



PLANT SCIENCE BULLETIN

SUMMER 2017 VOLUME 63 NUMBER 2

A PUBLICATION OF THE BOTANICAL SOCIETY OF AMERICA



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From the Editor

Greetings,

In this summer issue, you will find information about the upcoming Botany meeting in Fort Worth, Texas. I hope that many of you are planning to attend!

In putting together each *PSB* issue, we particularly enjoy showcasing the activities of BSA members in scholarship, teaching, conservation, and outreach. In this issue, we share the list of winners of several Botanical Society of America awards, and many more will be included in our Fall issue. These awards highlight the diversity and quality of research and teaching in which botanists engage. Congratulations to all!

We are also pleased to highlight actions that speak to policy makers and advocate for plant science. In the public policy pages, you will find reports from those who participated in the Biological and Ecological Sciences Coalition (BESC) Congressional Visits Day, as well as images from the March for Science held across the United States and abroad in April.

BSA members are also interacting with the public in innovative ways and utilizing new approaches to moving science forward. On page 64, you will find a report on the successful crowd-funding campaign to raise funds for the conservation of 'ōhi'a seeds in Hawai'i.

These are just a few snapshots of what BSA members have been doing this year. If you have examples of botanists in action, locally to globally, please don't hesitate to share them with *PSB*!



Mackenzie

PLANT SCIENCE BULLETIN Editorial Committee Volume 63



**Daniel K. Gladish
(2017)**

*Department of Biology &
The Conservatory
Miami University
Hamilton, OH 45011
gladisdk@muohio.edu*



**Kathryn LeCroy
(2018)**

*Environmental Sciences
University of Virginia
Charlottesville, VA 22904
kal8d@virginia.edu*



**Melanie Link-Perez
(2019)**

*Department of Botany
& Plant Pathology
Oregon State University
Corvallis, OR 97331
linkperm@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*



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Botanists March to Support Science: April 22, 2017





SOCIETY NEWS

Public Policy Committee Report from Congressional Visits Day

This year (2017) marks the sixth time that the BSA Public Policy Committee has participated in the annual Congressional Visits Day event, but the first just after the election of a new President of the United States. It is also exciting because members of the BSA Public Policy Committee have contributed to new legislation, H.R. 1054, colloquially referred to as the “Botany Bill”, which is receiving bipartisan support in the House of Representatives. (<https://www.congress.gov/bill/115th-congress/house-bill/1054/history?r=5>).

This year, the BSA awarded the Public Policy Award to two BSA members: Maribeth Latvis and Andre Naranjo. Each of them traveled to Washington, D.C. to participate in this annual policy event on April 25 and 26 to advocate on behalf of federal funding for basic research through the National Science Foundation (NSF) and H.R. 1054.

Maribeth Latvis's Experience

In this changing political climate, there is a growing need for scientists to communicate the importance of their work with lawmakers and the public. This certainly became evident when viewing President Trump's initial “skinny budget” proposal, which featured heavy cuts for many agencies funding scientific research. Interestingly, the National Science Foundation (NSF) was not part of this initial budget, and many of us were left wondering what fate would befall one of our largest sources of federal funding. With this in mind, I applied for a BSA Public Policy Award to attend the 2017 Congressional Visits Day (CVD) in Washington, D.C., hosted by the Biological and Ecological Sciences Coalition (BESC). Another motivation was my upcoming new position at South Dakota State University as an Assistant Professor in 2017. I felt the CVD would provide me with important training in public policy during this career transition, an opportunity to advocate for the NSF funding on which my future research program will depend, and hopefully the opportunity to



*By **Marian Chau** (Lyon Arboretum University of Hawai'i at Mānoa) and **Morgan Gostel** (Smithsonian Institution), Public Policy Committee Co-Chairs, along with **Ingrid Jordon-Thaden** (University of California Berkeley), ASPT EPPC Chair*



Congressman Scott Taylor (VA-2nd; center) meets with Andrew Owen (AIBS and George Mason University), Allison Cornell (Simon Fraser University), Morgan Gostel (Smithsonian Institution), and Maribeth Latvis (University of Idaho) during Congressional Visits Day.

establish ongoing relationships with legislators in my new home state of South Dakota.

The CVD event spanned two days and included a panel discussion, training session, and the Congressional meetings themselves. Prior to this event, each participant received resources from BESC and from American Institute of Biological Sciences (AIBS) Public Policy Office, including NSF fact sheets for each state, short legislator biographies, as well as a webinar training session. We were also encouraged to come equipped with state-specific examples of tangible payoffs for investing in biological research. This year's event occurred on the heels of the March for Science and during talk of a government shutdown over budget disagreements. Thus, I traveled to D.C. feeling prepared, but a little intimidated and pessimistic about the task at hand. Our main goal was to request an NSF budget of \$8 billion for fiscal year 2018, and I wasn't sure how such a request would be received. (Spoiler: it went well, because we have a very strong case!)

The panel discussion during the first day was hosted by the Ecological Society of America (ESA) and featured biologists speaking off the record about working in government agencies, such as the Department of Energy and the National Oceanic and Atmospheric Administration. The speakers had wide-ranging interests in the realm of public policy—from those who stepped away from academia to pursue government work, to those who secured professorships after their federal positions. A take-home message was that, as far as your involvement in public policy is concerned, you may take as big of a bite as you would like. For biologists wishing to stay in academia and dabble in this arena, it is effective to start at the local level. For example, legislator visits to district field offices are good opportunities for face time with them. They also discussed several training opportunities for students, postdocs, and faculty through the American Association for the Advancement of Science (AAAS).

Following the panel discussion, all BESC CVD participants convened for a training session

lead by Allison Mize from ESA, and Julie Palakovich Carr and Dr. Robert Gropp from AIBS. Those of us in attendance represented diverse research interests, backgrounds, geographic regions, and academic levels. All of us were passionate about our work and committed to securing this funding. The enthusiasm was infectious. I've also never seen so many biologists in business suits in one location, a testament to the formality of Washington, D.C. and working on Capitol Hill. Uncertainty hung in the air as we received an overview on the budget and proposed cuts to federal science funding. We were instructed on how to approach our meetings: start out with "the ASK" (\$8 billion for NSF in FY2018), and follow up with specific examples of why this funding is important to you personally as well as to the state/district. Legislators want to see a high return on investment, so it helps to have concrete examples on how the NSF contributes to innovation, patents, jobs, and technical training. It is also important to emphasize that the NSF provides fundamental knowledge on which other, more applied, agencies depend (e.g., USDA). An effective message needed to be free of scientific jargon and non-partisan, and we practiced our spiel in groups toward the end of the training session.

Our meetings on Capitol Hill occurred the following day. Participants were divided into teams by state and led by a team leader who would guide us to meeting locations throughout the day. My team represented the states of Alaska, South Dakota, and Virginia, and was led by Dr. Morgan Gostel from the Smithsonian Institution. Other team members included Dr. Allison Cornell (Simon Fraser University), Mr. Matt Norwood (Chincoteague Bay Field Station), and Mr. Andrew Owen (AIBS and George Mason University). Fortunately, I had a special opportunity to attend a "Sunrise Coffee" event for constituents

from South Dakota. This included actual face time and photo opportunities with Senator John Thune (R-SD), Senator John Rounds (R-SD), Representative Kristi Noem (R-SD), and their staffers! Interactions with the legislators themselves were brief and friendly. I introduced myself as an incoming faculty member at South Dakota State University and received a high-five and a "Go Jacks!" (both Senator Rounds and Rep. Noem are alumni of SDSU). Rep. Noem told me her daughters were interested in plant conservation, and that she would like to put them in contact with me to discuss this field! I had just enough time to mention the importance of NSF funding and the \$8 billion FY2018 budget before I was ushered off. I had more time for discussion with the staffers at this event, who were similarly friendly and engaging. Everyone exchanged business cards, which is part of the standard protocol in D.C. Senator Thune, Senator Rounds, and Rep. Noem have reputations as fiscal conservatives against environmental regulations, so I expected increasing NSF funding was going to be a difficult sell in this crowd. I did my best to carefully connect NSF funding to agriculture and hunting, both important sources of revenue for the state, educational opportunities for students, as well as our overall national security. They responded, "Well, we like science!"

Following the Sunrise Coffee, I met the rest of my team for our group meetings. I participated in meetings with the offices of Senator Warner (D-VA), Senator Murkowski (R-AK), Rep. Taylor (R-VA), Rep. Noem, and Rep. Connolly (D-VA). We ran into Rep. Taylor himself as he was visiting his office, and we had time for a conversation and photo op! Each team member took the lead representing his or her home state/district, with the rest of us there to offer support or share our own experiences. It was fun to discuss our scientific backgrounds

and the role that NSF funding has played throughout our careers. When visiting with the Representatives, we made a special point of asking for their support on H. R. 1054, “The Botanical Sciences and Native Plant Materials Research, Restoration and Promotion Act” (aka “the Botany Bill”).

What did it feel like to ask for \$8 billion? It felt exhilarating and empowering. Our team presented a very strong case for increasing the investment in NSF. It was helpful to understand the backgrounds of the legislators to frame our discussion effectively, whether it was ties to agriculture, entrepreneurship, or medicine. Everyone listened to what we had to say and seemed receptive to our message, especially if we were from their district—it is their job, after all.

The whole experience was enjoyable, and I am very grateful to the BSA for this opportunity. I left the CVD event motivated to keep in contact with my Senators and Representative from South Dakota, and to encourage other scientists to contact their legislators, as well. As Dr. Gropp said during our training session, “Advocacy is not a one-time event. You need to be persistent.” If we are diplomatic and persistent in our approach, the message will be heard. Given the threat of budget cuts under a new administration, scientists simply can’t afford to sit this out.

