing the questionnaires and consenting to the use of their answers. This work is financially supported by National Funds through FCT – “Fundação para a Ciência e a Tecnologia, I.P.” under project UID/CED/00194/2019.

## INTRODUCTION

The expression “monumental trees” has been adopted to refer to ancient trees (Haw, 2014), large, old trees (Lindenmayer et al., 2014; Liu et al., 2019), and other trees that represent a living memory about the historical and cultural identity of communities, also related to aesthetics and subjective enjoyment (Pederson, 2010; Blicharska and Mikusiński, 2014). Trees with special features, such as their longevity or featuring in old tales, are loved by communities and cultivate unusual social ties (Moon, 2014). Large, old trees are known to have important scientific and environmental attributes (Lindenmayer, et al., 2012, 2014), such as actively fixing large amounts of carbon compared to smaller trees (Stephenson et al., 2014), maintaining critical ecosystem functions (Lutz et al., 2018), or providing habitat for a variety of native species (Van der Hoek et al., 2017). In Portugal, trees that are distinguished from others of their species due to their size, design, age, rarity, or other natural, historical, cultural, or aesthetic features have been protected by legislation since 1938. Such trees are often called “Trees of Public Interest.” Once listed as being of public interest, monumental trees become living monuments and, as such, subject to certain advantages and constraints.

In general, however, and despite the value they represent, trees are disproportionately vulnerable in many ecosystems worldwide because of human activity (Lindenmayer et al., 2014; Patrut et al., 2018). Even with global concern about loss of biodiversity, strategies for protection of biodiversity—and plant biodiversity in particular—cannot reduce such loss without increasing public awareness of environmental problems (Fančovičová and Prokop, 2011). However, this is especially challenging since direct contact with nature

has tended to decrease within modern society (Laaksoharju and Rappe, 2017). Indeed, children are becoming disconnected from nature, for a variety of reasons, including urbanization and loss of green space (Bertram and Rehdanz, 2015) and perceived risk of nature, parental fears, or control (Moss, 2012). This leads to serious consequences for attitudes of students and the general public toward the environment and how they perceive nature (Lohr and Pearson-Mims, 2005). For these reasons, it is particularly important to stimulate the pro-environmental values and behaviors of the public (Bogner and Wiseman, 2004). Kattmann (2000) has shown that student interest in biology decreases as age increases, and by the time they become adults, knowledge about biodiversity issues has dissipated. This seems to be consistent with the Eurobarometer (2013) "Attitudes Towards Biodiversity" survey, which found that, across the European Union (EU), less than half (44%) of Europeans have heard the term "biodiversity" and know what it means.

In fact, concerning plant biodiversity, the phenomenon of "plant blindness" has been used to justify the inability to see or notice plants in one's environment, leading to the inability to recognize their importance in the biosphere and in human affairs (Wandersee and Schussler, 2001). To overcome this trend, it is important for people of different ages to increase direct tactile interaction with plants (Neiman and Ades, 2014; Schreck Reis et al., 2014) through educational science awareness actions where participants can focus on monumental trees. As Fančovičová and Prokop (2011) have shown, this strategy is a suitable alternative to conventional biology courses, to positively influence participants' attitudes toward and knowledge of plants. This idea was also reported on by Lohr and Pearson-Mims (2005), who showed that

children's active and passive interactions with plants influence their attitudes and actions toward trees and gardening as adults. In fact, children are more likely to respect trees if they plant and care for them, observing them as they grow and bloom (Viana, 1999). Other studies have showed that playing in nature during the early years forms children into environmentally responsible adults (Chawla, 2015; Broom, 2017).

Outdoor educational programs can be used to promote nature experiences with a positive impact. These interactions stimulate participants' curiosity, sense of empathy for creatures, responsibility for and unity with nature (Dienno and Hilton, 2005), and are also related to children's problem-solving capacities and emotional and intellectual development (Kellert, 2012). Outdoor family activities can play an important role in exploration and discovery, leading to new knowledge acquisition by members of all ages in an easy and pleasant way (Nadelson, 2013). A study conducted by Laaksoharju and Rappe (2017) showed that children's (7 to 12 years old) use of trees in urban spaces increased gradually as their connection with such spaces developed after a garden camp. Trees provided materials, play space, and activities that responded to children's needs.

Additionally, contact with nature has been shown to improve physical and mental health by reducing stress and pain (Kohlleppel et al., 2002; Tsunetsugu et al., 2007; Karjalainen et al., 2010). These studies give consistent evidence that human bodies and minds evolved simultaneously and interdependently. Hinds (2011) proposed that wonderment with the environment allows an individual to experience an uncomplicated state of mind, similar to "mindfulness." This psychological process is commonly defined as a certain

way of paying attention, in which attention is purposefully and non-judgmentally brought to the present experience on a moment-to-moment basis (Kabat-Zinn, 1990). This approach enhances the impact of experiences in nature and strengthens connectedness to nature (Howell et al., 2011). Several potential benefits are associated to mindfulness practice, such as increased body awareness, vitality, levels of concentration, productivity, creativity, and the ability to recognize and accept thoughts and emotions; reduced stress and anxiety levels; better overall emotional well-being and sleep; increased self-awareness and ability to challenge habitual thoughts and reactions to situations; and improved overall mental and physical health (Brown and Ryan, 2003).

Despite an apparent increase in understanding the role of trees in promoting both human and ecological health, and in representing opportunities for social interactions and behaviors (Coley et al., 1997), the specific use of the term “monumental tree” has not been developed in detail. These ideas underpinned the development of this project in which the link between botany and the mindfulness approach is used to develop science-awareness programs about monumental trees. The programs combine botanical exploration with mindfulness activities that increase concentration and favor a connection of the participants to the surroundings, with the intention of contributing to an increase in interest and curiosity about monumental trees, in particular those located in common green spaces of an urban city. This project aims to prevent “plant blindness” and, simultaneously, to promote intergenerational learning in botanical exploration, specifically through the exploration of a specific group of trees, so-called “monumental trees,” a category often largely ignored by the population.

Thus, this study contributes to the literature on science communication by analyzing practical and theoretical methodologies on family programs in the context of non-formal learning settings, as well as assessing the effects of botanical guided walks on children and adults’ pro-environmental attitudes and their emotions and intentions with regard to monumental trees. The tasks carried out allowed interaction between participants as well as stimulated curiosity and the spirit of discovery. Participants were encouraged to hug a tree, walk in silence, listen to the sounds of nature, observe and describe organisms supported by the trees, measure a tree, and/or describe an emotion or feeling.

Our study aimed to: (1) reduce “plant blindness” in children and adults, especially in relation to trees with monumental features; (2) promote botany to a non-specialist public, in a non-formal learning setting; (3) enhance recognition of scientific education and literacy for their contribution to the preservation of communities’ cultural and natural heritage; and (4) develop botanical and mindfulness activities, in outdoor contexts, as a way of sparking interest and knowledge in botany, and monumental trees in particular.

## RESEARCH DESIGN AND METHODOLOGY

### Activity setting

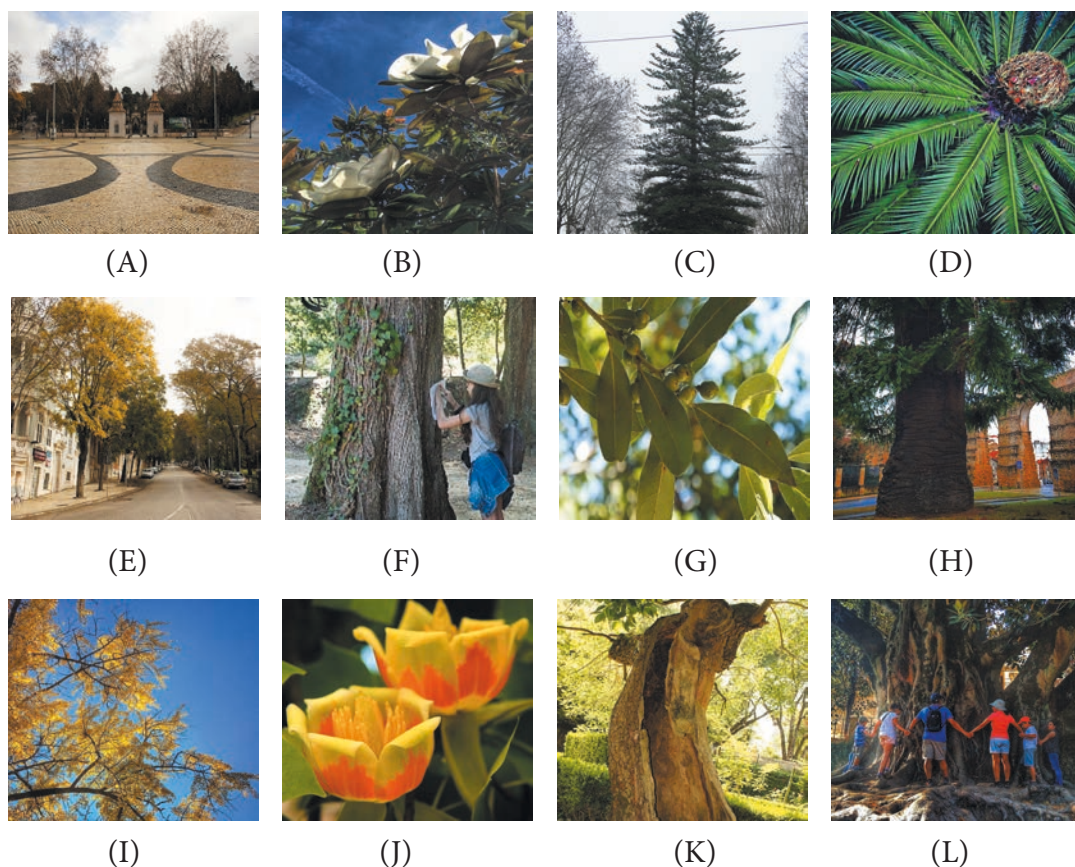
The project “Monumental Trees: Walk to Well-Being” was developed within the context of a nationwide Summer Science Program, promoted by *Ciência Viva* - Portuguese Agency for Scientific and Technological Culture. The sessions were carried out in the city of Coimbra, located in the center region of Portugal, and were included in the Events



of the Exploratório - Coimbra Science Center, in partnership with the Psychology Workshop Center. Four sessions were held over two days (26 July and 19 August 2015). Due to the methodological approach used, the number of people in each group was restricted to 15 people per session to enable greater quality of interaction. All participants agreed to participate in the study on a voluntary basis, after they were given a detailed explanation of the investigation around participant interactions with monumental trees.

### Preparation of the activity

The botanical guided walk was prepared by a researcher and a psychologist, involving a systematic and critical review of research on botanical programs and outdoor learning activities. Thirteen urban trees with monumental features were selected to be the focus of the outdoor learning activities (Figure 1) in different green spaces in the city of Coimbra. The trees were close enough to complete guided walk of 0.93 miles (1.5 km) over a period of three hours.



**Figure 1.** Monumental trees selected for the outdoor learning activities: (A) *Platanus x hispanica*; (B) *Magnolia grandiflora*; (C) *Araucaria heterophylla*; (D) *Cycas revoluta*; (E) *Tipuana tipu* and *Jacaranda mimosifolia* (both species planted along one avenue); (F) *Cupressus lusitânica*; (G) *Laurus nobilis*; (H) *Araucaria bidwilli*; (I) *Ginkgo biloba*; (J) *Liriodendron tulipifera*; (K) *Erythrina crista-galli*; and (L) *Ficus macrophylla*. All photographs by Raquel Pires Lopes (<https://www.instagram.com/followmytree/>).

Apart from their location, the selection reflects the diversity of trees within the city as well as their natural, scientific, historical, cultural, aesthetic, and ethnobotanical importance over time. All trees chosen for the guided walk are considered monumental trees and some have even become legally protected by Portuguese Law, becoming “Trees of Public Interest.” *Ginkgo biloba*, *Liriodendron tulipifera*, and *Erythrina crista-galli*, located at Botanical Garden of the University of Coimbra, also

have specific legal protection (Table 1).

Outdoor learning activities were selected taking into account the tree species, their significance, and the spaces explored. The hands-on and minds-on activities that were developed encouraged direct contact with the botanical elements, using the five senses.

At three of the stops, mindfulness activities were introduced to complement the botanical

**Table 1.** Trees explored and activities performed during the botanical guided walk “Monumental Trees: Walk to Well-Being”

Tree species per stop	Specific aspects	Activities approach	
		Botanic	Mindfulness
<i>Platanus x hispanica</i> (Mill.) Münchh	Aesthetic, scientific and dendrometric aspect	(a) “Dendrometric data”	(f) “Respiration through cardiac coherence” (g) “Breathe deeply”
<i>Magnolia grandiflora</i> L. <i>Araucaria heterophylla</i> (Salisb.) Franco <i>Cycas revoluta</i> Thunb.	Aesthetic, age, scientific and dendrometric aspect	(a) “Dendrometric data” (d) “Living fossil”	
<i>Tipuana tipu</i> (Benth.) Kuntze <i>Jacaranda mimosifolia</i> D. Don	Aesthetic and cultural aspect	(b) “Observe treetops”	
<i>Cupressus lusitanica</i> L. <i>Laurus nobilis</i> L.	Dendrometric and cultural aspect High representativeness	(a) “Dendrometric data”; (b) “Drawing a tree bark”; “Observe treetops”; “Discovers the smell of trees”	(h) “Awakening sounds and breaths” (i) “Explore the five senses”
<i>Araucaria bidwilli</i> Juss.	“Trees of Public Interest” by Portuguese Law	(e) “10 rules to visit monumental trees without damage!”	
<i>Ginkgo biloba</i> L. <i>Liriodendron tulipifera</i> L. <i>Erythrina crista-galli</i> L.	Age, dendrometric, scientific, historic, cultural and aesthetic aspect	(a) “Hug a tree”; “Tree ID”; (c) “2000 species in a tree, let’s find them!”; (d) “Living fossil”	(j) “Grounding”
<i>Ficus macrophylla</i> Desf. ex Pers.	Dendrometric aspect	(k) “Tree of Emotions”	

activities. These methodologies determined the development of tasks to promote connectivity and proximity between monitors, participants, trees, and the spaces explored (Table 2).