Andre Naranjo’s Experience

Advocating on behalf of science has never been more critical to our field or our country as it is now. Scientists have been stereotyped as keeping to themselves and lost in the world of their own subspecialty, oblivious to the impact decision makers were having on their work. After the Congressional Visit Days

organized by BESC, I realized this stereotype could not be further from reality. I have always been interested in public policy and advocacy; with the recent announcement of the Trump administration’s desire to cut research and development funding to several government agencies that fund the sciences, the interest to advocate on behalf of science funding grew even more. So when the opportunity arose, I applied for a BSA Public Policy Award to attend the 2017 Congressional Visits Day (CVD) in Washington D.C., co-hosted by AIBS and ESA. I believed CVD would provide me with important training in public policy necessary to further my experience in science advocacy as well as connect me with policy specialists in different congressional offices that represent me and other scientists in Florida.

BESC planned the two-day event, with day one covering the fundamentals of science funding across the federal government, and meeting with our teams to practice our meetings for the next day. Prior to this event, we received an NSF fact sheet for the nation at large and for our state, short legislator biographies, as well as a webinar training session. The next day we met with congressional staff at Capitol Hill to pitch our request: \$8 billion for the National Science Foundation. We met with our team leader, Dr. Mary Klein, a member of the AIBS Board of Directors. We visited offices under teams organized by state, with my team representing Florida and New Hampshire. The first office of the day we visited was that of Republican Representative Francis Rooney, from the 19th Congressional District of Florida. We spoke about the importance of NSF funding to wetland ecology research currently taking place in the area of Fort Myers, FL, and we were told the Congressman would support NSF funding. Phew—and I thought this would be more difficult! We then

met with Representatives Alan Lawson and Carlos Curbelo, who represent Tallahassee and Miami, respectively. Congressman Lawson's staffer assured us they would work to get the appropriate funding for NSF, and Congressman Curbelo's staffer went beyond that to ensure science funding was a priority for the next budget.

Later in the day, we met with Senator Bill Nelson and Senator Marco Rubio's staffers. I described my personal story to Senator Rubio's staffer, and how NSF has helped fund outreach opportunities that got me and other first-generation Hispanic college students interested to pursue a career in a STEM field. He assured me the senator was committed to helping advance science education and outreach, and would support NSF funding at current or higher levels than present. Senator Nelson's office was very friendly, with an almost instantaneous assurance of support for our goal! We spent the rest of the time discussing our personal research to the staffers who were all very interested. Senator Maggie Hassan's office was similarly supportive of our request. The last meeting of the day was with Congressman Ted Yoho, a well-known conservative firebrand who I thought would be reluctant about our request. I was proven wrong. His staffer informed us science/research & development funding is "one of the few things the government does well!" We all chuckled and thanked the congressman for his support.

Moving forward, I have a recommendation: contact those who represent you in Congress. Reach out to their staffers, describe your concerns, and express how a particular policy affects you as a constituent. It was incredibly reassuring for me to learn how willing representatives and senators are to sit down

with their constituents and how willing they are to fight for their interests. Once you meet with congressional staff, exchange contact information (the most prized currency in D.C. is a business card). Once you have a relationship with the staff, do not be afraid to reach out frequently whenever there is a policy development that affects you and the representative's district. Persistence is key to achieving policy outcomes you advocate for. It is imperative, however, that all of your communications be civil and tactful, especially if you are representing the interests of an institution that receives federal funding. Now more than ever, we need scientists expressing their views and communicating with decision makers about the future of our field and what is at stake for humanity as a whole. Be on the lookout for different professional societies offering travel opportunities to D.C. to meet with representatives. Being given the honor to convey the need for NSF funding by the BSA is something I am beyond grateful for.

Despite a deeply divided culture of Congressional politics this year, it is encouraging to see that support for federal funding for basic research, which leads to transformative innovation in the United States, is supported on both sides of the aisle, with bipartisan recognition of the value of this investment.

Our job, as botanists, is not only to continue to contribute leading research in plant sciences, but find our common voice and communicate the value and importance of our work to the policy makers and the public as well as to advocate for its continued support and growth in the face of challenges ahead for the future.

If you are interested in contributing to the BSA's Public Policy Committee or attending a future Congressional Visits Day, please don't hesitate to contact us at marianmchau@gmail.com or gostelm@gmail.com.

On behalf of the BSA's Public Policy Committee, Maribeth Latvis, Ph.D., Andre Naranjo, Morgan Gostel, Ph.D., and Marian Chau, Ph.D.

The #OhiaLove Project: Banking Seeds During the Rapid ‘Ōhi’a Death Crisis in Hawai‘i

In 2015, a fungal disease called Rapid ‘Ōhi’a Death (ROD) was spreading on Hawai‘i Island, killing thousands of ‘ōhi’a trees (*Metrosideros polymorpha*)—the keystone species of Hawaiian native forests. I recognized an urgent need to collect and bank seeds, and I knew, from our research at the Seed Conservation Lab in Lyon Arboretum’s Hawaiian Rare Plant Program, that the small seeds of ‘ōhi’a could be stored for decades under proper conditions. However, emergency funding was unavailable. Since one of the ways ROD spreads is via human activity, there was also an urgent need for outreach. I spearheaded the #OhiaLove Crowdfunding Campaign to raise both money and awareness. We launched in February 2016, and in 4 months, we raised \$50,000 with 457 donations from across Hawai‘i and mainland U.S., and even from other countries. I appeared on television news programs and other media, and joined the diverse and dedicated ROD Working Group to cooperate on statewide outreach efforts.



Ten thousand of the ‘ōhi’a seeds that have been saved through the #OhiaLove Project.

Once we had funding, I collaborated with Laukahi Hawai‘i Plant Conservation Network and the Hawai‘i Seed Bank Partnership to establish collection strategies, goals, and protocols. A year later, we now have collected and banked over 2 million ‘ōhi’a seeds from more than 10 regions on three islands. In February 2017, Lyon Arboretum was awarded \$100,000 through Hawaii Tourism Authority’s Aloha ‘Āina Program to build on these efforts with a ROD Seed Banking Initiative in 2017-2018.

Lyon Arboretum would like to say mahalo to all the BSA members who donated to this project or helped spread the word!

By Marian Chau, Lyon Arboretum University of Hawai‘i at Mānoa



‘Ōhi’a trees in the Kōʻolau mountains on the island of Oʻahu.

Welcome to Where the West Begins!

As botanists from around the world arrive at Fort Worth, Texas for BOTANY 2017, they'll have a unique opportunity to experience a global research institute and learning center nearby: the Botanical Research Institute of Texas (BRIT). Staff members at BRIT are thrilled to have conference attendees visiting right in their own backyard during this year's annual meeting. In addition to a great conference for which they have helped arrange some exciting field trips, there is much to do and see in Fort Worth—and of course, they'd love to have you come visit BRIT!



From the conference hotel, BRIT is just a short bus, Uber, or cab ride away at 1700 University Drive, Fort Worth, TX 76107, located next door to the Fort Worth Botanic Garden. BRIT is open to the public Tuesday through Friday, 10 am to 4 pm, and by appointment outside those times. And in celebration of an influx of botanical visitors to the city, BRIT is offering free tours Tuesday through Friday at 1:30 pm, during which you can visit our herbarium, tour the grounds, and check out their current exhibit, "The Hidden Gardens of BRIT: BRIT collections on display."

Please stop by and share your love of botany!
For more information, please go to www.brit.org.



© Photo by Glen E. Ellman

Botanical Society of America's Award Winners



Jennifer Richards Wins 2017 Distinguished Fellow Award

The Botanical Society of America Distinguished Fellow Award is the highest honor our Society bestows. Each year, the Merit 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, and 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.

Dr. Jennifer Richards has made many important contributions in the diverse areas of plant morphology, development, and ecology

of plants. Her research questions have ranged from the development of vegetative and reproductive parts of plants, to the ecology of their forms and functions, and comparisons of the evolutionary pathways of different taxa in the same and in different communities in response to environmental variation. Trained in classical plant morphology, she is now a whole-plant ecologist specializing in macrophytes of the southern Florida Everglades ecosystem, working with many collaborators in diverse fields of ecology and other disciplines to assess community and ecosystem effects of the extensive, long-term restoration projects taking place in the Everglades. She has also investigated the development and ecological implications of distyly in flowers, the function of leaves in carnivorous plants, the significance of water lilies as indicators of a healthy freshwater ecosystem in the Everglades, and potential methods of control for invasive exotic ferns.

Richards has served the BSA in a number of capacities, including the Conservation Committee, Developmental and Structural Section, Education Committee, *AJB* associate editor, Election Committee, the Committee on Committees, and Secretary of the BSA. In 2006, the BSA recognized Richards with a Centennial Award for her outstanding service to the field and the Society. She is an outstanding scientist, educator, and colleague who remains humble, approachable, and receptive to anyone with an interest in plants. Nominated by many of her colleagues, she is a botanist's botanist, who continues to serve the BSA, the botanical community, and her institution with distinction.