### “Tree of Emotions” Data Collection Instrument and Analysis

This study employed a qualitative research design using researchers’ observations and semi-structured interviews with open-ended questions assessed through content analysis collected during the “Tree of Emotions” exercise, completed at the end of the session at each guided walk. During this activity, participants were asked to choose which of the 13 trees explored reflected four different emotions—joy, fear, sadness, and love—according to their individual exploration during the guided walk. We chose this final exercise to gather participants’ observations during the botanical guided walk and to determine attitudes, opinions, perceptions, and knowledge about the monumental trees explored along the different stops. An excerpt from our interview is provided below:

Researcher (R): “*What feeling (joy, fear, sadness, and love) do you associate to the trees explored and why?*”

#### [Joy]

Child (C): “*The leaves have a similar format to a cat face, that I like*” [Liriodendron tulipifera]

(C): “*They have funny fruit*” [Jacaranda mimosifolia]

Adult (A): “*They have a festive name*” [Jacaranda mimosifolia]

(A): “*The happiness in seeing my children play around*” [Liriodendron tulipifera]

#### [Fear]

(C): “*It is hunchbacked like an old man*” [Erythrina crista-galli]

(C): “*It seems afraid and embraces other trees*” [Ficus macrophylla]

(A): “*I’m afraid that giant pine cones fall on me*” [Araucaria bidwilli]

(A): “*Flowers attract many bees that I am afraid of*” [Liriodendron tulipifera]

#### [Sadness]

(C): “*It seems sad and needs a hug*” [Erythrina crista-galli]

(C): “*It is old, and has a big hollow log... It looks very sad*” [Erythrina crista-galli]

(A): “*The tree is incomplete with a hollow log, it has died back*” [Erythrina crista-galli]

(A): “*The trunk color is not festive*” [Ficus macrophylla]

#### [Love]

(C): “*Is like a house, I fit in it*” [Erythrina crista-galli]

(C): “*Two leaves together are a heart*” [Ginkgo biloba]

(A): “*A plant that provides shelter and food to many beings, promoting biodiversity and this is a manifestation of the ‘love of nature’ sharing for all living beings*” [Liriodendron tulipifera]

(A): “*Because of its medicinal properties, which makes us well, like love [does]*” [Ginkgo biloba]

**Table 2.** *Description of the activities performed during the botanical guided walk “Monumental Trees: Walk to Well-Being.”*

	<b>Botanical Activity</b>	<b>Description</b>
(a)	<i>“Dendrometric data”; “Hug a tree”</i>	Determining certain dendrometric parameters related to size, height, and age using measuring instruments (tape measure, rope) or by hugging.
	<i>“Tree ID”</i>	Filling out a document about the tree data (e.g., scientific name, common name, dendrometric parameters, leaf shape, bark).
(b)	<i>“Drawing tree bark”; “Observe treetops”; “Discover the smell of trees”</i>	Analyzing particular features about the trees.
(c)	<i>“2,000 species in a tree, let’s find them!”</i>	Stimulating scientific curiosity through the exploration of botanical elements.
(d)	<i>“Living fossil”</i>	Stimulating scientific curiosity through the exploration of their ecological importance.
(e)	<i>“10 rules to visit monumental trees without damage!”</i>	Exploring the parameters that are used for “Trees of Public Interest” in accordance with Portuguese legislation, and the rules to visit them.
	<b>Mindfulness Activity</b>	<b>Description</b>
(f)	<i>“Respiration through cardiac coherence”</i>	Breathing technique to promote the balanced communication between the heart and the brain, helping to avoid negative feelings.
(g)	<i>“Breathe deeply”</i>	Focusing on the sensations of breathing, getting off autopilot to become aware of the present moment.
(h)	<i>“Awakening sounds and breaths”</i>	Closing the eyes to relax and feel the sensations present, such as breathing, as well as expand the focus of attention to surrounding sounds.
(i)	<i>“Explore the five senses”</i>	Using the five senses to explore the trees (e.g., feel different textures and scents, observe components of each tree).
(j)	<i>“Grounding”</i>	Feeling the importance and the necessity of stability and rooting either trees and humans.
	<b>Botanical and Mindfulness Activity</b>	<b>Description</b>
(k)	<i>“Tree of Emotions”</i>	Choosing a tree along the path that can be identified with certain emotions (joy, sadness, anger, and fear). These emotions are experienced throughout our lives constituting the inner signs of our body.

Responses were recorded by the three researchers during the collective sessions, and notes were later discussed. Participants' key monumental tree concepts were analyzed and categorized through interpretive research by four researchers, two specializing in psychology and two in biology. The researchers validated the answers collected in a collective discussion. The process was repeated to add or discard new coding. This procedure involved all the researchers. Tables were created to present and categorization all answers given.

### Participants

Approximately 39% (n = 23) of the 59 participants in the Science Summer Program were children aged 2 to 16 years old. Adults between the ages of 21 to 71 years old made up 61% (n = 36) of the participants in the program.

## RESULTS

The results presented were obtained from the answers collected during the "Tree of Emotions" exercise. From 236 answers expected (4 questions to 59 participants), a total of 141 answers were obtained (60% response rate): 117 from adults (83%) and 24 from children (17%). Non-response was lower in adults (28%) than children (72%). This may be explained by the fact that some children felt embarrassed of speaking in public or preferred not to answer. In some cases, the whole family worked together in filling the brochure for the guided walk and then one of the adults was the speaker.

### Categories emerging from the "Tree of Emotions" activity

During analysis of the 141 answers obtained in the "Tree of Emotions" exercise, key monumental tree concepts identified by

participants were analyzed and categorized into qualitative categories. Seven categories of concepts emerged and were useful for grouping participants' answers (Table 3). Each answer could have elements that were grouped into more than one category since the overall response reflected several interesting ideas and concepts. In this way, the database is richer.

Both children and adults justified their answers using subjective, affective, and well-being-related aspects with positive and negative feelings (43% of adult and 28% of child responses). Some observations showed concern about physical damage to trees caused by human activity (e.g., "I was sad to see roots damaged by works on the roadside"), dripping sap, or the attraction of insects. Better informed participants also focused on certain problems of particular concern, such as the proliferation of invasive and exotic plants (e.g., "I saw some invasive trees in the Mermaid's Garden and it scares me because they will not give space to our species").

Participants also frequently mentioned morphological features of the trees (19% of adult and 28% of child responses). For example, many participants noticed the giant cones of *Araucaria bidwillii*, the flowers of *Magnolia grandiflora*, *Jacaranda mimosifolia*, and *Liriodendron tulipifera*, and the leaves of *Ginkgo biloba* and *Liriodendron tulipifera*. Both adults and children also mentioned the oldest tree found on the walk, *Erythrina crista-galli*, which is over 200 years old and has a big hole in the trunk contributing to its dieback.

Analysis of the results shows that ornamental and aesthetic value of trees in urban landscapes (14%) and cultural aspects (6%) only occurred in answers from adults. Biological and environmental values occur in 9% of all participants' answers. Regarding cultural

**Table 3.** Representative examples of excerpts from the answers given and emerging categories from the question “What feeling (...) do you associate to the trees explored and why?” from the exercise “Tree of Emotions”.

Categories	Description	Occurrences		Excerpts from the answers given
		Children (C)	Adult (A)	
<b>Ornamental and aesthetic</b>	Related to tree’s presence in the landscape, by adding shape and beauty through their flowers, fruits, or other seasonal aesthetic aspects	0	38	(A): “They give us shade”; “Common in parks and gardens”; “Form very beautiful malls where I like to walk”; “Are pruned”; “Makes the city beautiful”; “Very common in Portugal”; “Have an ornamental use”; “Beautifies the gardens”
<b>Subjective, affective, and well-being</b>	Reflects individuals’ thoughts and feelings (good and bad), life satisfaction, sense of home and family and their own life experiences, by the combination of cognitive judgments and affective reactions	16	114	(C): “They have fun leaves”; “I don’t like cats”; “Gives me fear”; “Seems to be very sad”; “Fun fruit”; “The leaves look like a heart” (A): “It has a festive name”; “It has leaves like cats and I don’t like them”; “I am afraid of bees”; “I am afraid that a cone would fall on me”; “It gives me pity to look at it”; “I feel sad”; “I have affection for it”; “It transmits fear to me”; The happiness of seeing my children play around”; “It reminds me of my childhood”; “Gives me joy”
<b>Cultural</b>	Related with the symbolic value of trees, and sense of community that they inspire	0	15	(A): “When blooming, it is a landmark of the city”; “A strong connection to the city and its students”; “The flowers have the colors of the flag”; “It reminds me of a cemetery and death”

<b>Dendrometric</b>	Related with age and physical characteristics such as habit, shape, and tree measurements (Circumference at Breast Height [DBH], height or canopy dimension)	9	17	(C): <i>“It is too old”</i> ; <i>“Too big”</i> ; <i>“Because it is old and has a huge hole”</i> ; <i>“It’s huge”</i> (A): <i>“Size”</i> ; <i>“The oldest tree we know”</i> ; <i>“It is curved”</i> ; <i>“It’s huge”</i> ; <i>“Too big”</i> ; <i>“Is very old”</i>
<b>Morphological</b>	When description of botanical elements such as roots, trunk, bark, leaves, flowers, fruits, or seeds are present in the answers	16	51	(C): <i>“The tips are separated (trunk and branches)”</i> ; <i>“The leaves have a similar format to a cat face”</i> ; <i>“They have different leaves”</i> (A): <i>“Giant cones”</i> ; <i>“Trunk color”</i> ; <i>“Great growth”</i> ; <i>“Big fruit size”</i> ; <i>“Golden leaves”</i> ; <i>“Hollow log”</i>
<b>Biological and environmental</b>	Associated with the ecological functions of trees, also related with promotion of biodiversity and medicinal properties	2	24	(C): <i>“Grabs other plants”</i> ; <i>“Roots falling”</i> (A): <i>“Filtering air pollutants”</i> ; <i>“Survived the Hiroshima bomb”</i> ; <i>“Choke”</i> ; <i>“It has a chemical substance that can paralyse the body”</i> ; <i>“They have poison”</i> ; <i>“It looks dead”</i> ; <i>“They kill trees around them”</i> ; <i>“Trees that give shelter and food to many beings, this is a manifestation of nature’s love”</i> ; <i>“With medicinal properties”</i> ; <i>“Pigmentation of leaves”</i> ; <i>“Sap drips”</i>
<b>Anthropomorphism</b>	When trees are personified and attributed human features	14	8	(C): <i>“Hunchbacked like an old man”</i> ; <i>“Needs a hug”</i> ; <i>“Seems afraid and embraces the other trees”</i> (A): <i>“Seems to cry”</i> ; <i>“Selfish, looks like an octopus”</i> ; <i>“It has bad behaviors, like many people”</i>

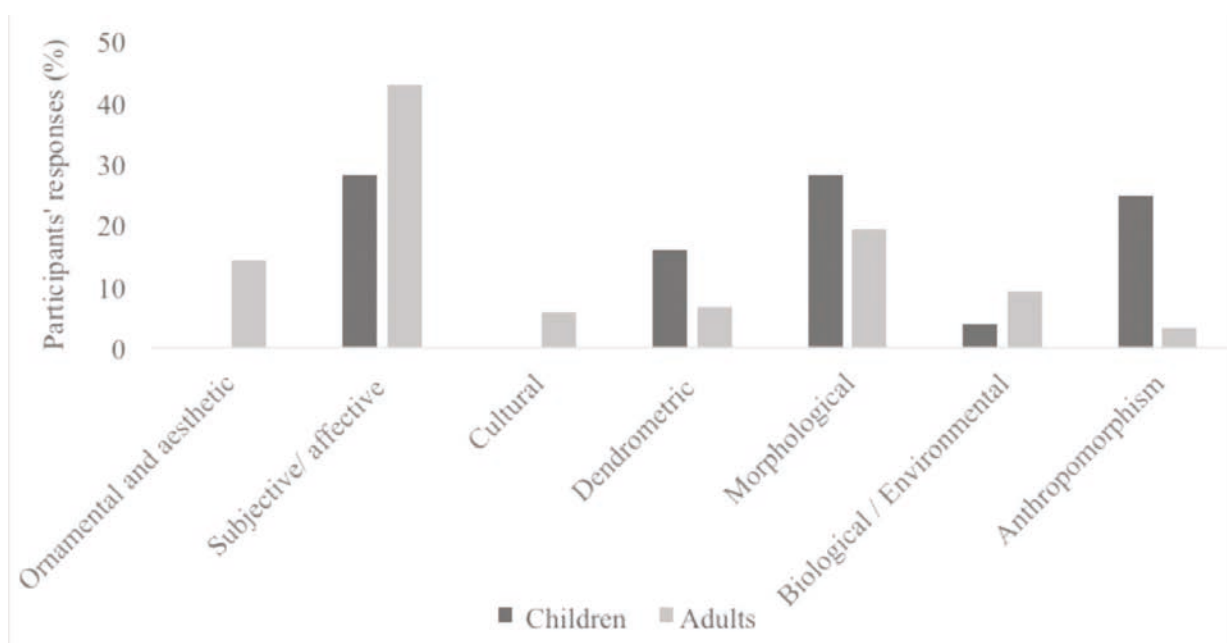
aspects of the trees, we found a connection between tree species and the city, which has an impact on local people. For example, when *Tipuana tipu* and *Jacaranda mimosifolia* are flowering, they have the colors of the city flag. Further, *Liriodendron tulipifera* was frequently referred to as “Árvore do ponto” (“Exam tree”), with a national reference as common name, because past university examination periods coincided with the flowering of this species. Other adult answers reflected dendrometric data (6%) and anthropomorphic features (3%).

Besides morphological aspects, children’s answers focused on anthropomorphic features (24%), where trees take on human traits. The descriptions were so realistic that one can even identify the tree despite no indication of a name. Children’s answers also revealed dendrometric features (16%), such as size and height of the trees, for instance. Fewer answers reflected biological and environmental values (4%). None of the children’s answers reflected ornamental and aesthetic or cultural aspects (Figure 2).

## DISCUSSION

The activities used in this study achieved a dynamic, cooperative, and playful learning involvement between children, their families, and the trees and places explored. The time provided to participants generated greater awareness and a more effective appropriation of the activity, according to the principles of mindfulness.

A large majority of participants were able to associate the emotions (joy, fear, sadness, and love) to the trees explored during the guided walk, and we were able to group the answers into seven categories (ornamental and aesthetic; subjective, affective, and well-being; cultural; dendrometric; morphological; biological and environmental; and anthropomorphic). The answers revealed the use of information provided during the botanical guided walk and were rich and different between the two groups of participants. This can be explained by the differences in age, life experiences, and cognitive development. In the case of the



**Figure 2.** Seven conceptual categories in participants’ answers to the “Tree of Emotions” activity: 117 for adults (A) and 24 for children (C).



anthropomorphism category, for instance, the participants' descriptions were very realistic and adapted to their respective ages. In the children's answers, there seemed to be a naïve perception, while adult responses seemed to reflect human behavior. These observations on anthropomorphism are in line with previous research that showed that trees are often seen as carrying symbolic meaning (Appleyard, 1980, as cited in Dwyer et al., 1991).

For both groups, the most common answers were in the subjective, affective, and well-being category. Participants' responses about the monumental trees evoked both positive and negative emotional reactions. Exploration and discovery of the trees fired the imagination and emotions of participants, as Blicharska and Mikusiński (2014) showed, but also caused loathing or association with beauty or ugliness, which reflects a cognitive, sensory, and individual perception about the tree and the place around. These results are consistent with previous studies about public perception of street trees. In the Schroeder and Cannon (1983) investigation, trees were considered the most important element of urban green spaces, with good and bad impacts to the general public. Dwyer et al. (1991) showed the significance of urban trees and forests to urban residents. Further, Lohr and Pearson-Mims (2006) found that people prefer scenes that have trees more than scenes that have inanimate objects, and have more positive emotions when viewing trees compared to inanimate objects. Some of the occurrences of negative emotions, such as the sadness or fear associated to trees, were deliberately used as discussion topics with the aim of demystifying certain conceptions and generalized ideas without a scientific basis in order to help people to notice and engage with plants. In addition, in most of the occurrences of negative emotions, these were expressed

through displays of concern for the trees and not negative emotions in relation to the trees themselves, which is a good indicator that the activities are on the right track to counteract the plant blindness phenomenon.

Regarding the presence of big trees, adults were impressed by their dimension, shape, and ornamental (e.g., shadow, beauty) and environmental importance (e.g., shade, air renewal). They also showed concern towards trees' abiotic (e.g., shading of buildings by trees), biotic (e.g., bees), and anthropogenic (e.g., root damage, pruning) impacts. Adjectives (e.g., "attractive", "decorative", "beautiful") were often used to describe ornamental and aesthetic features of trees (e.g., canopy, flowers, leaves). These observations seem to be consistent with a past study that found that larger and older trees are the most attractive to the public (Schroeder and Cannon, 1983). Dwyer et al. (1991) also showed that streets with mostly large, old trees of a single species may appear attractive, but they are susceptible to sudden loss of scenic value due to damage, pests, and breakage and may be costlier to maintain, such as the Emerald Ash Borer, and its extensive mortality of ash (*Fraxinus* spp.) (Liu, 2017). In a more recent study, a survey conducted in Morelia, Mexico, revealed that people prefer tall, leafy, and shady trees and consider that trees were beneficial to them, and for the city, by improving environmental quality, and aesthetically improving the landscape (Camacho-Cervantes et al., 2014).

Despite previous studies stating that air quality is less immediately perceptible than other physical benefits, such as reduced noise and wind speed (Schroeder et al., 2006), responses given by adults reflect trees' capacity to filter air pollutants. Additionally, there seems to be a strong environmental concern in the importance attributed to trees' representation

of biodiversity since plants, animals, and other organisms depend on them.

Researchers also noticed that participants paid more attention to colorful tree species, which was consistent with Kaufman and Lohr (2004), who demonstrated that people respond more positively to plants of some colors than others. Some botanical features could not be observed on the trees, although adults nonetheless recognized the species by their characteristic elements (e.g., flowers, fruits). Such absence of seasonal features sparked a discussion on the importance of repeating the botanical exploration in other seasons, namely spring, fall, or even during the winter, to give participants the opportunity to recognize the changes of the plant during the year (Schreck Reis et al., 2014).

*Cupressus sempervirens* was not explored, but the columnar shape of the species was mentioned during the guided walk. This species was associated with sadness, since it is traditionally used in cemeteries. Several studies showed that people exhibit positive emotional and physiological experiences in their responses to trees in general or to trees with wide, spreading, and globular canopies (Dwyer et al., 1991; Lohr and Pearson-Mims, 2006). Crown shape and density were important parameters mirroring human preference of large spreading street trees rather than columnar trees in Germany (Gerstenberg and Hofmann, 2016). This investigation also showed that a high, two-dimensional crown size to trunk height ratio and a high crown density could be used to predict people's preferences regarding deciduous trees (Gerstenberg and Hofmann, 2016).

Passive observation and active exploration contribute to building positive memories of

trees and certain notions about them. These also contribute to improving values and attitudes and to developing environmental responsibility within a family context. Such activities are a key component for increasing scientific literacy interactions, and have been recommended in several studies (e.g., Drissner et al. 2010; Nadelson 2013; Schreck Reis et al., 2014).

As Dwyer et al. (1991) ask, (1) "How many remember a big tree in front of their parents or grandparents home, and the deep sense of loss when it was removed?"; (2) "How many individuals have planted a tree as a child and watched it mature as they did?"; and (3) "[How many remember] planting trees as 'living memorials' to remember *loved ones*?" (Dwyer et al., 1991, p. 277). A good example of this was a mother with two children that had previously participated in other summer science programs related to trees, due to her children's interest. The example given is consistent with the Neiman and Ades (2014) study, suggesting that outdoor programs promote emotional affinity, giving an individual a concrete memory and a change in attitude for a long time after the activity. Furthermore, as Lohr and Pearson-Mims (2005) have already showed, childhood experiences with nature influence adult sensitivity to trees, and that influence is very strong.

Participant answers also revealed their memories of trees were related to daily life. Some of them, living in Coimbra, mentioned that it was a pleasure to rediscover trees present in their everyday lives that they had never looked at with enough attention. They also said that, from that day forward, they felt that they would pay closer attention to those trees. This observation is consistent with other studies (Dwyer et al., 1991; Sanders, 2007)

that have shown the importance of using everyday learning contexts as an opportunity for children and their families to interact with trees and the places in which they live.

During the final reflection, several participants mentioned that pauses during the guided walk were a way of “*relaxing*,” and allowed them to “*be calmer and become involved with the space and each other*.” Our results are consistent with Mullaney et al. (2015), who observed that, besides the aesthetics and provision of shade, most residents prefer the calming effect of the trees. In fact, combining mindfulness practice with direct contact with trees, not limited to a theoretical presentation of scientific subjects, allowed a greater focus on and connection to the green spaces explored. This approach can be a powerful tool toward facilitating a more effective interaction between people and natural elements, contributing to increased interest and curiosity in monumental trees.

## CONCLUSIONS

Our experimental study has contributed to filling a gap in outdoor learning programs by using monumental trees to reduce “plant blindness.” In addition, the project used intergenerational interaction between children and their parents to explore innovative methodologies for addressing botanical themes, at the same time using a mindfulness approach to promote well-being. The aim of the study, to explore monumental trees, was also innovative since there is a lack of studies about public interaction with this specific group of trees. On the other hand, monumental trees and other plants are present in all cities and are often unnoticed.

The explorations carried out helped participants to notice and engage with plants, thereby sparking interest and increasing knowledge about them. If positive emotions demonstrate appreciation, care, and attention toward the plants, negative emotions such as pity and suffering for the trees themselves also show concern and appreciation for plants. That is, negative aspects pointed out reveal positive outcomes with regards to the objective of the study: the prevention of the plant blindness phenomenon. Aspects related to insensitivity or contempt for plants were not observed.

Methods applied in the study (hands-on and minds-on activities, open-public spaces, botanical and mindfulness approaches) contribute to providing participants with an opportunity to create a more positive attitude toward plants and, specifically, monumental trees. Our methodology was consistent with previous studies and can be adapted to investigate how attitudes toward trees vary through a science program, even such a short-term program as this one. Our survey results support a positive overall assessment of trees and botanical subjects. Contact with participants provided important feedback used to measure strategies and adjustments of the project, to be applied in further sessions.

Our findings provide increased understanding in our efforts to counter the plant blindness phenomenon by showing the interest of non-specialist public in educational science awareness experiences as a way of sparking interest and sharing knowledge in botany. Further research on outdoor activities in formal, non-formal, and informal learning applied to direct experiences with monumental trees and on how to improve the public’s knowledge about that matter is needed in the future.

## LITERATURE CITED

- Bertram, C. and K. Rehdanz. 2015. The role of urban green space for human well-being. *Ecolgi-cal Economics* 120: 139–152.
- Blicharska, M., and G. Mikusiński. 2014. Incorporating social and cultural significance of large old trees in conservation policy. *Conservation Bi-ology* 28: 1558–1567.
- Bogner, F. X., and M. Wiseman. 2004. Outdoor ecology education and pupils' environmental perception in preservation and utilization. *Science Education International* 15: 27-48.
- Broom, C. 2017. Exploring the relations between childhood experiences in nature and young adults' environmental attitudes and behaviours. *Austra-lian Journal of Environmental Education* 33: 34.
- Brown, K. W., and R. M. Ryan. 2003. The benefits of being present: mindfulness and its role in psy-chological well-being. *Journal of Personality and Social Psychology* 84: 822.
- Camacho-Cervantes, M., J. E. Schondube, A. Castillo, and I. MacGregor-Fors. 2014. How do people perceive urban trees? Assessing likes and dislikes in relation to the trees of a city. *Urban Ecosystems* 17: 761-773.
- Chawla, L. 2015. Benefits of nature contact for children. *Journal of Planning Literature* 30: 10.1177/0885412215595441.
- Coley, R. L., W. C. Sullivan, and F. E. Kuo. 1997. Where does community grow? The social context created by nature in urban public housing. *Envi-ronment and Behavior* 29: 468-494.
- Dienno C. M., and S. C. Hilton. 2005. High school students' knowledge, attitudes, and levels of enjoyment of an environmental education unit on nonnative plants. *The Journal of Environmen-tal Education* 37: 13-25.
- Drissner, J., H. Haase, and K. Hille. 2010. Short-term environmental education - does it work? - An evaluation of the 'green classroom'. *Journal of Biological Education* 44: 149-155.
- Dwyer, J. F., H. W. Schroeder, and P. H. Gobster. 1991. The significance of urban trees and for-ests: toward a deeper understanding of values. *Journal of Arboriculture* 17: 276-284. Retrieved from [http://www.nrs.fs.fed.us/pubs/jrnl/1991/nc\\_1991\\_dwyer\\_001.pdf](http://www.nrs.fs.fed.us/pubs/jrnl/1991/nc_1991_dwyer_001.pdf)
- Eurobarometer. 2013. Attitudes towards biodi-versity Summary. *European Commission*. Flash Eurobarometer 379. Available at [http://ec.europa.eu/public\\_opinion/flash/fl\\_379\\_sum\\_en.pdf](http://ec.europa.eu/public_opinion/flash/fl_379_sum_en.pdf).
- Fančovičová, J., and P. Prokop. 2011. Plants have a chance outdoor: Educational Programmes alter students' knowledge and attitudes towards plants. *Envi-onmental Education Research* 17: 537-551.
- Gerstenberg, T., and M. Hofmann. 2016. percep-tion and preference of trees: A psychological con-tribution to tree species selection in urban areas. *Urban Forestry & Urban Greening* 15: 103-111.
- Haw, K. 2014. *Ancient Trees*. Woodland Trust Wood Wise: Woodland Conservation News.
- Hinds, J. 2011. Exploring the psychological re-wards of a wilderness experience: An interpretive phenomenological analysis. *The Humanistic Psy-chologist* 39: 189-205.
- Howell, A. J., R. L. Dopko, H. A. Passmore, and K. Buro. 2011. Nature connectedness: Associa-tions with well-being and mindfulness. *Person-al-ity and Individual Differences* 51: 166-171.
- Kabat-Zinn, J. 1990. *Full catastrophe living*. New York: Dell Publishing.
- Karjalainen, E., T. Sarjala, and H. Raitio. 2010. Promoting human health through forests: over-view and major challenges. *Environmental Health and Preventive Medicine* 15: 1-8.