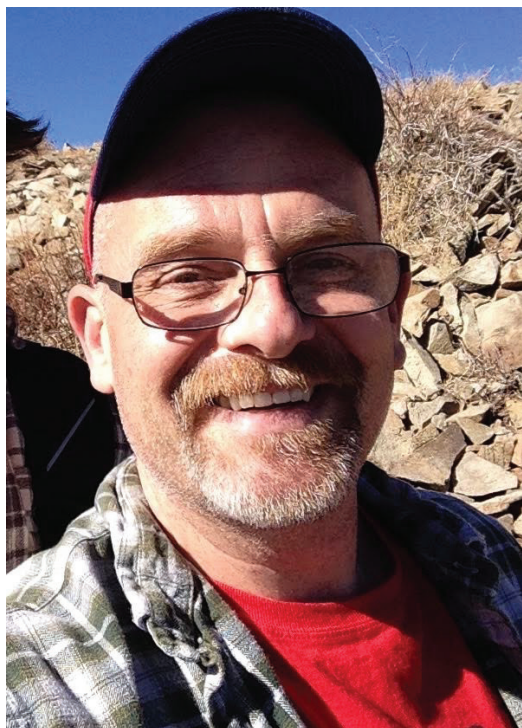
Benjamin Blackman Receives BSA Emerging Leader Award

Dr. Benjamin Blackman is an Assistant Professor in the Department of Plant and Microbial Biology and the University of California, Berkeley. Blackman earned his B.S. in Biological Sciences at Stanford University and then continued on there as a technician in the lab of Dr. David Kingsley. Blackman received his Ph.D. in 2009 from Indiana University, Bloomington, where he worked with Drs. Loren Rieseberg and Scott Michaels, and he completed an NSF Postdoctoral Fellowship in Biology at Duke University and University of California, Berkeley with Drs. John Willis and Daniel Rokhsar, respectively. Blackman served as a faculty member in the Department of Biology at the University of Virginia for seven semesters before starting his current position at UC Berkeley in January 2016. Over this period, Blackman has been a highly productive researcher, authoring over 25

publications, and he also has an impressive record of fellowship and grant support from the National Science Foundation.

Blackman's research takes a highly integrative approach to understanding how plant development responds to seasonal and diurnal environmental fluctuations and how these plastic responses evolve during adaptation or domestication. His work applies genomic, functional, and comparative approaches in two classic and diverse systems: sunflowers and monkeyflowers. In doing so, Blackman has made many novel insights spanning from the nucleotide level to population ecology in the evolution of photoperiodic flowering as populations adapt to local habitats, the contribution of gene duplication to evolutionary innovation during domestication, and the biology of solar tracking.

Blackman's commitment to teaching, outreach, and professional service is also impressive. Since defending his Ph.D., he has mentored over 70 undergraduates and high school students. Many of these diverse students have continued on in STEM fields, and Blackman was recognized as an outstanding faculty mentor by the VA-NC Louis Stokes Alliance for Minority Participation in STEM in 2015. Blackman has also organized several regional meetings and symposia, and he has served on the BSA Public Policy Committee since 2013. Among his achievements in outreach, Blackman mentored K-12 Planting Science teams for five years, helped develop and implement a discovery-based genomics curriculum for high school summer interns at the National Museum of Natural History, and is now a lead organizer of Walking with Wildflowers, a new citizen science initiative for monitoring plant phenology along the Pacific Crest Trail.



J. Philip Gibson Receives Charles Edwin Bessey Teaching Award

Dr. J. Philip Gibson, of the Department of Microbiology & Plant Biology and the Department of Biology at the University of Oklahoma, clearly brings all of the qualities recognized by the Charles Edwin Bessey Teaching Award: enthusiasm, innovation in teaching that increases student and/or public interest in botany, innovation in teaching botany that increases the quality of botanical education, and BSA Membership. Gibson's commitment to effective teaching began in

graduate school where he developed a forest ecology summer field course because he recognized the critical importance of taking students into the field and providing research experiences.

As a faculty member, Gibson's pioneering work with student engagement has expanded to include development of numerous case studies that use primary research to teach fundamentals, flipped classes complete with YouTube videos, and card games that teach phylogenetic concepts. Gibson is exceedingly generous with each of these innovations. The case studies are provided as freely available PowerPoints and are meticulously documented with notes for using the case studies in the classroom. Not only is Gibson committed to improving education for college students, he has published three textbooks aimed at K-12 students.

His commitment to public outreach is equally impressive. Throughout his career, he has given presentations at venues ranging from Native Plant Societies, to Natural History Museums, to Community Centers. Gibson twice led the BSA contingent at the USA Science and Engineering Festival (<http://www.usasciencefestival.org/>) attended by many thousands of visitors. Finally, Gibson is a loyal and energetic member of the BSA. He has taken on leadership roles in the Teaching Section, including service as chair, vice chair, program coordinator, and now secretary/treasurer. Gibson took on the leadership of PlantEd, where he is committed to providing a platform for disseminating new developments in education.

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.

1st Place



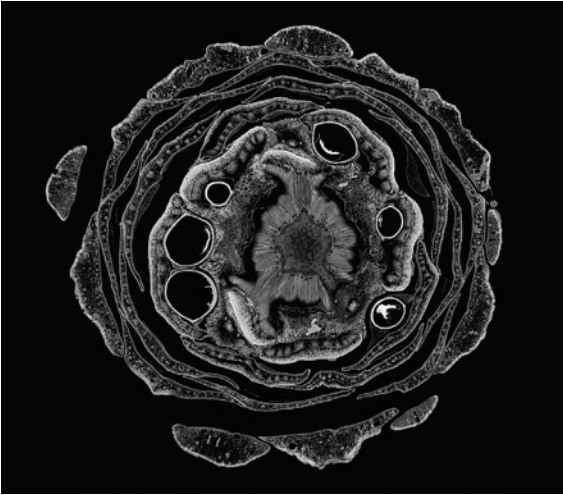
Ya Min

Harvard University

Feast for the pollinator

Aquilegia petal spurs can produce a large volume of nectar when fully blooming. Diverse forms of petal spurs of Columbine flowers are always used as textbook examples of pollination syndrome and adaptive radiation: most species are mainly pollinated by one kind of pollinator, and the lengths of the petal spurs match the pollinators' tongue lengths. The fully blooming flower in the photo is of a horticultural strain “Origami”, with sweet and delicious nectar filled almost half of the long petal spurs—what a feast for the pollinators!

2nd Place



Kelly Matsunaga
University of Michigan
"Cone-templation"

This image depicts a digital transverse section of a *Pinus resinosa* (red pine) seed cone, based on X-ray micro-computed tomography (μ CT). μ CT is a technique used in many scientific disciplines for non-destructively imaging and analyzing three-dimensional objects. Similar to hospital CT, or CAT scans, μ CT scans produce a series of high resolution 2D X-ray images taken through 360 degrees of rotation, which are then reconstructed using computer software. These reconstructions generate 3D data sets that can then be analyzed in a wide range of programs to study the internal and external structure of the object. μ CT scans of plants have many applications in botanical research and education because they can be used to efficiently and non-destructively study 3D morphology and anatomy, perform digital dissections, and produce 3D models that are useful for teaching, scientific communication, and public outreach. In this digital section of the seed cone we can see the cone axis, including the pith and secondary xylem, diverging ovuliferous scales, and seeds.

3rd Place



Carolina Siniscalchi
University of Memphis
Hitting the sweet spot

Ant drinks nectar from nectary on the external part of a corolla on a *Chresta speciosa* flower. Plants have developed a wide range of defense mechanisms to protect themselves against herbivory. Some produce toxic compounds on leaves and flowers, other have dense layers of hair protecting leaves and some recruit insects to help with the work. This species, *Chresta speciosa*, has a tiny nectar-producing gland on the outside of the corollas; this may look like a waste of energy, but the nectar droplets attract ants. Some ants are very aggressive regarding protection of food sources and will fight other bigger insects when they try to prey on the plant. Therefore, by producing extra nectar, the plant manages to keep lots of ants on its stem and inflorescences, and they will protect the plant from most predators.

BSA Public Policy Awards

The Public Policy Award was established in 2012 to support the development of tomorrow's leaders and a better understanding of this critical area. The 2017 recipients are:

Andre A. Naranjo, Ph.D. Student, Florida Museum of Natural History, University of Florida
Maribeth Latvis, Postdoctoral Associate, Tank Lab, University of Idaho

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 J. S. Karling Graduate Student Research Award

Ya Min, Harvard University (Advisor: Elena Kramer), for the proposal: *The genetic architecture of stamen whorl variation in Aquilegia*

The BSA Graduate Student Research Awards

Prabha Amarasinghe, University of Florida (Advisor: Nico Cellinese), for the proposal: *An integrated approach for understanding the drivers of diversification in Memecylon (Melastomataceae)*

Lauren Audi, Northwestern University (Advisor: Nyree J. C. Zerega), for the proposal: *Genetic characterization of Caribbean Breadfruit: Advancing food security and local sustainable agriculture via germplasm conservation and collaboration with local growers*

Nicholas Bard, University of Colorado at Denver (Advisor: Leo P. Bruederle), for the proposal: *The diversity of adaptation: A population genomic study of two disjunct conspecific plant taxa*

Amanda Benoit, University of Tennessee (Advisor: Susan Kalisz), for the proposal: *Sit-and-wait predators as drivers of plant mating system evolution*

Brittany Cavazos, Iowa State University (Advisor: Haldre S. Rogers), for the proposal: *The impact of frugivorous bird extinction on plant reproductive traits*

Alexa DiNicola, University of Wisconsin at Madison (Advisor: Kenneth J. Sytsma), for the proposal: *Evolution of the *Potentilla breweri* complex: Adaptation, hybridization, and radiation in the Great Basin sky islands*

Anna Farrell, Northern Illinois University (Advisor: Nicholas A. Barber), for the proposal: *Functional plant trait variation along disturbance gradients in restored prairies*

Jessica Hoch, Columbia University (Advisor: Matthew I. Palmer), for the proposal: *Drivers of microbial assemblages, plant-microbial mechanisms, and ecosystem services in urban green infrastructure*

Johanna Jantzen, University of Florida (Advisor: Pamela S. Soltis), for the proposal: *Diversification and niche evolution in Neotropical *Tibouchina* s.s. (Melastomataceae)*