- Kattmann, U. 2000. Lernmotivation und Interesse im Biologieunterricht. *Lehren und Lernen im Biologieunterricht* S.13-31.
- Kaufman, A. J. and V. I. Lohr. 2004. Does plant color affect emotional and physiological responses to landscapes? *Acta Horticulturae* 639: 229-233.
- Kellert, S. R. 2012. *Building for Life: Designing and understanding the human-nature connection*. Washington, D.C.: Island Press.
- Kohlleppel, T., J. C. Bradley, and S. Jacob. 2002. A walk through the garden: Can a visit to a botanic garden reduce stress? *HortTechnology* 12: 489-491.
- Laaksoharju, T., and E. Rappe. 2017. Trees as affordances for connectedness to place: A model to facilitate children's relationship with nature. *Urban Forestry & Urban Greening* 28: 150-159.
- Lindenmayer, D. B., W. F. Laurance, and J. F. Franklin. 2012. Global decline in large old trees. *Science* 338: 1305-1306.
- Lindenmayer, D. B., W. F. Laurance, J. F. Franklin, G. E. Likens, S. C. Banks, Blanchard, W., P. Gibbons, et al. 2014. New policies for old trees: averting a global crisis in a keystone ecological structure. *Conservation Letters* 7: 61-69.
- Liu, H. 2017. Under siege: Ash management in the wake of the emerald ash borer. *Journal of Integrated Pest Management* 9: 5.
- Liu, J., D. B. Lindenmayer, W. Yang, Y. Ren, M. J. Campbell, C. Wu, Y. Luo, et al. 2019. Diversity and density patterns of large old trees in China. *Science of the Total Environment* 655: 255-262.
- Lohr, V. I., and C. H. Pearson-Mims. 2005. Children's active and passive interactions with plants influence their attitudes and actions toward trees and gardening as adults. *HortTechnology* 15: 472-476.
- Lohr, V. I., and C. H. Pearson-Mims. 2006. Responses to scenes with spreading, rounded, and conical tree forms. *Environment and Behavior* 38: 667-688.
- Lutz, J. A., T. J. Furniss, D. J. Johnson, S. J. Davies, D. Allen, A. Alonso, Kristina J. Anderson-Teixeira, et al. 2018. Global importance of large-diameter trees. *Global Ecology and Biogeography* 27: 849-864.
- Moon, B. 2014. *Ancient Trees: Portraits of Time*. Abbeville Press: New York, New York.
- Moss, S. 2012. *Natural Childhood*. London: National Trust.
- Mullaney, J., T. Lucke, and S. J. Trueman. 2015. A review of benefits and challenges in growing street trees in paved urban environments. *Landscape and Urban Planning* 134: 157-166.
- Nadelson, L. S. 2013. Who is watching and who is playing: Parental engagement with children at a hands-on science center. *The Journal of Educational Research* 106: 478-484.
- Neiman, Z., and C. Ades. 2014. Contact with nature: effects of field trips on pro-environmental knowledge, intentions and attitudes. *Ciência & Educação (Bauru)* 20: 889-902.
- Patrut, A., S. Woodborne, R. T. Patrut, L. Rakosy, D. A. Lowy, G. Hall, and K. F. von Reden. 2018. The demise of the largest and oldest African baobabs. *Nature Plants* 4: 423.
- Pederson, N. 2010. External characteristics of old trees in the eastern deciduous forest. *Natural Areas Journal* 30: 396-407.
- Sanders, D. L. 2007. Making public the private life of plants: the contribution of informal learning environments. *International Journal of Science Education* 29: 1209-1228.

- Schreck Reis, C., A. Moreira, H. Nunes, C. Azevedo, R. Lopes, and P. Trincão. 2014. Botanical Kits “Let’s Sow Science!” In Costa, M. F., P. M. Pombo, and J. B. Dorrió (Eds): *Hands-on Science – Science Education with and for Society: Hands on Science Network*, pp. 87-95.
- Schroeder, H. W., and W. N. Cannon. 1983. The esthetic contribution of trees to residential streets in Ohio towns. *Journal of Arboriculture* 9: 237-243.
- Schroeder, H., J. Flannigan, and R. Coles. 2006. Residents’ Attitudes Toward Street Trees in the UK and US communities. *Arboriculture and Urban Forestry* 32: 236-246.
- Stephenson, N. L., A. J. Das, R. Condit, S. E. Russo, P. J. Baker, N. G. Beckman, D. A. Coomes, et al. 2014. Rate of tree carbon accumulation increases continuously with tree size. *Nature* 507: 90-93.
- Tsunetsugu, Y., B. J. Park, H. Ishii, H. Hirano, T. Kagawa, and Y. Miyazaki. 2007. Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in Yamagata Prefecture, Japan. *Journal of Physiological Anthropology* 26: 135-142.
- Van der Hoek, Y., G. V. Gaona, and K. Martin. 2017. The diversity, distribution and conservation status of the tree-cavity nesting birds of the world. *Diversity and Distributions* 23: 1120–1131.
- Viana, M. 1999. *Environmental education: technical staff and their critical confrontation with the science curricula of 5 and 7 years of basic education. Contributions to the formation of teachers*. University of Aveiro: Department of Educational Teaching - Department of Biology - Department of Geosciences.
- Wandersee, J. H., and E. E. Schussler, E. 2001. Toward a theory of plant blindness. *Plant Science Bulletin* 47: 2-9.



## Education News and Notes

### CONGRATULATIONS TO 2019 BESSEY AWARD WINNER SUZANNE KOPTUR!

This year the BSA recognized **Dr. Suzanne Koptur**, Professor at Florida International University, with the Charles Edwin Bessey Teaching Award. This award recognizes outstanding contributions made to botanical instruction and celebrates individuals whose work has improved the quality of botanical education at a regional, national, or international level. The Bessey Award is the highest honor for Teaching and Educational Outreach given by the Botanical Society of America.

Suzanne has been an active member of the BSA since graduate school. She has presented over 40 papers at BSA conferences over the years, both ecological and educational, and



is a member of the Teaching, Ecology, and Tropical Biology sections.

Suzanne is a clear fit with the qualities recognized by the Charles Edwin Bessey Teaching Award. During her career she has mentored an exceptional number of graduate and undergraduate students, including many from groups under-represented in the sciences. She actively seeks funding to provide early opportunities for her students, providing opportunities for undergraduate researchers to join her and her graduate students in the lab and field, supporting and encouraging them to attend and present at botanical meetings, and to be involved in the PLANTS mentoring program and other career-building opportunities. In 2017 she was awarded the **FIU University Graduate Student Provost Award for Mentorship of Graduate Students**, which recognized her mentoring efforts. One of her former students writes: “Through her vocation to training the



**By Dr. Catrina Adams,**  
*Education Director*

*BSA Science Education News and Notes serves as an update about the BSA's education efforts and the broader education scene. We invite you to submit news items or ideas for future features. Contact Catrina Adams, Education Director, at [cadams@botany.org](mailto:cadams@botany.org).*

next generation of botanists, she has left a lasting legacy. Every one of us that has had the great fortune in having Suzanne as a teacher will go forth as emissaries for science, creating a ripple effect that will spread her passion for plants far and wide throughout the world.”

Suzanne is an active and engaged teacher who embraces new teaching techniques like active learning, flipped courses, and online teaching. She was active in creating a new FIU initiative, **Quantifying Biology in the Classroom (QBIC)**, to help biology students develop quantitative skills to help them succeed. She served as the QBIC director from 2012 to 2016, and continues to serve this program as co-director. She contributes to the research on teaching and has made great impact in developing and supporting a culture of teaching innovation within her department.

In addition to her work at FIU, she is active in community outreach. She has been a supporter and proponent of Fairchild Tropical Botanic Garden’s Connect to Protect program encouraging citizens and schools to help create habitat corridors between the endangered South Florida Pine Rocklands.

She has worked with local schools to build butterfly gardens, organizes several conferences that bring researchers and natural resource management professionals together, and serves on county committees to develop conservation initiatives.

The Bessey Award is given annually in honor of one of the great developers of botanical education, Dr. Charles Edwin Bessey. Dr. Bessey served first as professor of botany and horticulture, and later as dean at the University of Nebraska. His work and dedication to improving the educational aspects of Botany are most noted in what Nebraskans call “The Bessey Era” (1886-1915), during which Nebraska developed an extraordinary

program in botany and ranked among the top five schools in the United States for the number of its undergraduates who became famous botanists.

Past Bessey award winners include: Lena Struwe, J. Phil Gibson, Bruce K. Kirchoff, Shona Ellis, Paul H. Williams, Les Hickock and Thomas R. Warne, Susan Singer, Geoff Burrows, Chris Martine, Roger Hangarter, Beverly Brown, Michael Pollan, Thomas Rost, James Wandersee, W. Hardy Eshbaugh, David W. Lee, Donald Kaplan, Joseph Novak, William Jensen, Joseph E. Armstrong, Marshall D. Sundberg, Gordon Uno, Barbara W. Saigo and Roy H. Saigo, and Samuel Noel Postlethwait.

## SEEKING 20 GRADUATE STUDENTS AND POST-DOCTORAL RESEARCHERS FOR PLANTINGSCIENCE MASTER PLANT SCIENCE TEAM ONLINE MENTORING OPPORTUNITY

*“I wanted to get in contact with school kids, because I think this is a great time—if you want to do science communication, this is a great age to get students engaged in science.”*  
– PlantingScience Liaison

Graduate students and post-doctoral researchers: does mentoring with PlantingScience sound exciting to you? Do you have good communication skills already and some experience with or a strong interest in helping secondary students and teachers? If so, consider serving as a teacher/scientist liaison as part of our Master Plant Science Team. We provide training in what it takes to excel as an online mentor and reveal behind-



the-scenes aspects of how the program works. First, you'll get to mentor several teams to learn the ropes and practice mentoring with diverse groups of students. Then you are paired with one of our participating teachers to help the teacher get the most from the program, make sure the teacher's mentors get the classroom and scheduling context they need to be good mentors, and helping to keep the student/scientist conversations going strong. It is an excellent opportunity to see how a variety of mentoring styles play out with students and a powerful way to develop your own mentoring and communication style. Liaisons make the program possible! In exchange for your extra help, we sponsor your BSA membership for the year and provide a 50% discount off of meeting registration. Learn more and apply (by August 11): <https://plantingscience.org/joinmpst>

**Trying to decide if this opportunity is for you?** Join us at the PlantingScience Reception Monday at Botany 2019 to learn more about the program. You'll meet mentors and former MPST members who can share their experiences working with PlantingScience.

You can also take a look at the PlantingScience Star Project Gallery to see examples of the work of PlantingScience student teams and the conversations they had with their scientist mentors over the course of their project: <https://plantingscience.org/psprojects/starprojectgallery>

Many thanks to the following **2018-2019 BSA-sponsored MPSTs** for their hard work and dedication: Ioana Anghel, Alina Avanesyan, Liming Cai, Ghana S. Challa, Foong Lian Chee, Mason Kamalani Chock, Aayudh Das, Kelsey Fisher, Laura Klein, Joshua Kraft, Jill Marzolino, Angela McDonnell, Molly Ng, Funmilola Mabel Ojo, Mischa Olson, Carlos J. Pasiche-Lisboa, Kelly Pfeiler, Christina Scara, Jaime Schwoch, Elizabeth Scott,

Nicolette Sipperly, Elizabeth Stunz, and Lauren Elizabeth Whitehurst.

## FEATURED EDUCATION RESOURCE

Check out cool teaching resources that have just been release on BSA's PlantEd Digital Library platform!

### Tree Tender Supplemental Teaching Bundle

([https://planted.botany.org/r2701/tree\\_tender\\_supplemental\\_teaching\\_bundle](https://planted.botany.org/r2701/tree_tender_supplemental_teaching_bundle))

The short film Tree Tender (2016) follows a young woman, Gaia, becoming the newest Tree Tender, learning about the Tree of Life, the connections between all organisms on the Tree, the importance of understanding these connections, and the human-caused mass extinction currently occurring. Each of the major concepts is highlighted in this bundle of educational resources appropriate for both K-12 and Undergraduate Education. All materials will assist in increasing critical thinking and communication skills while connecting current events, events from the film, and scientific knowledge.

Login to PlantED to download resources: <https://planted.botany.org/>

Submit Your Teaching Ideas to PlantED: [https://planted.botany.org/EcoEdDL\\_SubmissionInstructions](https://planted.botany.org/EcoEdDL_SubmissionInstructions)

# EDUCATION FEATURES AT BOTANY 2019: SKY ISLANDS AND DESERT SEAS

Joining us in Tucson? Consider attending some of the many education, outreach, and training opportunities:

## Sunday, July 28

- Workshop: Present your Work in Three Minutes
- Workshop: Using HHMI Videos and Data Points as Tools for Engaging Students from Molecules to Ecosystems
- Workshop: Broadening Botanical Pathways in Teaching
- Workshop: Empowering Citizen Science Leaders with Tools for Robust Community Engagement
- Workshop: Interdisciplinary Outreach through Botanical Data
- Workshop: Timing is Everything! Using Phenology to Stimulate Interest by Undergraduate Students in the Plant Sciences and Climate Change
- Workshop: Strategies for Successful Faculty/Undergraduate Student Collaborative Research at PUIs

## • Monday, July 29

- Contributed Paper Session Education and Outreach I: Creating an Inclusive Experience in the Classroom and Across the Discipline
- Special Session: The Future of Botany: Educating for a Diverse and Inclusive Community in Botany
- Reception: PlantingScience Reception

## Tuesday, July 30

- Contributed Paper Session Education and Outreach II

## Wednesday, July 31

- Germinating Ideas: Lightning Talks

**Looking forward to seeing many of you in Tucson!**



# Diversity and Inclusion Initiative

*Join us for exciting programming that promotes our shared goal of expanding the community of plant scientists!*



*Sunday, July 28th, 10:00AM - 3:00PM*  
*Workshop*

## **Broadening Botanical Pathways in Teaching**

*Monday, July 29th, 8:00AM - 11:45AM*  
*Contributed Papers: Education and Outreach*

## **Creating an Inclusive Experience in the Classroom and Across the Discipline**

*Monday, July 29th, 1:30PM - 5:15PM*  
*Special Session*

## **Educating for a Diverse and Inclusive Community in Botany**

*These sessions are pending support by the  
National Science Foundation*



*Any opinions, findings, and conclusions  
or recommendations expressed in this  
material are those of the author(s) and  
do not necessarily reflect the views of the  
National Science Foundation*

The Botanical Society of America invites members to

JOIN THE 2019-2020

# planting science

MASTER PLANT  
SCIENCE TEAM



The Master Plant Science Team provides compensation for a cohort of 20 graduate students and postdocs who make a substantial contribution as an online scientist mentor.

Master Plant Science Team Members receive

- Free membership to BSA for the year commitment
- 50% off meeting registration to Botany 2020 in Anchorage, Alaska
- PlantingScience T-shirt

Team involvement Requirements

- Participate in online mentorship training
- Mentor 2-3 student teams via the web during BOTH fall and spring sessions (each session lasts ~2 months)
- Post to student web pages ~3 times per week
- Provide extra support and facilitate communication for one classroom teacher and his or her teams

One year as a member of the Master Plant Science Team has the potential to positively affect the rest of your professional life and inspire lifelong appreciation for plant science in young learners.

*Participating as a mentor with PlantingScience has been a tremendously valuable experience! I feel like I have an opportunity to communicate my life's passion as a scientist and researcher to students in a medium that makes such communication possible like no other resource I have seen.*

*How could any scientist not want to do this? Learning from the students and understanding how they approach scientific topics and the scientific method help me communicate my research to a more general audience. Simply put, PlantingScience makes me a better researcher and teacher.*

-Former Master Plant Science Team



**BOTANICAL SOCIETY OF AMERICA**  
leading scientists and educators  
since 1893

Apply at [HTTPS://PLANTINGSCIENCE.ORG/JOINMPST](https://plantingscience.org/joinmpst)

Please apply by August 11, 2019. For details or to apply:  
[psteam@plantingscience.org](mailto:psteam@plantingscience.org).

BSA membership is not required. Please pass this information on to others who might be interested.



# STUDENT SECTION

## A Journey to the Southwest: A Student's Guide for Botany 2019

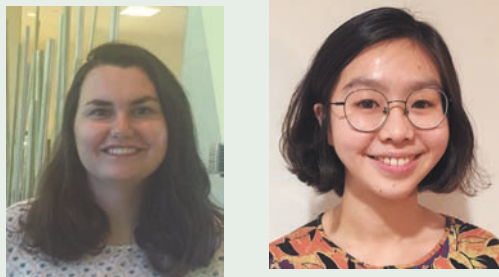
The annual Botany conference is nearly here! With 6 days of formal talks, dual poster sessions, workshops, field trips, social events, networking, and more, you're probably wondering how you can get the most out of this year's experience. Well, don't worry because we've got you covered in our student-focused guide below.

### TRAVEL AND LODGING

1. **Finding a Roommate:** Are you looking to save \$\$\$ by splitting hotel costs at Botany 2019? Check out BSA's nifty roommate finder tool at the conference site at <http://images.botany.org/housing/roommate.shtml>. It can be a great way to connect with your peers, make new friends, and forge life-long professional connections. Also, for more information on discounted hotel rates check out: <http://www.botanyconference.org/hotels.html>.

2. **Volunteer at the Conference:** Did you know that you can earn your early registration fee back if you volunteer to assist BSA staff at the conference? In fact, the conference couldn't happen without the gracious help of students who run the registration booth, monitor ticketed events, and make sure that sections, symposia, and colloquia run smoothly. As long as you registered for the conference by May 31, you should have received the email requesting applications for student volunteers. When you work 10 hours at the conference as an assistant, you earn back your conference registration fee and will be reimbursed.

3. **Plan ahead for Next Year's Travel Grants:** Although it is too late to apply for BSA-related travel grants this year, keep these opportunities on your radar for spring 2020! You can find a consolidated list of these awards as well as details pertaining to them online at <http://www.botanyconference.org/awards-given-at-botany-2019.html>!



By **Chelsea Pretz and Min Ya**  
*BSA Student Representatives*

### EVENTS FOR STUDENTS

If you have already registered for Botany 2019, it is incredibly easy to add events to your conference registration! Navigate to the conference website at <http://www.botanyconference.org/> and click the link "Register Online for Botany 2019". Once you are redirected to the registration page, then

click “Modify Registration”. Please note that while some events are free, all of them are reasonably priced!

## Saturday, July 27: Fun in the Field

**Field trips:** There are several field trips to get to know the area and other botanical professionals! These range from exploring the desert flora of the Tucson Mountains to Bats of Southern Arizona. BSA student members can be reimbursed up to \$100 for this field trip, but this is on a first-come basis. Learn more about the field trips by visiting the conference website: <http://www.botanyconference.org/field-trips.html>.

## Sunday, July 28: Student-Focused Workshops

Every year at the Botany conference, Sunday is filled with many different opportunities to network and learn new skills. Below we highlight some of the student-focused workshops, but for the full list, visit the conference website: <http://www.botanyconference.org/workshops.html>.

**Professional Writing: Covering Personal Statements, Research Statements, and Teaching Statements:** This BSA Student Rep-hosted workshop will be led by professionals that will provide an informational lecture, followed by time to work on an outline for one of these statements. (Free, but please register!)

**Tips for Success: Applying to Graduate School:** Led by Anna Monfils, this is a panel discussion designed to introduce undergraduate students to the specific requirements for applying to graduate programs in plant biology. (Free, but please register!)

**Undergraduate Student Networking Event:** This is our third annual Undergraduate Student Networking Event, which will be held before the Plenary Lecture on Sunday evening (5:30 - 7:00 pm). This event was a great success last year! Not only will it provide attendees with an excellent opportunity to meet fellow undergrads, but it will also allow individuals to make some new friends/contacts to help them navigate through the rest of the conference. You'll also get a chance to hear about different career paths! (Free – food will be included!)

## Monday, July 29: Must-Attend Events

**Student Involvement in Botany Luncheon – A Focus on Botanical Career Opportunities:** What can you do with a degree in botany? Make sure that you are present at the annual Student Luncheon to find out! We will kick off the event with a short talk from our keynote speaker, Dr. Betsy Arnold, who is a professor at the University of Arizona and the curator of the RLG Mycological Herbarium. Then, you will get a chance to chat with panelists from various career paths in a “speed-dating” format. FYI: the panelists usually have insider information on open positions for graduate school or careers. (\$10 - includes a catered lunch)

**Student Social and Networking Event:** This year's event, sponsored in part by the BSA

publishing partner Wiley, will be held at the Playground in Tucson. More information on transportation will be provided closer to the event. Come catch up with old friends and meet new ones while enjoying craft brews and snacks. (\$10 - includes a drink ticket)

**Poster Session:** Whether you are presenting your own work or just there to see what other people are working on, this is a great time to talk science, learn about cutting-edge plant research, and meet people! Poster sessions will happen on Monday, July 29. Be sure to check out a detailed schedule on the web at <https://www.botanyconference.org/engine/search> or via the Botany Conference app, which will be available soon! (Free - no ticket required)

## OTHER NOTABLE EVENTS

**CV Review Sessions:** Want to have your CV reviewed by someone with a lot of experience before you send it out for job/school application? Botany 2019 has got you covered this year! BSA has teamed up with other scientific societies to organize these review sessions. This will be a one-on-one review session where you can get feedback on your CV. This is completely free, but does require you to sign-up for a slot. Sign up here: <https://docs.google.com/spreadsheets/d/1CC9kgGmO5Js9ZVgjGBldKlKH0KrOiu8QzRp2zuRqVgk/edit?usp=sharing>.

**For most ticketed events, it's not too late to register!** Tickets for these events are easy to add to your conference registration: Navigate to the conference website at <http://www.botanyconference.org/> and click the link "Register Online for Botany 2019". Once you are redirected to the registration page, click "Modify Registration". You can also register for events at the registration booth once you arrive at the conference; however, events tend to fill up fast so plan accordingly!

## THE BOTANY CONFERENCE APP

**Schedule Planner:** With so many events occurring during the conference, planning each day can be a daunting task! However, with the Botany conference app, you will have the freedom to effortlessly browse talks and events as well as create your own easily accessible schedule to stay on track. The app for this year has not been released yet, so make sure to read your BSA newsletters that come via email and keep tabs on the conference website (<http://www.botanyconference.org/>) for more details!

**Share your Botany experience:** Social media allows you to share your experiences at the conference, and the number of tweets, posts, likes, and shares are growing every year. The social media aspect lets you share your photos and thoughts throughout the conference, and it can also be a way to share your work and increase your visibility. It's a great way to see what is going on and keep tabs on all of your conference buddies! Be sure to use #Botany2019 in your posts!

# The Path into Botany: Student Stories from Botany Conferences

## JANET K. MANSARAY'S STORY

As an undergraduate student at Howard University, I spent three years researching the genus *Rumex* in a plant systematics lab with Dr. Janelle Burke. During this experience, I investigated sexual dimorphism and phylogeography to better understand the evolutionary history of *Rumex*. Dr. Burke encouraged me to attend a Botany Conference, and to apply for the Preparing Leaders and Nurturing Tomorrow's Scientists (PLANTS) program. Soon afterwards, I was on my way to Savannah, Georgia to attend my first Botany Conference. The conference was a tad overwhelming at first because there were so many talks and workshops that seemed interesting. As part of the PLANTS program I was paired with two mentors that helped me

navigate the conference. This was incredibly helpful since they helped me to focus on talks that fit my research interests.

In addition to mentors, I was expected to attend informative luncheons and sessions. One of these luncheons focused on the different career options in the field of botany. During this lunch I was able to talk with professors and professionals at various stages in their careers. It was here where I was first introduced to Dr. Laura Lagomarsino. At the time, she was an associate researcher at the Missouri Botanical Garden in St. Louis but would soon be starting as an assistant professor at Louisiana State University. During this conversation, I was immediately excited by the way she expressed approaching systematics on a broader scale by combining aspects of ecology with taxonomy. While talking with Dr. Lagomarsino, she mentioned that she was looking for graduate students. At the time, I was not sure I wanted to pursue a PhD in botany, but after interacting with so many successful, passionate people, I started to change my mind. These interactions gave me the boost I needed to take my botany career more seriously.

After I graduated from Howard University, I accepted a position at the Morris Arboretum of the University of Pennsylvania as a Flora of Pennsylvania Intern. As an intern, I spent half my week digitizing and barcoding specimens as a part of the Mid-Atlantic Megalopolis



By Janet Mansaray (Louisiana State University) and Brian Atkinson (University of Kansas)



At the time, I was not sure I wanted to pursue a PhD in botany, but after interacting with so many successful, passionate people, I started to change my mind. These interactions gave me the boost I needed to take my botany career more seriously.

(MAM) Project and the other half performing necessary herbarium duties (mounting, filing, etc.). During this time, I decided to apply to graduate schools. I recalled the interaction I had with Dr. Lagomarsino during the Botany Conference and how enthusiastic she was about her research, a field that aligned well with my interests. Thus, she was the first professor I reached out to. Within days, she responded and from our various exchanges it seemed like I'd be a great fit for her lab! Just two years after my first Botany meeting, I accepted an offer from Louisiana State University to become Dr. Lagomarsino's first graduate student. Today, my research focus is on the phylogenetics and morphological trait evolution of *Centropogon* subgenus *Centropogon*, a group of neotropical bellflowers. I recently finished my first year of graduate school and I am excited to attend Botany this summer as a graduate student. Not only did the PLANTS program allow me the opportunity to network and meet my current advisor, but it also gave me opportunity to make friends that I still keep in contact with today.

## BRIAN ATKINSON'S STORY

My name is Brian Atkinson and I am a paleobotanist at The University of Kansas (KU). From Antarctica to Japan to the Pacific Northwest, I travel around the world to unearth new species of long extinct plants, and I try to figure out what they can tell us about plant evolution by directly integrating them in evolutionary analyses. In August 2019, I will begin a tenure-track position as an assistant professor/curator in the department of Ecology and Evolutionary Biology and the Biodiversity Institute at KU. I am overwhelmingly excited to start this position and further the field by doing what I love and training students. I've been asked to briefly share my experiences and career path, and it's my pleasure to do so.

My career path wasn't exactly straightforward. I started my undergraduate degree at Ohio University as a fine arts major; however, right before my freshman year began, I had a change of heart and switched my major to Environmental Plant Biology in the Environmental and Plant Biology Department. This was a choice inspired by my enjoyment of drawing/painting plants in high school. The botanical courses that I took were my first memorable introductions to the diversity and evolution of plants. To say the least, my mind was blown and my curiosity caught fire. I followed what further ignited my curiosity and pursued a variety of different research opportunities, but nothing really stuck until I saw a talk on paleobotany by Dr. Gar Rothwell. This was the first time I've ever heard of the field and I was captivated by the way he described how fossil discoveries can make major impacts on our understanding of evolution. Immediately after his talk I asked him if I could do a research project in his lab and Gar generously gave me one, which involved describing a new species of conifer

from the Cretaceous. To say the least, this type of work continued to further my curiosity in a satisfying way, so it was a wrap after that. The project proceeded and Gar encouraged me to join the Botanical Society of America (BSA) and attend the 2011 meetings.

Botany 2011 was the first national conference that I attended and proved to be a significant milestone in my career. Moreover, my attendance was fully funded by the PLANTS program, which aims to enhance diversity at BSA conferences. Although the Paleobotany section was very welcoming, the PLANTS program helped me feel even more welcomed and integrated in Botany by bringing in a diversity of students. A year later, I returned to Botany to give my first talk. I was certainly terrified, but members of the paleobotanical section and others were incredibly supportive of me as well as other students, which certainly took the edge off. I recall someone telling me not to worry because I was among friends. Such experiences and interactions allowed me to feel safe to be intellectually engaged and energized at Botany, which set a high bar for all other conferences—and I found myself returning to these meetings every year since then.

Over the years Botany has continued to be a place where I can communicate my research and ideas by giving talks to a broad

Such experiences and interactions allowed me to feel safe to be intellectually engaged and energized at Botany, which set a high bar for all other conferences—and I found myself returning to these meetings every year since then.

botanical audience, participate in engaging conversations with other researchers, learn about some of the most exciting research, and cultivate collegial and collaborative relationships with other botanists (several of which are now close friends). My experiences at Botany have nourished my research program, and without a doubt these meetings will continue to play an important role in my career. Although I must note that BSA/Botany have much to do in the way of enhancing diversity and inclusion, programs such as PLANTS are critical steps in the right direction.