Melanie Kazenel, University of Vermont (Advisor: Alison K. Brody), for the proposal: *Assessing the consequences of bumblebee declines for native plants and pollinators*

Xiaoxian Liu, University of Florida (Advisor: Doug Soltis), for the proposal: *Evolutionary impact of genome duplication on alternative splicing: Genome-wide assessment in a polyploid plant (*Tragopogon*)*

Chelsea Pretz, University of Colorado at Boulder (Advisor: Stacey D. Smith), for the proposal: *Pollination biology and hybridization among *Tomatillo* (*Physalis*) Species in the Southwestern Region of North America*

Adam Ramsey, University of Memphis (Advisor: Jennifer Mandel), for the proposal: *The effects of mitochondrial heteroplasmy on individual fitness in wild carrot*

Jon Richey, University of California at Davis (Advisor: Isabel Montanez), for the proposal: *Reconstructing paleo-plant physiology and vegetation-climate feedbacks of late paleozoic seasonally-dry tropical biomes*

Rosa Rodriguez-Pena, Ohio State University (Advisor: Andrea D. Wolfe), for the proposal: *Investigating the agents driving diversification in *Penstemon* using high-throughput sequencing technology*

Annika Smith, University of Florida (Advisor: Pamela S. Soltis), for the proposal: *Floral evolution & diversity in the *nasturtiums* (*Tropaeolum*)*

Elizabeth Stunz, University of Texas at El Paso (Advisor: Michael L. Moody), for the proposal: *Landscape genetics of Arctic dwarf birch (*Betula nana*) in the context of gene flow and climate change*

Katherine Wenzell, Northwestern University (Advisor: Jeremie Fant), for the proposal: *Geographic variation in floral traits and pollinators in relation to population genetic structure of two Castilleja species (Orobanchaceae)*

Colby Witherup, Northwestern University (Advisor: Norm Wickett), for the proposal: *Investigating the evolutionary history of meiosis genes in genera with diploid and polyploid clades*

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.

Farahnoz Khojayori, Virginia Commonwealth University (Advisor: Dr. Wenheng Zhang), for the Botany 2017 presentation: *“CYC2-like genes elucidate floral symmetry evolution following a major biogeographic disjunction”* Co-authors: Jingbo Zhang, Elena Kramer, Charles Davis, and Wenheng Zhang

Keir Wefferling, University of Wisconsin-Milwaukee (Advisor: Dr. Sara Hoot), for the Botany 2017 presentation: *“Disentangling the subalpine marshmarigold polyploid complex: Phylogeography of Caltha leptosepala s.l. (Ranunculaceae)”* Co-author: Sara Hoot

The BSA Undergraduate Student Research Awards

The BSA Undergraduate Student Research Awards support undergraduate student research and are made on the basis of research proposals and letters of recommendation. The 2017 award recipients are:

Christopher Bidlack, Bucknell University (Advisor, Drs. Christopher T. Martine and Jason T. Cantley), for *Comparing salt tolerance in germination and adulthood between four Australian Solanum species*

Michelle (Shelly) Gaynor, University of Central Florida (Advisor, Dr. Chase Mason with Drs. Linda Walters and Eric Hoffman), for *Assessing genetic diversity within populations of smooth cordgrass to ensure effective restoration efforts*

Jackie Ndem, Bucknell University (Advisor, Drs. Jessica E. Hall and Christopher T. Martine), for *Molecular analysis of pollen grains from a morphologically androdioecious but functionally dioecious Solanum species*

Kelly Pfeiler, Humboldt State University (Advisor, Dr. Alexandru M. Tomescu), for *An early Cretaceous seed cone provides a window into the deep phylogeny of sequoioid Cupressaceae*

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 BSA. The 2017 “Certificate of Special Achievement” award recipients are:

Ethan Baldwin, University of Florida (Advisors: Drs. Pamela and Douglas Soltis)

Dana Bergenfeld, Connecticut College (Advisor: Dr. Chad Jones)

Lana Bolin, University of Minnesota (Advisor: Dr. David A. Moeller)

Brandon Corder, University of Florida (Advisors: Drs. Pamela and Douglas Soltis)

Nic Diaz, Bucknell University (Advisors: Drs. Christopher T. Martine and Jason T. Cantley)

Paige Fabre, University of Washington (Advisor: Dr. Dick Olmstead)

Emma Frawley, Bucknell University (Advisors: Drs. Christopher T. Martine and Jason T. Cantley)

Julian Ginori, University of Florida (Advisors: Drs. Pamela and Douglas Soltis)

Nicolas Glynos, Cornell University (Advisor: Dr. Karl Niklas)

Makenna Hill, Weber State University (Advisor: Dr. Sue Harley)

Lia Leibman, University of Virginia (Advisor: Dr. Laura Galloway)

Warner Lowry, James Madison University (Advisor: Dr. Conley K. McMullen)

Nathan Luftman, Bucknell University (Advisors: Drs. Christopher T. Martine and Jason T. Cantley)

Janet Mansaray, Howard University (Advisor: Dr. Janelle M. Burke)

Rebekah Mohn, Miami University (Advisor: Dr. Michael A. Vincent)

Cody Myers, University of Florida (Advisors: Dr. Pamela and Douglas Soltis)

Nicholas Shaw, Weber State University (Advisor: Dr. Heather Root)

Hannah Thomas, Pittsburgh State University (Advisor: Dr. Neil Snow)

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.

Kefren Arjona, University of Florida (Advisor: Dr. Doug Soltis)

Laymon Ball, Long Beach State University (Advisor: Dr. Amanda Fisher)

Nana Britwum, Cornell University (Advisor: Dr. Rena Borkhataria)

Michelle Gray, University of Maryland College Park (Advisor: Dr. Maile Neele)

Monique Harvey, Howard University (Advisor: Dr. Janelle Burke)

Rebecca Hayes, University of Pittsburgh (Advisor: Dr. Tia-Lynn Ashman)

Lillian Hendrick, Central Michigan State University (Advisor: Dr. Anna Monfils)

Glen Morrison, California State Polytechnic University (Advisor: Dr. Amy Litt)

Jocelyn Navarro, Connecticut College (Advisor: Dr. Kristine Hardeman)

ShaunAnn Peters, Central Michigan State University (Advisor: Dr. Anna Monfils)

Kasey Pham, Michigan State University (Advisor: Dr. Alan Prather)

Melissa Vergara, University of California-Santa Cruz (Advisor: Dr. Kathleen Kay)

Sienna Wessel, Northern State University (Advisor: Dr. Jodie Ramsay)

Ecology Section Student Presentation Awards

Matthew Haynsen, George Washington University (Advisor, Dr. Keith Crandall) for the Botany 2017 presentation: “*Population Genetic Analysis of Invasive Kudzu (Pueraria montana var. lobata) throughout Asia and the United States*” Co-authors: Mohammad Vatanparast, Liu Luxian, Fu Cheng-Xin, Keith A. Crandall and Ashley N. Egan

Sarah Augusta Maccracken, Smithsonian Institute National Museum of Natural History (Advisor, Dr. Conrad Labandeira) for the Botany 2017 presentation: “*Insect Herbivory of the Kaiparowits Formation Flora, Late Cretaceous (Campanian) of Utah*” Co-authors: Ian M. Miller, Charles Mitter and Conrad C. Labandeira

Carlos J. Pasiche-Lisboa, University of Manitoba (Advisors, Drs. Michele D. Piercey-Normore and Rene Belland) for the Botany 2017 presentation: “*Survival of fragments from three boreal mosses to extreme temperatures*” Co-authors: Rene Belland and Michele D. Piercey-Normore

The BSA Developing Nations Travel Grants

Francisca Ely, Universidad de los Andes, Venezuela

Eliezer Cocoltzi Vásquez, Instituto de Ecología, Mexico

Kamal Jit Singh, Panjab University, India

Julián Aguirre-Santoro, Universidad Nacional de Colombia, Columbia

Victor Amoroso, Central Mindanao University, Philippines

Natalia Ivalu Cacho, Universidad Nacional Autonoma de Mexico, Mexico

Emilio Estrada-Ruiz, Instituto Politecnico Nacional, Mexico

Caroline Umebese, University of Lagos, Nigeria

Malka Saba, University of Gujrat, Pakistan

Matias Köhler, Universidade Federal do Rio Grande do Sul, Brazil

The BSA Professional Member Travel Grants

Jeremy Coate, Reed College

Linda Hardison, Oregon State University

Nina Baghai-Riding, Delta State University

Robert Baker, University of Wyoming

Catherine Borer, Berry College

Juan Losada, Brown and Harvard Universities

Stanley Rice, Southeastern Oklahoma State University

Laura Lagomarsino, University of Missouri-St. Louis

Seana Walsh, National Tropical Botanical Garden

Stephanie Conway, University of Washington



SPECIAL FEATURE

Three Sisters and Integrative Faculty Development

Abstract

Lessons on building integrated academic careers in diverse settings emerge from a contemplative walk through a Three Sisters garden. The Three Sisters of corn, bean, and squash are central to traditional plant knowledge and American indigenous farming practices. These crops have been planted together because of the interactive relationships that occur and which support more robust growth than would be observed through planting each in monoculture. These sisters have interdependent relationships that are supported both by the order of their emergence, successful establishment, and distinct yet complementary roles. Here, I draw parallels between the Three Sisters of traditional plant cultivation and the three distinct domains of focus of academic careers:

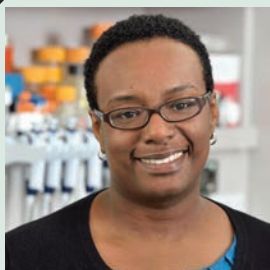
research, teaching, and service. Specifically, I draw on lessons from the Three Sisters, and related concepts of plant ecophysiology, to highlight strategic approaches for building integrated careers that are developed and sustained through early engagement of self-reflection, mentoring, and active cultivation, as well as intentional engagement in a large community of support. The importance of the order of establishment of particular academic domains, productive cultivation practices to support integrated growth, and additional implications for supporting individuals in diverse communities are discussed in the context of specific academic environments in which they are being planted. The lessons that can be harvested from the Three Sisters garden regarding the building and cultivating of effective and productive integrated academic careers are plentiful, lasting, and potentially transformative for higher education environments.