# BOOK REVIEWS

## Ecological

Atlas of Poetic Botany .....	125
Biodiversity and Climate Change .....	126
Next Generation Biomonitoring: Part 1. Advances in Ecological Research Volume 58..	128

## Economic Botany

Managing the Wild: Stories of People and Plants and Tropical Forests .....	130
Trees in Art.....	132
Why Look at Plants? The Botanical Emergence in Contemporary Art.....	135

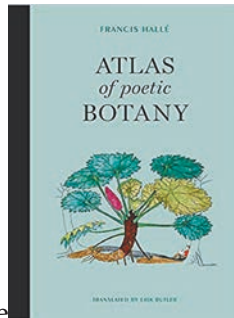
## Systematics

Centric, Araphid and Eunotioid Diatoms of the Coastal Laurentian Great Lakes Bibliotheca Diatomologica, Volume 62 .....	135
Diatom taxonomy and ecology: From France to the sub-Antarctic Islands.....	136
Flora of Florida, Volume VI: Dicotyledons, Convolvulaceae through Paulowniaceae.....	136
Syllabus of Plant Families, Part 1/3: Basidiomycota and Entorrhizomycota .....	137

## ECOLOGICAL

### Atlas of Poetic Botany

Francis Hallé  
2018. ISBN: 978-0-262-03912-3  
Hardcover; \$24.95 (£20.00),  
128 pp.  
MIT Press, Cambridge,  
Massachusetts



This short volume can be considered a coffee-table book that provides a light-hearted treatment of interesting and specialized plants from the tropical regions of the world. The author, Francis Hallé, is a French botanist who has expertise in tropical rainforests with a focus on tree architecture, and this book is an English translation from the original work in French.

Hallé makes a philosophical point of providing drawings rather than photographs, which he

considers to be ephemeral. Rather, the high-quality drawings provide a synthesis and interpretation of the plants, which he shows in an engaging but sometimes a whimsical manner. For instance, he shows a curious shrew sitting on a type of pitcher plant, *Nepenthes lowii*, a species endemic to Borneo. In fact, there is a small locator map provided for each featured plant.

The author refers to one of Darwin's most underappreciated works, the *Power of Movement in Plants* (Darwin and Darwin, 1880) since some of the plants in this book were first described by this seminal scientist. For example, the dancing plant, *Codariocalyx motorius*, is a tropical Asian shrub and is one of the few plants capable of rapid movement in response to sound. Other better-known species that exhibit rapid movement include the sensitive plant (*Mimosa pudica*) and the Venus flytrap (*Dionaea muscipula*).

The book organizes the plants into several topics, including: record-setting species, interesting adaptations, “mysterious” behavior, coevolution between plants and animals, and “biological singularities.” Records include one of the biggest tree in Africa (*Baillonella toxisperma*), the biggest leaf in the world (*Raphia regalis*), and plants with very fast growth rates (water hyacinths, *Eichhornia crassipes*). Adaptations include a plant that is a single leaf (*Monophyllaea insignis*) and an orchid without leaves (*Microcoelia caespitosa*) from western Africa.

Some of the plants considered by the author are well known such as *Rafflesia arnoldii*, which has the largest flower in the world, and the bromeliad Spanish moss (*Tillandsia usneoides*), but most species are not. This book is delightful and will be enjoyed by both amateur and professional botanists.

## LITERATURE CITED:

Darwin C., Darwin F. 1880. The Power of Movement in Plants. John Murray Publishers, London.

--John Z. Kiss, Department of Biology, UNC-Greensboro, Greensboro NC 27402

## Biodiversity and Climate Change

Thomas E. Lovejoy and Lee Hannah

2019. ISBN: 978-0-300-20611-1

Paperback, US\$40.00. 416 pp.

Yale University Press, New Haven, Connecticut, USA.



It can be extremely difficult to stay informed in a field that is constantly expanding in terms of research and information output. The task becomes even more difficult when the field itself is a rapidly and continually transforming global phenomenon spanning multiple disciplines. We need an updated comprehensive guide to inform an overarching (and simultaneously detailed) picture of climate change and its many effects on the living world. Editors Thomas E. Lovejoy and Lee Hannah do just this in Yale University Press's new book *Biodiversity and Climate Change*—a sequel to their 2005 work *Climate Change and Biodiversity*.

Lovejoy and Hannah are ideal curators of this work, not only having edited the previous volume, but both have prestigious and prodigious research careers related to biodiversity, climate change, environmental science, and conservation. A brief foreword by famed ecologist E.O. Wilson introduces this work, which is divided into five main sections. Each section contains several chapters (totaling 28) by a combination of senior and more junior authors, resulting in a thorough and rich perspective. Chapters provide introductions to the topic at hand, as well as theoretical background, informative figures and tables, empirical evidence, predictions for the future, unanswered questions, and brief conclusions. The book also includes 11 different case studies that succinctly walk through specific examples of effects of climate

change and eight color plates that visually highlight major points.

The first section asks “What is climate change biology?” and briefly walks the reader through the ways in which the biological world is changing and what, exactly, climate change is. These chapters provide a starting point for the remainder of the book, explaining the many ways in which humans are changing the living world, how and why the climate is changing, and how these elements interact to affect biodiversity across the globe.

In the second section, authors discuss the currently observed changes in biodiversity that are related to climate change. These range across multiple biological sub-disciplines, such as the genetic signatures of change, population- and species-level changes in range and abundance, species interactions, and ecosystem changes. The reader is presented evidence from across a diversity of organisms (insects, cnidarians, plants, birds, fish, etc.) and in both terrestrial and aquatic ecosystems. Diverse systems are represented throughout the entire book, lending a holistic view of biodiversity and climate change.

Part three focuses on what past changes in climate can tell us about contemporary and future changes. Taking a more paleoecological perspective, authors focus on geologically historic abrupt climatic changes and how biodiversity subsequently transformed. I was especially intrigued by the “metaphor of deep time” in Chapter Nine, in which current and future communities are characterized by their structural and functional compositions and compared to compositions of previous geological time periods.

The fourth focus, and the most comprehensive, is on the future. Part four contains information on specific research areas, their theoretically

predicted changes, findings from current empirical research, and what changes are likely to occur in the future. Topics include species distribution modeling, the impact of ocean acidification on biodiversity, mountain biodiversity, food web changes, invasive species, and disease. A case study on dynamic management of a tuna fishery in Australia is especially eye-opening, demonstrating the many different types of data and communication between different types of organizations necessary to properly manage and conserve resources that are of importance to biodiversity and human economic and social interests.

Finally, the book turns to the ways in which conservation and policy can respond to the threats of climate change to biodiversity. Authors focus on themes such as protected areas, ecosystem-based adaptation and restoration, and connectivity. A chapter on the effects of climate change on agriculture and food security reinforces the ways climate change will directly affect humans, and how human populations that are least equipped to deal with negative effects will be the ones that suffer the most. Beyond the biological and physical science, a chapter on public awareness and behavior changes dives into the social sciences and how best to communicate climate change to the public and how to enact personal changes that will reduce human effects on biodiversity.

Who should read this book? This work is both comprehensive and detailed, outlining broad pictures across disciplines while also giving specific examples. I personally would not recommend this book to readers who are looking for a beginning introduction to the field—the language and detail are meant for a slightly more scientific audience and the book employs enough jargon and detail to

likely disinterest a reader seeking a “popular science” book.

I would, however, strongly recommend this work to scientists, policy-makers, or communicators in several fields, including biology, environmental science, environmental policy, earth and planetary science, science journalism or writing, climatology, and others. Members of each discipline will recognize principles that they are familiar with, and other topics about which they are either not well versed or may not have considered in detail. This is an excellent reference for those who are already more senior in their fields as well as those who are just beginning. I can see this book being utilized in a graduate course or upper-level undergraduate course on biodiversity or climate change. Overall, *Biodiversity and Climate Change* is an excellent, thorough, and detailed snapshot of our current understanding of how human-induced climate change is affecting the living world.

--Nora Mitchell, Department of Biology,  
University of New Mexico, Albuquerque, New  
Mexico, USA

### Next Generation Bio- monitoring: Part 1. Advances in Ecological Research Volume 58

David A. Bohan, Alex J.  
Dumbrell, Guy Woodward, and  
Michelle Jackson (eds.)  
2018. ISBN: 978-0-12-813949-3  
Hardcover, US\$219.00. 293 pp.  
Academic Press, Oxford, UK.



*Next Generation Biomonitoring: Part 1* is a collection of contributed papers that addresses the gap between the conceptual simplicity of biomonitoring (i.e., observe and record) and the challenges in implementing large-scale efforts to gather high-quality data. Biomonitoring data are critical for developing, executing, and assessing conservation policy, as well as growing our fundamental understanding of the interaction between ecosystem patterns and processes. The book emphasizes methodological approaches in molecular ecology, ecoinformatics, and remote sensing that have been developed in the last 15 years in a deliberate shift away from the use of methods that were designed for smaller scale and less-intensive monitoring.

The book is edited by David. A Bohan, Alex J. Dumbrell, Guy Woodward and Michelle Jackson, and its six chapters comprise the first of two volumes about contemporary biomonitoring in the Advances in Ecological Research series. The series has been published since 1962 and it is currently publishing annually. The contributions come from 84 co-authors, reflecting the distributed and highly collaborative science commonly practiced in the field. Each chapter is written accessibly for a broad audience, but the book seems to be targeted at professionals and students involved in the acquisition or use of monitoring data.

The first two chapters look at the use of molecular approaches in biomonitoring. The

chapter “Biomonitoring for the 21<sup>st</sup> century: Integrating next-generation sequencing into ecological network analysis” by Derocles et al. focuses on the use of molecular data, such as from environmental DNA, to parameterize ecological network models, particularly multilayer networks. We learn how parameterized networks can be analyzed to monitor ecosystem change and quantify ecosystem functions and services. The second chapter by Leese et al., “Why we need sustainable networks bridging countries, disciplines, cultures and generations for aquatic biomonitoring 2.0: A perspective derived from the DNAqua-Net COST action,” examines biomonitoring of freshwater systems by applying DNA metabarcoding (the high throughput sequencing of target regions of DNA for purposes of species identification) to samples such as those containing environmental DNA. Leese et al. advocate for a reimagined view of high-volume species monitoring that would largely replace traditional manual approaches, even though they acknowledge that we are still limited in realizing this vision due to technical challenges, such as the availability of taxonomic expertise and adequate methods to quantify the relative abundance of species.

Chapter three, “Advances in monitoring and modelling climate at ecologically relevant scales” by Bramer et al., examines the challenge of obtaining fine-scale environmental data, finer than the resolution typically obtained from networks of weather stations (>10 km scale). The need for these data stems from the common observation that organisms respond to variation in temperature, humidity, radiation, wind, and soil moisture at 0.001–100 m scales, defined here as the microclimate range. To understand the distribution and abundance of organisms, we require

environmental measurements relevant to the scale at which they operate.

The next two complementary chapters look at fundamental issues of study design in large-scale biomonitoring efforts and the analysis of the data collected. In “Challenges with inferring how land-use affects terrestrial biodiversity: Study design, time, space and synthesis,” De Palma et al. look at different study designs that are typically used to assess the effects of land-use change on biodiversity. They compare designs such as times series, space-for-time substitutions, and before-after-control-impact to consider the rationale and limitations of each. The fifth chapter, “Modelling and projecting the response of local terrestrial biodiversity worldwide to land use and related pressures: The PREDICTS Project” by Purvis et al., is a thorough review of a large effort that has resulted in the compilation of a global diversity dataset with thousands of species and sites. The source data for the project come from a vast assortment of studies that have collected data on many different species and places using all sorts of methods. The authors identify that handling the hierarchical structure in these kind of data is the principle challenge in analysis. The reasoning involved in the analysis of these data is likely to be informative, even for those with relatively modest datasets, as the basic structure for analysis presented here serves as a general template for handling hierarchical ecological data.

In the last chapter, “Mapping Mediterranean wetlands with remote sensing: A good-looking map is not always a good map,” Perennou et al. examine the use of remote sensing technologies in biomonitoring using Mediterranean wetlands as a case study. We are told that wetlands are inherently challenging to assess because the spatio-

## ECONOMIC BOTANY

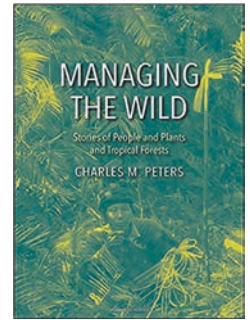
### Managing the Wild: Stories of People and Plants and Tropical Forests

By Charles M. Peters

2018. ISBN 978-0-300-22933-2

Hardcover, \$30.00. 184 + xxiv pp.

New York Botanical Garden and Yale University Press.



temporal dynamics of wetland habitats are complex and difficult to characterize even with substantial amounts of data. Wetland habitats are also hard to differentiate, such as distinguishing between artificial and natural wetlands, where accurate assignment is important because natural wetlands are associated with significantly higher levels of biodiversity. The detection of long-term trend signals within the noise of natural variation is also hard because of intra- and interannual variation in water availability in wetlands. Remote sensing is fundamentally changing the scope of biomonitoring, particularly on the regional and global scale, but in the end we learn that remote sensing needs various forms of complimentary ecological knowledge for it to be of conservation value.

*Next Generation Biomonitoring: Part 1* is successful in describing important modern approaches to biomonitoring. The six chapters of this book consistently present the logic of methods, along with their strengths and weaknesses, and offer practical insight into their implementation. Peer-reviewed journal articles have established a hegemony on publication in the scientific community, but the chapters of *Next Generation Biomonitoring: Part 1* show the benefits of leeway in word count to fully articulate ideas and approaches beyond a condensed journal form. For most target readers, it is likely that only several chapters will be of direct interest, but those chapters are likely to be insightful.

--Tan Bao, *Department of Biological Sciences, University of Alberta, Edmonton, Canada.*

This is a well-written book, eminently readable on several levels, on plants and people. First, it is an engaging description of work in tropical forests, some infested with tigers, and the culture of the people who depend upon these forests. Second, it discusses forestry research techniques, using methods and equipment suitable to local people. Lastly, and especially meaningful to me as an ethnobotanist, it describes culturally sensitive ethnobotanical methodology,

Peters accepts the local people as partners in his research, gaining autochthonous knowledge from the experts. His respect for their culture and his humility of approach is palpable. In this way, he models what successful ethnobotanical practice should be. In a wonderful balance, he collects forestry data on timber and non-timber use of plants (agave in the dry forests of Central America, rattans in Borneo and other parts of Southeast Asia), which has resulted in many papers in scientific journals but also provided an appreciation of forest metrics for local people.

We learn that the “pristine forests” do not mean there has been no human activity. Contrariwise, Peters shows that the forests have been maintained for hundreds of years—if not longer—so that they are truly sustainable. Hence, the title *Managing the Wild*. Sadly, he documents the sometime disastrous results



of well-intended bureaucratic government foresters.

The coverage of the book is global with short, pithy chapters of work in Mexico, Peru, Indonesia, Uganda, China, Papua New Guinea, Myanmar, and Vietnam. For anyone who loves ethnobotany, there is a treasure trove of information on a wide diversity of plants and plant products.

I highly recommend this book for the general public, anthropologists, botanists, ethnobotanists, ecologists, foresters, and anyone interested in sustainable tropical forestry.

--Lytton John Musselman, *Blackwater Ecologic Preserve, Department of Biological Sciences, Old Dominion University, Norfolk, Virginia*  
23529-0266

### Trees in Art

Charles Watkins  
2018. ISBN: 978-1-78-023930-9  
Cloth, US\$55.00. 256 pp.  
Reaktion Books, London

A number of attendees of botanical and other kinds of scientific meetings look for the nearest art museum and add that to their schedule. This book will certainly be of interest to all art lovers, as well as those who are interested in the role trees have played in depiction of many historical periods, often as background, but sometimes as central figures of the painting or other work of art. Charles Watkins takes us through the ages, with a decidedly British and northern European bias, relating the stories and historical underpinnings of many beautiful images. He includes work by famous artists, as well as a number less well known to



this reviewer.

Starting with the earliest depictions of trees in art, both B.C. and less than 100 years A.D., the author reviewed various teachers and their techniques. I was fascinated with 'blot' depictions of foliage and landscape, which Alexander Cozens developed as a technique for teaching students; he was inspired by a comment made by Leonardo da Vinci, that you can imagine faces, woods, and landscapes and other things from the patterns of marks found on an old wall (or clouds for that matter!). But da Vinci himself made many drawings and paintings of trees with extreme detail and accuracy. Grimm (who also illustrated *Natural History and Antiquities of Selbourne* for Gilbert White) was considered a good artist but lacking in his portrayal of trees, which were "not pleasing" and drawn with too much "humor." Not many artists before 1800 drew trees with great accuracy.

The 19th century saw a turn to realism with many portraying trees with bark and other features characteristic of the species. But then there were the Cubists (Braque, Picasso) and the Impressionists (Matisse, Monet, Redon), capturing the essence of plants with their shapes and textures, without the details.

Many ancient stories involved trees. In Ovid's *Metamorphoses*, many women and men turn to trees. Cyparissus killed his favorite stag by accident and asked to mourn him until the end of time; he became an evergreen cypress. Trees are strong and can withstand a lot of abuse, as a chapter devoted to Lopping and Pollarding examines. It is incredible how trees can withstand such extreme torture (and this was without any mention of bonsai...!)

Watkins discusses sacred trees and woods, important in many cultures. There are trees that stand for the elders in a community, often single oaks in temperate zone cultures,

taking on a wizened appearance with their enormous size. He devotes a chapter to trees and timber, as he reminds the readers there is no natural woodland without human influence (including deliberate fire, grazing, wood cutting, tree disease, and pollution). The penultimate chapter considers Western art abroad, as there was a need to describe distant lands to those for whom travel was not possible. Many learned of the landscapes of faraway lands by the paintings and other depictions created by western artists traveling to those places, including works done in Australia, the Bahamas, Brazil, Canada, Egypt, Lebanon, and Tenerife.

The final chapter considers “more than real trees,” considering many phantasmagoric images, from the grotesque images of Hieronymous Bosch and Giuseppe Arcimboldo, to the ominous trees depicted by Arthur Rackham in the fairy tales of The Brothers Grimm, and the beautiful but made-up vegetation in the works of Henri Rousseau. Mind-bending works by Max Ernst, Salvador Dali, and more contemporary artists such as Vera Röhm, Giuseppe Penone, and Ai Weiwei among others are depicted in the last pages—a forward-looking ending to this enjoyable book.

I truly learned a lot reading through this book and recommend it to everyone as a pleasing addition to your botanical bookshelf. It would make a nice gift to someone who likes nature, plants, and trees (being coffee-table sized), and a popular choice in any library collection.

--Suzanne Koptur, *Plant Ecologist and Professor of Biology, Florida International University*

## Why Look at Plants? The Botanical Emergence in Contemporary Art

Giovanni Aloï, author and editor

2018. ISBN 978-9-004-37524-6  
Hardcover; US\$34.95. 280 pp.  
Koninklijke Brill, Leiden, the Netherlands.



Giovanni Aloï, an art historian specializing in the representation of animals and plants in contemporary art—who currently teaches at the School of the Art Institute of Chicago, Sotheby’s Institute of Art New York and London, and Tate Galleries and is the Editor in Chief of *Antennae: The Journal of Nature in Visual Culture*—offers an uncommon approach to botany in this collection of 35 essays. Combining historical and ecological analyses, he tackles topics from the perspective that local events are a consequence of, or influenced by, political processes that occur on a world scale. Overall themes embody plant–people relationships, organized into sections thematically: Forest, Trees, Garden, Greenhouse, Store, House, Laboratory, Other Spaces. Some encompass new, unexpected directions. Aloï opens each section, writing his own detailed, thoughtful, and engaging introductions to contributions by 27 others.

Aloï’s essential Introduction to the subject opens with tribute to the herbarium, effectively an iconographical precursor of natural history objectification. The practice of collecting live plant specimens for the purpose of study was introduced by Luca Ghini, founder of the academic study of nature in Bologna and Pisa. Dried specimens provided much-needed truth to begin secular, taxonomic projects based on the empirical scientific method. Next, Aloï observes the symbolism of plants (e.g., palm, iris, daffodil) and the iconography in Arcimboldo’s vegetal compositions aimed to criticize rich peoples’ conduct. He expands

on the cultural significance of flower color such as marigolds, now ubiquitous in India, that derive from new varieties received from South America via Portugal. Chrysanthemum is symbolic in China, of the 9th month, including a phonetic analogy between “nine” and “longtime.” The pronunciation of the name chrysanthemum in Chinese sounds like the verb “to remain.” Fruits appear later in history (but precede flowers), as in artworks after Caravaggio’s 1599 *Basket of Fruit*; lemons symbolize the Virgin Mary; pomegranates, resurrection; apples, temptation and original sin; figs, fertility.

Aloi stresses the inclusion of imperfections in paintings of that era, as metaphorical language to symbolize hardships, such as Courbet’s paintings (1871-2) that depict decayed fruit, and chipped bowls, by a leader of the Realist movement, a revolutionary, highly political congregation of artists. Forbidden to paint humans, they painted damaged apples as an act of resistance. He exposes the British obsession for ferns, ‘Pteridomania’, and ‘Orchidelerium’ as embodiments of indiscriminate pillaging of exotic lands, or destruction of pristine environments; he associates climate change with the origins in capitalism.

Aloi’s introduction to “Forest: ‘Lost in the Post-Sublime Forest,’” initiates readers to his pivotal goal: overcoming plant blindness, i.e., the inability to see plants other than as resources or aesthetic objects. He views the environmental movement contributing to emerging tourist industries, treating plant appreciation as pornography, as through capitalism, participants become disconnected from other ethical obligations.

Aloi’s introduction to “Trees: ‘Upside-Down, Inside-Out, and Moving,’” illustrates graphically how stunningly Hiroki transformed a value-less rotting tree to luxury objects validated by the art world. His focus

on Christmas trees demonstrates how they led to commercialization through market-driven consumption of decorations and other embellishments. A celebration initially intended as a redeemer of consumerism became an emblem of the human–tree capitalist relationship.

‘Falling from Grace’, Aloi’s introduction to the “Garden” section, features Quinn’s year 2000 art installation of plants immersed in 26 tons of low-viscosity silicone in a cold room and tank maintained at  $-20^{\circ}\text{C}$ . Personally, I shudder at the waste of energy resources required to maintain this exhibit. Aloi tackles weeds at length, which he views as a capitalist construct, defined by their geography inside the garden, edges of roads, fronts of garages, and cracks in pathways, transgressing boundaries. Paradoxically, Aloi views them as more “natural,” yet demonized. However, Aloi omits from consideration in this volume any attention to dangerously invasive weed species, whose introduction causes or is likely to cause economic or environmental harm, or harm to human health, such as kudzu, water hyacinth, poison ivy, or lesser celandine (*Ranunculus ficaria* L.), the classic case of an invasive species native to Europe, northern Africa, western Asia, and Siberia that was brought to the U.S. as an ornamental plant, but by its spreading tuberous bulbs, displaces many woodland Spring-flowering species, destroying natural areas and gardens.

‘Thoreau’s Beans’ by Marder expands the discussion of weed sovereignty as expressed by Thoreau experimenting with self-sufficient living. Thoreau cultivated a small bean-field close to the hut he had built in the woods, but questioned his right to remove the weeds to encourage his beans to grow.

‘Greenhouse Effects’, Aloi’s introduction to “Greenhouse,” provides superb support to the current debate about climate change, using the

example of cultivated hothouse tomatoes, not at all ecological, but rather extremely expensive using “mastodonic geodesic domes set in a greenhouse-prototype model intended for educational/research institutions.” Aloi views the industrial revolution as having irreparably tampered with the structure of botanical gardens and research labs as sanctuary to prevent loss of species. One might scrutinize Aloi’s condemnation of Kew’s explorations for their ventures in colonial expansion, as the “principal node for economic botany” defining that discipline as “the study and cultivation of plants for financial gain, which was of crucial importance to the success of the British Empire.”

One might also question whether the use of blue and red acrylic, as described by Luftwerk in ‘Solarise’, is methodologically sufficient to subject plants to “plant wavelength spectrum absorption,” or whether it is merely an artistic device. Palmer’s ‘Lichen Museum’ celebrates the fact that “lichens successfully resist human manipulation,” picking up the persistent anti-capitalist theme running throughout this volume.

In my view, Aloi’s opening chapter ‘Hyperplant Shelf-Life’ renders “Store” the strongest section of this compilation. It introduces PLANT-CAPITAL: Objectification and Agency in a Consumerist World, with an 18-minute video (<https://www.youtube.com/watch?v=dej18GiPTrA>) arguing against consumption of plants from big box gardening centers, documenting details about the side effects of the production of supermarket flowers with associated consequences of ecological and social exploitation: sex harassment, relentless exposure to dangerous chemicals, and exorbitant demands for water. “Behind the beauty of cut flowers always

lurks layers of capitalist exploitation.” Aloi gives as examples Tesco’s carnations and lilies from South America; based on first-hand experience, I would add Kenya’s flower farms surrounding Lake Nakuru, expelling fertilizer-laden waste water into the Lake, leading to eutrophication and contamination of local drinking water. Aloi considers potted plants as products as well as victims, because their persistence is unsustainable outside the greenhouse, indispensable to maintain a controlled environment. Another example is the quick turnover expected of plant inventory at Home Depot, hence no investment is made by Home Depot into plant care. Plants are used only as eye-catching decoys to induce buyers to purchase more expensive outdoor appliances, including lawn furniture, barbeque grills, etc. Subsequently, the plants are destroyed, for the same economic reasons. ‘Home Depot Throwing Out Plants’, by Various Contributors, continues this trajectory, revealing that despite persistent pleas by customers, Home Depot’s corporate directive is to discard their plants, viewing them as disposable.

Overall, I found the section titled “Laboratory” most disappointing. Aloi’s introduction, ‘Psychoactives and Biogenetics’, discusses the artistic, psychotropic, and poisonous aspects about foxglove but fails to mention its stunning medicinal benefits, used to make a prescription drug called digoxin—one of the few medicines used by cardiac patients derived directly from plants, not synthesized in the laboratory. Another extreme example given is of embryonic tissue of *Arabidopsis thaliana* (L.) Heynh. fed with steroids extracted from an artist’s urine. This causes alterations in the embryos’ epigenetic patterns, leading to the productions of morphologies that stray from the recurring plant form in the wild, termed

“monsters”—“an ontogenesis generating from impossible love.”

Aloi's book is loaded with opinions about plants from an art-historical and contemporary artist's perspective. I appreciated Aloi's select quotations placed to open of each of his introductory chapters. Many illustrations are gorgeous, as would be expected. Their sources are credited well, and the book's pages are laid out beautifully. There is a 10-page bibliography, but only a scanty 2-page index that prevented me from locating entries I had not marked; I noticed several misspelled words on pages 10, 103, 129, 214, and 237. For all their depth and fresh outlook, these essays leave open the question of why they belong together in a book. Frankly, the essays by other authors seemed to be postscripts on an already-developed framework. It's not evident who the target audience is for this interdisciplinary work bearing an environmental-conservation message; it may appeal to a select group of artists or plant lovers.

–*Dorothea Bedigian, Research Associate, Missouri Botanical Garden, St. Louis, Missouri, USA*

## SYSTEMATICS

### **Centric, Araphid and Eunotioid Diatoms of the Coastal Laurentian Great Lakes Bibliotheca Diatomologica, Volume 62.**

Euan D. Reavie and Amy R. Kireta  
2015.

ISBN: 978-3-443-57053-8

€79. 184 pp.