Footnotes

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² Corresponding e-mail: montg133@msu.edu

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*By Beronda L. Montgomery²
Michigan State University,
DOE—Plant Research Laboratory,
East Lansing, MI*

Key Words

academic career; career integration; faculty development; plant ecophysiology; research; service; teaching; traditional plant knowledge

Recent conversations have been sparked regarding bridging the gap between indigenous and scientific bases of knowledge (Kimmerer, 2015; Mistry and Berardi, 2016). In speaking of drawing on both scientific and indigenous knowledge, botanist Robin Wall Kimmerer (2015) speaks of learning how “to drink the nectar and gather pollen from both” scientific and indigenous “flowers” of knowledge (p. 47). She argues that “it is this dance of cross-pollination that can produce a new species of knowledge, a new way of being in the world” (p. 47). I also see reflection on both scientific and indigenous knowledge bases as fertile motivation for the integration of knowledge across distinct life and career domains to support the building of a personal approach to understanding and being in the world. In this context, we have much to learn from plants, organisms that by virtue of being sessile have developed exquisite abilities to sense what is going on around them and tune their growth and development to environmental cues to maximize productivity and survival. Plant geochemist and geobiologist Hope Jahren (2016) declared that “human civilization has reduced the plant...into three things: food, medicine, and wood” (p. 279). Plants have so much more to offer, if we are able to overcome the common ailment of “plant blindness,” i.e. humans’ failure to recognize, observe, and learn from the plants around us, and to see them and hear the lessons that they present. Herein, lessons from the Three Sisters prevalent in indigenous plant practices and ecological knowledge are explored.

Common, commercial agricultural practices showcase vast fields of monocultured maize, soybeans, and other crops, starkly distinct from the diverse inter-planting of crops or polyculture—including the venerable Three Sisters cultivated by Native Americans and other broad ranges of crops planted by other indigenous peoples globally. Rather than question or challenge the source of the gift of the Three Sisters, or other traditional plant or ecological knowledge, I ask what questions can be drawn and what wisdom can be gained from this concept. The Three Sisters knowledge, which is based on the practice of co-planting corns, beans, and squash, is common to many American tribes (Chenault, 2008; Kimmerer, 2015, pp. 128-140). The inter-planting of the species draws on the complementary strengths of the three crops. Corn provides vertical support for beans, which in turn provide accessible nitrogen to fertilize themselves and corn. Finally, low-to-the-ground squash, which is also nourished by the beans’ supplied fertilizer, inhibits weed growth and maintains moisture of the soil for the other two partners. Plants growing in polyculture in a Three Sisters garden produce greater yield from their integrated growth than if each were grown in monoculture (Kimmerer, 2015, p. 132). The Three Sisters story is equally applicable to discussions about reciprocal relationships, sacrifice, and communal values (Chenault, 2008), as it is to those about basic biological concepts of symbiosis, ecological niche partitioning, and cycling of nutrients (Kimmerer, 2002). Following is a discussion of the Three Sisters with specific application to integrated academic careers in diverse academic communities.

Polyculture Vs. Monoculture and Productivity

The general phenomenon of improved productivity in ecosystems containing diverse plant species, which is characteristic of the Three Sisters, has been documented for many different plant types (Adetiloye, 2004; Li et al., 2007; Li et al., 2014; Wang et al., 2014). One potential mechanism underlying the observed improved productivity associated with inter-cropping is that individual plants or plant species mobilize resources, including nutrients that improve their growth and contribute interchangeably to the growth of other plants in the community through a process referred to as *interspecific facilitation* (Li et al., 2014). Thus, the distinct plants growing in polyculture reciprocally contribute growth-promoting, or protective, properties to each other. Indeed, as Kimmerer describes (2015), “lessons of reciprocity are written clearly in a Three Sisters garden” (p. 131).

The nature of reciprocal existence of the three partners in the Three Sisters garden has direct implications for establishing interaction and enhancement of the domains of a faculty member’s career. Very frequently the domains of research, teaching, and service in which faculty members operate are viewed as competing interests (Whittaker and Montgomery, 2014). Given that the degree of competition for time and energy between these domains is largely driven by the rewards attributed to each by institutions in which practitioners work and are reviewed for success (O’Meara and Braskamp, 2005; O’Meara, 2005), involvement in one domain is frequently viewed as taking valuable time and energy away from the pursuit of the others and would leave the faculty member

constantly juggling competing demands. Instead, integration across academic domains—a proxy for polyculture—can yield impactful outcomes. These outcomes can lead to specific approaches to promoting diverse and strategic pathways to success in academic environments, including integrated approaches to career development.

The consideration of research, teaching, and service as different, yet all valuable, avenues through which one can accomplish individual purpose and vision leads to the potential to view these activities not as distractions one from the other, but as integrative scholarship. Teaching in this integrated context becomes not just the passing on of disciplinary knowledge from instructor to student, but an opportunity to encourage students to understand how the knowledge available is a component of their doing what they are “supposed” to be doing. Research in this integrative context represents an opportunity to understand the natural world and its order and how an individual realizes oneself and works most effectively in that context, in addition to or as a part of what is commonly described as “discovery and research.” Service in this integrative context may be viewed as “a way to bring...scholarship, leadership and advocacy together” (Dockry, 2015, p. 36), in ways that are synergistic and result in an outcome that is much greater than the sum total of its parts.

In reflecting back on the Three Sisters, “the beauty of the partnership is that each plant does what it does in order to increase its own growth. But as it happens, when the individuals flourish, so does the whole” (Kimmerer, 2015, p. 134). Ultimately, promoting an integrative approach to one’s academic career is the essence of the principles of a Three Sisters

ecosystem. That is, in well-thought out and well-executed integrated careers, the three sisters of an academic career share with the Three Sisters of traditional plant knowledge that “the gifts of each are more fully expressed when they are nurtured together than alone” (Kimmerer, 2015, p. 140).

Timing of Emergence and an Integrated Existence

The sequence of emergence and establishment of the Three Sisters is critical for maximizing the potential of their synergistic existence. Kimmerer (2015) describes that the “sequence of their germination, their birth order, is important to their relationship and to the success of the crop” (p. 130). Some additional plant studies also corroborate the Three Sisters lesson of the importance of timing of establishment of relationships on the ultimate productivity outcomes in polyculture crops (Adetiloye, 2004). Timing the planting of the Three Sisters such that corn emerges first and uses its property of being proficient at absorbing moisture available in the soil to promote its germination is critical. The corn seedling takes root, initiates development and expansion of leaves, and establishes robust photosynthesis that allows it to transition from depending on the resources gifted to it from its mother plant to producing its own food that supports it in growing tall. The next to emerge is the bean, which in the absence of a support system would grow along the soil and become susceptible to many stresses from living (biotic) and non-living (abiotic) factors. The “slow” sister is squash, which emerges last, and spreads its broad leaves close to the soil surface in open spaces in the canopy through which light penetrates and covers the established root systems of the first two sisters. This low-to-the-ground covering

provided by squash prevents weeds from forming and protects the soil from drying out, and its prickly leaves can serve as a deterrent to herbivory (Kimmerer, 2015, p. 131). This importance of the timing of establishment is representative of “knowledge of relationship” (Kimmerer et al. 2015, p. 140) and has strong implications for the establishment of the three domains for an academic career. In this context, which of the three domains is the first sister is largely predicated on the context of the faculty member’s career, the faculty member’s self-defined and self-cultivated career goals, and the criteria by which the faculty member will be assessed for promotion and/or tenure. Faculty members generally allocate time and energy to the domains of their work in proportion to how these areas will be weighted for tenure and promotion (Ruscio, 1987; Finnegan and Gamson, 1996; O’Meara and Braskamp, 2005; O’Meara, 2005; Toews and Yazedjian, 2007).

Considered in the Three Sisters’ framework, establishment of one’s research is likely to be the first “sister” to emerge for faculty members in research institutions, whereas teaching and pedagogy may be the primary focus for those in teaching institutions. In each of these contexts, much like the corn in the Three Sisters garden, the first domain planted should be viewed as a foundation upon which to support the interdependent growth of another career domain. Having established a strong research foundation, research-intensive faculty may next seek to promote growth of teaching that is interdependent with and supported by their research interests. Such efforts may include scholarship-based approaches to teaching and learning or lab-based, inquiry-driven instruction related to their core research (Anderson et al., 2011; Whittaker and Montgomery, 2014). Alternatively, teaching-intensive faculty may seek to use their

established lecture, or especially lab, courses to develop and integrate research questions. Finally, service and outreach may well be viewed as the “slow sister” for all faculty members. Having established the primary criteria by which most institutions will evaluate faculty success, faculty members can assess complementary service activities that may integrate with or elevate their teaching and research interests in ways that result in a partnership between career domains that like the corn, bean, and squash of a Three Sisters garden are “cooperating, not competing” (Kimmerer, 2015). Ultimately, the model of the Three Sisters provides a rich framework for inspiring integration across career domains.