Schweizerbart Science Publishers, Stuttgart, Germany



This slim, informative volume is a most helpful and informative addition to the “usual suspects” for identifying freshwater algae. Diatoms usually get short shrift because of the detailed attention and knowledge of “minutiae” required to correctly identify to genus and species. This volume is based on hundreds of nearshore sampling on the U.S. side of all five Great Lakes, and includes information on a “suite of environmental measurements.” As is typical, each species has its scientific name and authority stated, is clearly described, and refers to one or more excellent photos. The photography is excellent and allows for a better understanding of morphology to aid in identification. Additionally, the authors provide information on the taxon's presence in one of six nearshore habitats, prevalence in each of the five Great Lakes, and averaged total P and total Cl for that taxon. They have also calculated and presented the “stress power” and “stress rank” that “depict the relative ability of a taxon to track stress and whether the taxon reflects low or high stress.”

All in all, an excellent and informative volume that is sure to become commonplace in the identification of freshwater centric, araphid and eunotioid diatoms of the United States. (Recommended level: Specialist)

--*Susan T. Meiers, Western Illinois University*

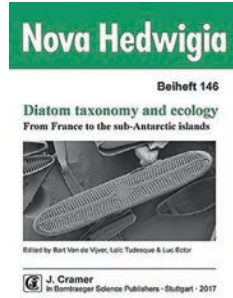
## Diatom taxonomy and ecology: From France to the sub-Antarctic Islands.

*Nova Hedwigia*, Beihaft 146.  
Bart Van de Vijver, Loïc Tudesque, and Luc Ector (eds)  
2017.

ISBN 978-3-443-51068-8

Paperback; €139.00. 325 pp.

J. Cramer, in Borntraeger  
Science Publishers, Stuttgart

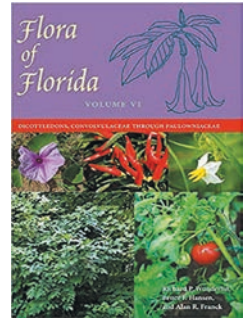


## Flora of Florida, Volume VI: Dicotyledons, Convolvulaceae through Paulowniaceae

Richard P. Wunderlin, Bruce F. Hansen, and Alan R. Franck.  
2019. ISBN: 978-0-8130-5613-5

Cloth US\$70. 372 pp.

University Press of Florida.



*The Flora of Florida, Volume VI* is part of a series of books comprising 10 volumes; Volume 1 focuses on pteridophytes and gymnosperms, Volumes 2 through 7 on identification of dicotyledons, and volumes 8 through 10 on monocotyledons. *Flora of Florida, Volume VI* (6) concentrates on taxonomic treatments of 19 families: *Convolvulaceae*, *Solanaceae*, *Sphenocleaceae*, *Hydroleaceae*, *Oleaceae*, *Tetrachondraceae*, *Plantaginaceae*, *Scrophulariaceae*, *Linderniaceae*, *Pedaliaceae*, *Martyniaceae*, *Acanthaceae*, *Bignoniaceae*, *Lentibulariaceae*, *Verbenaceae*, *Lamiaceae*, *Mazaceae*, *Phrymaceae*, and *Paulowniaceae*.

The book begins with an introduction that explains the organization of flora within the book: taxa included, taxa excluded, systematic arrangement, descriptions, common name, derivation of scientific names, synonymy, habitat, distribution, endemic or exotic status, reproductive season, hybrids, and references. The organization of taxa included are specified by the following: (1) an herbarium specimen has been seen to document its occurrence in Florida, or (2) a specimen is cited from Florida in a monograph or revision whose treatment is considered sound. It is noted periodically within the book when a taxon is excluded due to a misidentified specimen(s), a lack of documentation by means of a specimen, or a misapplied name. The end of the introduction includes a section titled "Taxonomic Concepts." This states that the references provided are updated monographs or revision of various groups, except flora

Editors Bart Van de Vijver, Loïc Tudesque, and Luc Ector have gathered a wealth of information and techniques from 40 authors in 20 chapters to help illuminate the biogeography, ecology, paleoecology, and biodiversity of diatoms from France to the Kerguelen Islands ("Desolation Islands") of the Southern Indian Ocean. The fine volume is dedicated to Dr. René Le Cohu, a noted French diatom ecologist and taxonomist for his 80th birthday.

The chapters address population succession over multiple decades in the small pond at Botanic Garden Meise, Belgium; explores contrasting methods in DNA barcoding and morphological methods in diatoms from the Eightmile River in Connecticut, USA; and details multiple new species and genera from around the world. This is a solid offering of techniques and well-documented descriptions of new and/or reorganized taxa, which shows how active diatom ecology and taxonomy still is. The final chapter is a bibliography of the works of Professor René Le Cohu from 1965 to present.

--Susan T. Meiers, *Western Illinois University*

that are believed to have recent evidence that necessitates a change.

After the brief but thorough introduction to the contents within the book, it begins with references to the “Systematic Treatments” and “Keys to Major Vascular Plant Groups.” This offers what volumes are related to each step of the key and a description of pteridophytes, gymnosperms, dicotyledon, and monocotyledons. Starting with Convolvulaceae, the families are in morphologically similar order and the genera within each family is alphabetical. Each family and genus has a very thorough description of the specified flora. The book includes a literature cited, an index to common names, and an index to the scientific names.

In terms of design, the book is very well made. It is hardcover and printed on quality paper. As far as the contents, the descriptions are thorough and the book is laid out simplistically, yet includes what you need in order to identify taxa while in the field. My biggest issue with the book is the layout of the 19 families within the book. Without flipping constantly to the “contents” page, there is little indication when you have reached a new family. The family font is bigger, but it is still difficult to search for without a contents check. In conjunction, the “contents” of the book should be more complete, and it should number the pages for the genera for ease of identification, since it only includes the “acknowledgments, introduction, families, literature cites, index to common names, and index to scientific names.”

Overall, I truly think the authors have done a wonderful job and are very descriptive in the way you need in the field or just a tool to refresh your knowledge. The issue with bringing this book into the field is the number of books you

may need to carry. As mentioned, the book is hard cover and the weight is not unreasonable, yet if I am going out into the field to study dicotyledons, I would have to bring Volumes 2-7; I personally would not enjoy lugging around that many. In hindsight, Florida does have more than 4300 taxa and having to carry many books in order to identify species is the nature of plant identification in Florida.

Richard P. Wunderlin is professor emeritus of biology at the University of South Florida, Bruce F. Hansen is curator emeritus of biology at the University of South Florida Herbarium, and Alan R. Frank is curator at Florida International University. As per the acknowledgments, many herbaria collections and facilities were utilized in preparing this volume. In addition, Flora of Florida is an ongoing project that has been strongly supported by the University of South Florida Institute for Systematic Biology.

--Erin Downey, University of Southern Florida

**Syllabus of Plant Families, Part 1/3:  
Basidiomycota and  
Entorrhizomycota**

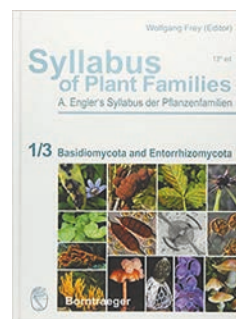
Dominik Begerow, Alistair McTaggart, and Reinhard Agerer (Series editor: Wolfgang Frey)

2018. ISBN: 978-3-443-01098-0

€139.00. 471 pp.

Schweizerbart Science Publishers, Stuttgart, Germany

This volume represents the final installment dealing with Kingdom Fungi within the thirteenth edition of the recently resurrected *Engler's Syllabus of Plants Families*. This new version of the classic series considers the major groups of diverse organisms once treated as “plants” (and still often taught together in



introductory botany classes), subjecting each to a contemporary biosystematic overhaul that utilizes the most recent data sets and current phylogenetic principles. The basal groups of true Fungi were treated in a previous volume (Part 1/1), which also included myxomycetes, heterotrophic stramenopiles such as the oomycetes, and, unexpectedly, the cyanobacteria, whereas the Ascomycota were dispatched in their own volume (Part 1/2, reviewed in *PSB* 63[3]:116). Although the rationale for how the series is organized at the broadest levels is not always clear, a predictably phylogenetic scheme is followed within each major group considered. The present volume treats the Basidiomycota, plus a page and a half dedicated to the Entorrhizomycota, a small, isolated clade of root parasites once thought to have affinities among the smut fungi but now placed in uncertain relationship to the *Dikarya* and *Glomeromycota*.

The Basidiomycota are currently resolved into three major clades: the Pucciniomycotina, the Ustilagomycotina, and the Agaricomycotina. The first of these includes not only the rust fungi (Pucciniales), a familiar group of obligate plant parasites, but also a considerable diversity of less well-known fungi with diverse structure and ecology, some of which even produce fruiting bodies. The fungal kingdom's most complex life cycles occur in this group, where a single species may show as many as five different spore types and two distinct, obligate plant hosts. The second subphylum, Ustilagomycotina, encompasses mainly plant parasitic fungi, most notably the smuts, that show characteristic interaction zones ultrastructurally at the fungus-host interface, now considered a synapomorphy for the group. The third subphylum, the Agaricomycotina, includes the bulk of the Basidiomycota, and

particularly the diverse fleshy fungi most familiar to the field mycologist and forager. They obtain carbon as saprotrophs, parasites, mycorrhiza-formers, and lichen-formers.

Many useful figures—color photographs, light and electron micrographs, and line drawings—are provided. All figures are arranged in plates grouped together at the end of the text treatment of each of the three subphyla. The organization is not particularly user-friendly. The figures are called out in the text not by page number but according to plate and figure number, making it more time-consuming to find them. Furthermore, the legends are all grouped apart from the figures themselves, so one needs to triangulate among three separate locations to interpret the images in context. For the Pucciniomycotina and the Ustilagomycotina, a cladogram is provided among the figures, helping the reader to place the taxonomic scheme in phylogenetic context. Unfortunately, however, no cladogram is provided for the Agaricomycotina, the largest of the three subphyla and the one that includes most of the macrofungi. These taxa have undergone profound rearrangement in the last few decades, with once-familiar groupings of commonly observed fungi such as the “aphyllophorales” and “gasteromycetes” now dissolved in favor of new placements that are more meaningful phylogenetically but often unexpected morphologically. A cladogram would help the reader assimilate these changes and better appreciate the extent to which convergent evolution has repeatedly generated the same syndromes in basidiocarp structure and spore dispersal. It's a bit disappointing that the text barely comments on such trends. Indeed, there is little text discussion at all; most of the prose consists of character description lists for each taxon



considered. The fungal taxonomist will surely appreciate the authors' painstaking work in compiling and systematizing the current state of basidiomycete diversity, but the paucity of discussion means that this work will serve primarily as a reference tool rather than as any sort of textbook.

In many places, the text would have benefited from copyediting by a native-speaking proofreader. There are many instances where errors of grammar, punctuation, and diction require one to pause and re-read, although ultimately most meanings are clear from context. No glossary is provided. The

*Dictionary of the Fungi* (or similar reference) will therefore be needed to interpret the specialized terminology that abounds in the character descriptions, as well as to distinguish some typos from unfamiliar terms (e.g., [sic:] teilospores, peridal, biozonate, hypgrophanus...).

Imperfections aside, this volume is clearly a significant work that provides a thorough, contemporary treatment of a fungal class that is of central importance in the biosphere.

--*William B. Sanders, Florida Gulf Coast University*



Canadian  
**Science**  
Publishing

# Empower the world with scientific knowledge

Canadian Science Publishing journals ***Botany***, ***Genome***  
and ***FACETS*** welcome manuscript submissions from  
delegates at the **2019 Botany Conference**

**[canscipub.com/botany-2019](http://canscipub.com/botany-2019)**

*Botany* published since 1929, is an international journal  
for plant biology.

*Genome* published since 1959, is an international journal  
for genetics and genomics.

*FACETS* is Canada's first multidisciplinary open access journal,  
publishing papers from a range of scientific research areas  
including plant sciences.

Plant Science Bulletin



ISSN 0032-0919

Published quarterly by  
Botanical Society of America, Inc.  
4475 Castleman Avenue  
St. Louis, MO 63166-0299

Periodicals postage is paid at  
St. Louis, MO & additional  
mailing offices.

POSTMASTER:

Send address changes to:  
Botanical Society of America  
Business Office  
P.O. Box 299  
St. Louis, MO 63166-0299  
bsa-manager@botany.org

The yearly subscription rate  
of \$15 is included  
in the membership

**Address Editorial Matters (only) to:**

Mackenzie Taylor, Editor  
Department of Biology  
Creighton University  
2500 California Plaza  
Omaha, NE 68178  
Phone 402-280-2157  
psb@botany.org

The Botanical Society of  
America is a membership soci-  
ety whose mission is to: pro-  
mote botany, the field of basic  
science dealing with the study  
& inquiry into the form, func-  
tion, development, diversity,  
reproduction, evolution, & uses  
of plants & their interactions  
within the biosphere.

# Plant Science Bulletin

# Botany 2019

July 27-31  
Tucson, Arizona  
Sky Islands & Desert Seas



## SYMPOSIA AND COLLOQUIA

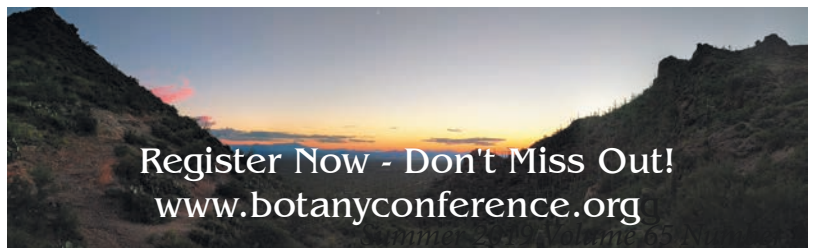
## TOPICAL PRESENTATIONS

## EXHIBITS

## INFORMATIVE POSTERS

## FIELD TRIPS

## WORKSHOPS



Register Now - Don't Miss Out!  
[www.botanyconference.org](http://www.botanyconference.org)

# Botany

Anchorage, Alaska  
July 18-22

# 2020