Belowground Interactions and a Role for Shared Resources in Integrating Career Domains and Promoting External Collaborations

Plants operate in community in more ways than exemplified by a first encounter with the Three Sisters. Many visitors to a Three Sisters garden are likely to focus on the more readily observable aboveground interactions between the sisters, including the careful “placement of their leaves, carefully avoiding one another’s space” (Kimmerer, 2015, p. 132). Few are likely to fully see or recognize, or may indeed exclude, the role of support players in this ecosystem. Notably, the belowground parts of the plants are busily engaging in plentiful interactions with the soil and roots of other plants largely out of view of the human eye (Kimmerer, 2016). The roots of corn are rather shallow and thus occupy a different part of the soil than the deep taproots developed by

beans. Squash positions its roots in places unoccupied by the roots of the two established sisters (Kimmerer, 2015, p. 133). In fact, when and where the stem of the squash encounters soil, it can initiate additional stem-derived roots known as *adventitious roots* (Kimmerer, 2015, p. 133). Additionally, secondary roots, adventitious roots, and root hairs of each sister further distribute throughout available parts of the soil, which allows the plants to further search for resources or establish relationships with others. This underground cooperation extends beyond what is easily seen, but is as important to the cooperative relationships established between sisters as those readily observed above the surface. Plants in a Three Sisters garden, thus, have belowground interactions that demonstrate the reciprocity of the plants in co-cultivation as robustly as aboveground plant organs, again demonstrating that “all gifts are multiplied in relationship” (Kimmerer, 2015, p. 140).

Apart from interactions with the soil, the roots of plants establish symbiotic relationships with other organisms, including the bacteria required for some plants to fix nitrogen and with fungi to produce mycorrhizae that improve water uptake and nitrogen and phosphate acquisition. This latter association with fungi is apparently true of nearly all land plants (Smith and Read, 2008). These bacterial or fungal interactions with plants result in bilateral benefits to the two partners (Hartmann and Trumbore, 2016). Central to the Three Sisters paradigm are the symbiotic relationships that some roots have with bacteria; in fact, the second sister bean provides the nitrogen fertilizer based on its colonization by a specific nitrogen-fixing *Rhizobium* bacteria (Kimmerer, 2015, p. 133; Sprent, 2009; Yang et al., 2009). As a part of these symbiotic, belowground exchanges, plants share fixed carbon, an energy source,

with the bacteria or fungi in exchange for access to nutrients or improved water uptake. Although not a focus of the traditional Three Sisters metaphor, mycorrhizae (plant-fungal associations) play critical roles in plants' establishment and productivity in natural environments and in particular have critical roles in community building and communication, because a single fungus can connect multiple plants underground resulting in the building of connections and networks via plant roots. Thus, mycorrhizae not only acquire carbon from the plants they colonize, but also serve an important role in facilitating the sharing of carbon among the many plants with which they interconnect (Klein et al., 2016). This carbon sharing is facilitated by interactions between the obvious aboveground plant organs and the hidden-from-view belowground parts of plants and results in the establishment of resource sharing networks between distinct plant parts and distinct individuals bound together in community. This resource sharing serves as a practical model for envisioning the importance of establishing an ecosystem of support and collegiality in academic environments that can run counter to predominant individual success models (Whittaker and Montgomery, 2012; Montgomery et al., 2014).

Indeed, these network relationships have broad implications for the building and sustaining of scientific or learning collaborations, both for the benefit of mentoring or research engagements and as a salient demonstration of the power of diverse communities. Although formal mentoring assignments may occur through academic programs, informal mentors or mentoring networks may serve a vital "belowground" role for supporting the establishment and growth of academics throughout a career (Montgomery, 2017). The embedding of faculty members in

symbiotic relationships and interconnected communities of support and reciprocal value provides ample opportunities for sustaining individual success and strengthening a larger productive community.

Early Engagement with Environment Impacts Future Success

Seedlings are vastly impacted by environmental factors to which they are exposed early in their development (Poorter, 2007; Muscarella et al., 2013; Warpeha and Montgomery, 2016). Kimmerer (2015) notes this observance in the following way: "Trees are affected by their sapling days as much as people are by their childhoods" (p. 143). This recognized role of the impacts of environmental factors and engagements on organisms early in their development suggests a strong need for early interventions and timely engagement of mentoring during academic careers to promote the maximal benefits of integrated career planning. Furthermore, it is clear that the impact of early environmental exposures affects plants throughout their life cycles and has significant input into species persistence, species diversity, and community composition (Poorter, 2007; Muscarella et al., 2013). Thus, early interventions do not just impact individual career formation and success, but can impact long-term health and diversity of communities and contribute directly to the establishment and maintenance of communities of support over the long term as well. The latter has clear implications for inclusion goals and broad-based support of all individuals in diverse academic contexts. In this regard, the cross-species interactions that underlie the interdependent existence of the Three Sisters yield robust lessons about

the multiple benefits that can emerge from engaging and sustaining a diverse collection of individuals and diverse perspectives that can arise when supporting personalized, integrated career approaches. Such effective engagement is promoted by building cross-cultural understanding or competence (Reich and Reich, 2006). Lessons in cross-cultural competence are deeply embedded in gardens of the Three Sisters and dependent upon “the capacity of others [biological organisms] as our teachers, as holders of knowledge, as guides” (Kimmerer, 2015, p. 58). If we are able to open our eyes to these lessons, “imagine the access we would have to different perspectives, the things we might see through other eyes, the wisdom that surrounds us” (Kimmerer, 2015, p. 58).

Conclusions

Herein, I have reflected on lessons harvested for integrated academic careers in diverse environments from repeated visits to contemplate a Three Sisters garden and other bases of plant ecological knowledge. The lessons that I have described depend strongly on the recognition that significant and valuable input is inspired by traditional plant knowledge, which is the foundation of the Three Sisters. Receiving the gifts that are intended from the Three Sisters requires us to understand that “science asks us to learn about organisms. Traditional knowledge asks us to learn from them” (Kimmerer, 2016). The lessons that can be drawn from the Three Sisters are many, including those of productive growth in diverse environments supported by reciprocity, the beneficial impacts of readily observable and nonpublic interactions in community, *and* promotion of an ecosystem-based approach to supporting success. However, the greatest and most

enduring lesson that may emerge is as follows: “The most important thing each of us can know is our unique gift and how to use it in the world. Individuality is cherished and nurtured, because in order for the whole to flourish, each us has to be strong in who we are and carry our gifts with conviction, so they can be shared with others” (Kimmerer, 2015, p. 134). Drawing on the rich lessons that emerge from nature such as the Three Sisters garden provides a wealth of lasting gifts for building and sustaining integrated academic careers positioned to draw on the gifts of diverse individuals in a synergistic, and potentially transformative, means for sustaining all involved.

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Tools for the International Botanist: Navigating the Nagoya Protocol *A 2016 Workshop Recap*

Plants don't naturally have politically drawn boundaries, but the people who have managed and studied them for many generations do, and ethical progress is grappling with this. The stories of the voyages in the 1800s didn't raise our hairs with tales of incomplete paperwork; their risks were more of the nature concerning whether the ship would make it over the high seas or whether the caravan would be raided as it climbed over the pass to transport time-sensitive collections. Now sleepless nights of worry fixate on the bureaucratic webs woven by both home and host country. What if the plant inspector at the airport isn't in a good mood? What if I forgot a signature? How long will my permit take? My international plant collections have included nearly as many days drinking tea with municipal officials and filing collection permits, transport permits, phytosanitary certificates, export permits, and letters of agreement as hiking mountains or interviewing farmers. And let's just say it: paperwork sucks. Thinking of filing a form raises my blood pressure. God forbid you're trying to work in Indonesia where your

chances of getting a research permit accepted are super slim, where I've heard stories about people having to wade through a flooded lobby to check on their permit status.

I bet I know what you're ready to point out about international botanical research today that's a whole lot different from 100 years ago: it's about collaborative relationships, right? Each written agreement between scholars or institutions across borders is an opportunity for intellectual exchange and cross-training. It's a lot of time investment to set these up; sometimes you have to move at a pace that is much slower and cautious than you're used to. You have to learn the hierarchical structure of other bureaucratic systems and institutions, and navigate within and between them. But contracts serve an important purpose: they set roles and expectations, and minimize the likeliness that someone won't get an outcome they expect, such as co-authorship or a return of results to a community, which burns bridges and hurts future science. The *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization* ("Nagoya Protocol" from here) was formed by the Convention on Biological Diversity (CBD) in good faith that putting a system in place would foster better and fairer collaborative science, would remove the fear of unethical exploitation of collections and knowledge, or would provide long-term benefits to communities.



By Rachel S. Meyer

*Executive Director of the
UC Conservation Genomics
Consortium, Department of
Ecology and Evolutionary
Biology, University of Cali-
fornia, Los Angeles
E-mail: rsmeyer@ucla.edu*

The problem is that the system in place is still nebulous and isn't yet working well. But BSA members are proactive and attune, refusing to let older collections go unused or new collections and research slow because of the bureaucratic burden. I ran a Navigating the Nagoya Protocol workshop at BOTANY 2016 in Savannah and saw many examples of the ways botanists are applying the Protocol. Here's a summary of the workshop.

The CBD formed in 1993, and its central aim is not to protect people's interest, but rather, to reduce the rate of biodiversity loss, which is currently estimated to be 1000 times the background rate. Sensitive biodiversity hotspots are concentrated in tropical and subtropical climates with many developing economies. Many have only emergent natural science research programs. Some may not reflect the same separation of government-science and academic-science. Some deal with heavy ongoing threats of poaching and overexploitation, and display a full spectrum of capacities to manage their biodiversity (just see Brunei and its neighbors on Google Earth!). The CBD is attempting to influence how the international community engages with biodiversity and the people whose livelihoods and future depend on those species.

The Nagoya Protocol has a mission to combat biopiracy by setting rules. But it affects us. So, we have to ask ourselves the existential questions of what is biopiracy on our planet and am I possibly a part of it? I had to think what my area of research would look like in 20 years to begin to understand the many ways I could harm people. And that's coming from a crop ethnobotanist, where drawing connections between publications and future food and medicine products is pretty easy. If you are in basic research, you are the seed corn

As facilitators, we must make sure there is legal certainty and clarity of the mission and scope of the research or collection. We must make sure to obtain prior informed consent and obtain an agreement on the terms.

of innovation. How could people be creative and try to use the discoveries you've made or the knowledge you've helped spread? How do we make sure the people who donated their time and help, and who've shared germplasm and information, benefit?

The Nagoya Protocol entered into operation in October 2014. It requires not only that you obtain research permits, but also Access and Benefit Sharing (ABS) agreements. The provider should set the terms. As facilitators, we must make sure there is legal certainty and clarity of the mission and scope of the research or collection. We must make sure to obtain prior informed consent and obtain an agreement on the terms. Nations are tasked with issuing permits when these agreements have been made. Nations are also tasked with providing a system that encourages research that contributes to biodiversity conservation and sustainable use.

Most of us in the BSA work in the realm of terrestrial plants. In a way, we can consider ourselves lucky. If we try, we're not likely to be the bad guys (can you tell I'm an optimist?). Imagine if you worked in oceans and had to

determine appropriate parties to benefit from your unrealized discoveries. Well, industry happens to be looking mostly to oceans for the next natural products and is increasingly using omics sequencing to catalyze discovery rates. Imagine you discover a cosmopolitan cone snail with venom that's a great painkiller, or a cold-water fish with proteins that become excellent anti-freeze in ice cream. Who benefits? These are real challenges! Consider that 64% of oceans are owned by all (i.e., ungoverned). Patent data tell us that discovery and benefits mainly trace to 10 countries, none of which are in the biodiversity-rich tropics. The Nagoya Protocol is the first regulator of neutral water. At least as botanists and ethnobotanists, we've got some starting resources. For example, there are ethics manuals for conducting and communicating ethnobotanical research.* Kew Gardens also shares their policy on access to genetic resources and benefit-sharing.†

For botanists beginning international fieldwork, you need to demonstrate a commitment to adhering to the protocol before you start your fieldwork and implement a plan conforming to the standards at that location. Given that botanists have been obtaining permits and setting up collaborations for a while now, you are likely doing much of the needed work already. You mainly just need an ABS agreement and a material transfer agreement (MTA). Some countries may have resources available on what an ABS agreement would look like for your situation (e.g., Brazil). Others haven't yet. So, in those cases, you and your collaborating party can be creative with the terms. For example, if you don't know of any monetary benefit that will arise from the work, can you or your institution give something in return for the knowledge or germplasm? Would you share research results with them early, donate duplicate

collections to create a school herbarium, or offer for scholars to visit your lab? It's useful to think along the lines of building capacity, preserving traditional knowledge, and making educational resources that carry the biodiversity conservation mission.

In 2015, I went to West Africa to do African rice (*Oryza glaberrima*) research with subsistence farmers. The U.S. still has not ratified the Nagoya Protocol, but the National Science Foundation, who supported my fieldwork through a grant supplement, had just enforced a rule that all NSF-supported researchers adhere, as if we were signatories, to the Nagoya Protocol and the International Treaty (which facilitates materials transfer for certain types of organisms and really deserves its own article). I tried to set up versions of ABS agreements at institutional and individual levels.

- I obtained Institutional Review Board approval for my project through my university.
- I identified collaborators abroad, shared my proposed plan and interview questions, and made modifications based on their input.
- ABS agreement part 1: I made for co-authorship for multiple scenarios of how the data would be published (because I didn't know exactly how I would divide the data I hoped to obtain into manuscripts).
- I decided to avoid an MTA by leaving all germplasm collections with local institutions, which also became resources for local graduate students to use for their studies. If I want these collections, I agreed to request them from that country's CGIAR (Consultative Group on International Agricultural Research).

- ABS agreement part 2: I brought hard copies of an information form with project contact information into the field and had translators to orally communicate the information. I recorded oral consent prior to each interview. I also obtained prior informed consent from the local municipal leaders before interviewing civilians.
- ABS agreement part 3: I asked informants what they would want in return from me and my collaborators in the country. They asked for attention to their situation, asked me to help them find opportunities to get machinery for their farms, and requested more collaboration between them and the national institution. They were able to directly discuss the latter with the national institution representatives that accompanied me in the field. For the former, I avoided empty promises and was clear that I wasn't connected to ag investors or able to fundraise for them, but that I would help raise public awareness through documentary and scientific publication of the interview details. Note: if you know of ways I can help donors provide farm equipment to West African subsistence farmers, I'm all ears!

In an idealized case, my collaborators are to work within the system in their respective countries to report to the Access and Benefit Sharing Clearing House (ABSCH). This ABSCH system has not been fully formed in many countries, and you can see the status of the projects deposited in the system at <https://absch.cbd.int>. This is the system that should facilitate the exchange of information and the implementation of the Nagoya Protocol for years to come. It lists the country's ABS national focal point, the competent national authorities, policy measures, national databases, certificates of compliance, and checkpoints. Guidance documents to help the clearing house gain use will be released

in 2020. In the meantime, there are some guides, most recently published an available through the clearing house is "Nagoya Protocol: Challenges Arising from a Complex, Ambiguous and Controversial Text," available only in Spanish.‡

Competent national authorities should ideally help encourage grassroots collaborations by identifying appropriate collaborating sovereign states at various levels. In other words, each country could post a Nagoya Office Advisor who would help new researchers trying to set up ABS agreements. As this is no easy post, it's no wonder that in the short time since the Nagoya Protocol launched, few countries have such a system.

But there is useful fine print on the CBD website that gives my collaborators substantial flexibility. *"Finally, the article of the Protocol addressing the relationship with international agreements and instruments may also be of interest. It refers to the possibility for Parties to develop and implement other relevant international agreements, including other specialized access and benefit-sharing agreements, provided that they are supportive of and do not run counter to the objectives of the Convention and the Protocol. It also refers to the need to pay due regard to ongoing work under relevant international organizations."*

Don't let regulatory ambiguity slow down your science. Strengthen international collaborations as best you can and be as transparent as possible about expectations.

Basically, my collaborators can decide to manage this relationship, these agreements, the research products, the germplasm, through the system *they prefer*, so long as it is aligned with the objectives of the Nagoya Protocol. Of course, they must comply with the existing domestic legislation. As an international collaborator, you can protect yourself by making sure this custom structure is in writing and is signed by all parties.

During the BOTANY 2016 workshop, some great questions were raised about collections made prior to October 2014. Multiparty frameworks initiated before October 2014 *are* honored. However, if there are collections with no framework in place, then curators have to take action.

If rectifying relationships of acquired collections, you should reach out *three* times to create an agreement on the utilization of those collections. This might mean contacting a natural history museum in the country of origin of those collections, presenting the problem to a tribal elders council, or working with a partnering herbarium to put some access and use language in place. The international MTAs for research purposes have excellent language to start these frameworks. Again, it is important to envision the long-term, from both the curation perspective and innovation perspective. What regulations put added workload on curatorial staff? What access structure promotes the use of collections or information for the conservation of biodiversity and promotion of sustainable practices? What discoveries could arise from these resources? If it is currently unclear what the benefits should be, propose a mechanism for the sovereign state to define benefits when the time is right.

During the workshop, a diverse group of botanists created their own draft ABS agreements that helped us all get our minds thinking of the right starting points for our own situations. We wanted to create a template for the BSA as a whole, but I feel the scientific community is still reacting to the Protocol; while the concerns are emerging, it's hard to generalize appropriate practice. As I understand it, in 2016, a first meeting of the Subsidiary Body on Implementation of the Convention on Biological Diversity was held to develop recommendations to help the scientific community navigate these terms. And several reports have been released that the Protocol may undergo revision. It looks like we have to wait until the November 2018 COP13 meeting in Egypt for some version of Nagoya Protocol 2.0. In the meantime, recommendations from our workshop were to encourage people to brainstorm with each other and share their own ABS agreements, MTAs, and stories of how the process went for them. Don't let regulatory ambiguity slow down your science. Strengthen international collaborations as best you can and be as transparent as possible about expectations. We hope there will be workshops that bring scientists together from botany, zoology, and other fields who are navigating through the Nagoya Protocol regulations. In the meantime, please connect with BSA's Economic Botany section if you want help.

* <http://www.global-diversity.org/wp-content/uploads/2015/03/Conducting-and-Communicating-Ethnobotanical-Research.pdf>.

† <http://www.kew.org/sites/default/files/ABSPolicy.pdf>

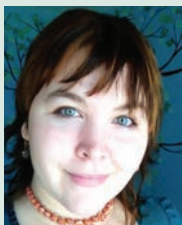
‡ <https://absch.cbd.int/database/VLR/ABSCH-VLR-SCBD-208976>



SCIENCE EDUCATION

PlantingScience participates in STEM for all Video Showcase

PlantingScience is one of more than 150 projects participating in the 2017 STEM for all Video Showcase. This year's theme is Research & Design for Impact. If you are curious to know more about PlantingScience and the Digging Deeper professional development program, please watch our 3-minute video at <http://stemforall2017.videohall.com>. (The video recently won the "Facilitator Choice" award for the Showcase!)



**By Catrina Adams,
Education Director**

BSA Science Education News and Notes is a quarterly 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.

Urgent need for PlantingScience mentors for Fall 2017 Session

I am extremely happy to report that PlantingScience is growing at an amazing rate. The Digging Deeper grant has helped us move to a new platform where we can accommodate more teachers and students than ever before. We are anticipating over 100 teachers will participate with their students this fall (September 18 – November 22), which is three times the number we have worked with this spring. This will mean that about 1000 teams and 3000 students will be participating.

This unprecedented growth means that for the first time in PlantingScience's 12-year history, we are likely to be short of mentors! If each scientist mentor is willing to work with 2 teams, that means we'll need over 500 mentors, and so far we have just under 400 mentors signed up—which means we are more than 100 mentors short! So please, if you have mentored before, we can use your help this fall. And please help us recruit colleagues who you think would make good mentors. If you have not mentored before, please sign up! Mentoring online is easy to do, and only takes about an hour a week while the teams are active. You can mentor from anywhere with an internet connection. Learn more about what mentoring with PlantingScience is all about and sign up at: <https://plantingscience.org/community/joinplantingscience/becomeamentor>.

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<http://plantingscience.org>



PlantingScience Teachers Say Thanks!

"I want to send a huge thank you to all of you mentors.... It is amazing to me how much my students have learned throughout the process not just about seeds, but about being a researcher in general. I enjoy hearing them get excited when you comment or send them videos or research that you are doing in your careers.... I know they have enjoyed interacting with you all."

"The idea that a research scientist would take the time to communicate with them was the highlight for each and every student involved in this program."

"They felt so special to be part of the experience. This was easily the most loved experience of the semester, even though this unit used to be the most dreaded part of the year."

"My students blew me away with their presentations. I sat there totally amazed by their work. They loved the experience, learned a great deal, and are very grateful for the experiences. THANK YOU SO MUCH for allowing my students to be a part of this program."

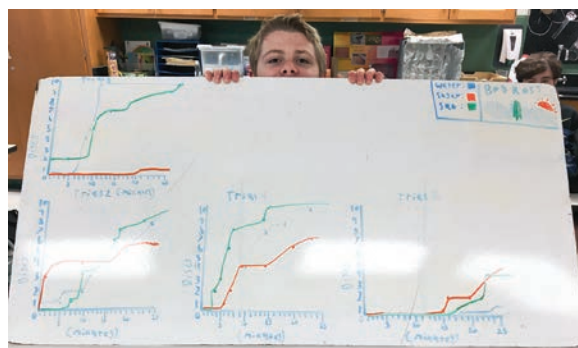
Upcoming Education Conferences

Undergraduate Biology Education Research Gordon Research Conference, July 9-14 - Improving Diversity, Equity, and Learning in Biology Education

This conference will be held at Stonehill College, Easton, MA. Applications must be submitted by June 11. Learn more at <http://grc.org/programs.aspx?id=16909>.

Life Discovery Conference, October 19-21 – Data: Discover, Investigate, Inform

BSA co-sponsors the Life Discovery Conference, a stand-alone education conference for high school and undergraduate biology educators. This year the conference



Team Bob Ross (<https://plantingscience.org/projects/carlsonteamc>) proudly shares data and graphs with their mentor, Jordan Hay (<https://plantingscience.org/members/1340>).

will be held at the University of Oklahoma. A recent NSF award is providing limited travel grants for high school teachers and community college faculty to attend. We're still accepting proposals for the Education Share Fair where you can share your in-progress teaching ideas and get feedback from your peers. This is a great conference for networking with others who have a passion for biology education. For more information visit <http://www.esa.org/ldc/>.

A Cartoon by Mavis Harris



Don't miss Botany 2017: Botanical Crossroads

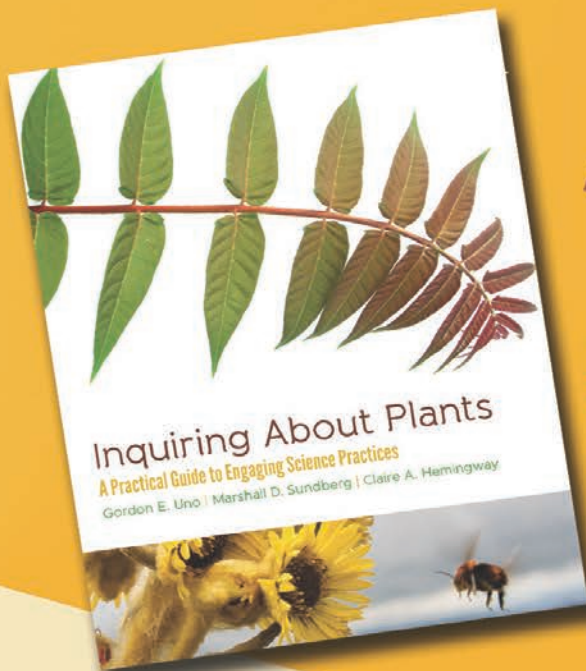
<http://www.2017.botanyconference.org/>

Joining us in Fort Worth? Consider some of these education, outreach, and training opportunities:

Workshops:

- Planting Inquiry in Science Classrooms workshop (Sunday, 9 am-12 pm)
- AIBS Communicating Science to Decision-makers (Sunday, 9 am-12 pm)
- Tips for Success: Applying to Graduate School (Sunday, 1 pm-3 pm)
- Cutting the cord, a workshop for computer-free presentation skills (Sunday, 3:15 pm-5:15 pm)

Also, don't miss the Teaching Section presentations and posters, and the PlantingScience reception. Check the website for schedule updates.



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Key Features:

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Botanical examples to develop skills of observation

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the evolution?



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All proceeds support the PlantingScience online mentoring program



STUDENT SECTION

Getting the Most Out of BOTANY 2017: A Guide for Students

The BOTANY conference is officially just a few weeks away! With 6 days of lectures, field trips, workshops, socials, and more... how can you get the most out of the conference? Don't worry, we've got you covered with some student-focused tips below.

Travel and Lodging

Travel Grants: Although it is too late to apply this year, you can take advantage of the many travel grants next year (keep these on your radar for spring 2018!). You can find them online at <http://www.botany.org/>; at the website, click on "Awards," scroll down to "Travel Awards for Students," and a list will pop up with links to each of the following:

- **PLANTS grants** are funded by NSF and BSA to bring talented and diverse undergraduates to the conference.

- **Triarch Botanical Images Awards** provide acknowledgement and travel support to BSA meetings for outstanding student work that captures botanical beauty. If you use images of plants in your research, submit your favorites to show them off!
- **Section Awards:** There are many to choose from, so be sure to check with your sections.
- **Vernon I. Cheadle Awards** are generally given to students who are presenting in a session sponsored by the Developmental and Structural Section.

2. Find a Roommate: BSA usually obtains a special student rate for early registrants to the conference, so look out for this next year. If you're looking for people to share costs with, take advantage of the 2017 BOTANY Housing Partner Finder: <http://images.botany.org/roommate.shtml>. Besides saving you \$\$\$, it can be a great way to connect with your peers as well as make new friends and contacts.

3. Volunteer at the Conference: Did you know that you can earn your early registration fee back by volunteering your time at the conference? The conference couldn't happen without the help of students who run the registration booth, help at ticketed events, and make sure that sessions run smoothly. For more information, be sure to check your e-mail in early June as well as the website (<http://2017.botanyconference.org/>)!



*By Becky Povilus and James McDaniel
BSA Student Representatives*

Events for Students

It's easy to add events to your conference registration! Find a link to register for the conference at <http://2017.botanyconference.org> and click "Modify Registration." Some events are free, but all are reasonably priced.

Workshops:

- **"Cutting the Cord: A Workshop for Computer-Free Presentation Skills,"** led by your friendly neighborhood BSA student reps, and featuring tips from Melanie Link-Perez about how to give a good presentation, no matter what tools you have. You'll have the opportunity to craft and practice a mini chalk-talk of your own and get feedback! (*Free*)



- **"Tips for Success: Applying to Graduate School,"** led by Anna Monfils and Ann Sakai, is a panel discussion designed to introduce undergraduate students to the specific requirements for applying to graduate programs in plant biology. (*Free*)
- **"Faculty Life at an Undergraduate Institution":** Working at an undergrad-focused institution offers unique challenges and re-

Student Section

wards, and may be the career option you've been looking for. Hear from a panel of current botany faculty as they address what it's like to apply to and work at undergraduate-focused institutions. (*Free*)

Student Involvement in Botany Luncheon – A Focus on Careers in Botany

What can you do with a degree in botany? Come find out at the Student Luncheon! We'll start off with a short talk by William (Ned) Friedman (a professor and director of the Arnold Arboretum), and then you'll get a chance to chat to representatives from various career paths in a "speed-dating" format. And FYI, the representatives often have insider info on open positions for grad school or post-grad jobs. (\$10 - *includes a catered lunch*)



Student Social and Networking Event:

An annual favorite! This year we'll be at the T&P Tavern in Fort Worth, a beautiful piece of the historic Texas & Pacific Railway Station. Come catch up with old friends and meet new ones while enjoying craft brews and snacks. (\$10 - *includes a drink ticket*)

Undergraduate Student Networking Event:

A new event for this year! Held at the beginning of the conference, this is a chance to meet fellow undergrads and make some contacts to

help you explore the rest of the conference. You'll also get a chance to hear about different career paths! Pizza is included. (*Free*)

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 June 26. Be sure to check out a detailed schedule on the web at <http://2017.botanyconference.org/engine/search/> or via the Botany Conference app, which will be available soon! (*Free - no ticket required*)

Field trips:

Fort Worth has a rich history and unique local ecosystems, which you can explore first-hand with local experts! This year, ten different field trips are being offered; you can choose from tours of historic sites, winery and brewery tours, and hiking trails that showcase the flora and fauna. (*Cost varies by field trip*)

A special note about field trips for student members of the ASPT or BSA Systematics Section: Did you know that ASPT and/or BSA Systematics Section members are eligible for field trip grants? Send John Schenk an e-mail (jschenk@georgiasouthern.edu) after you register for the field trip. Include your name, e-mail address, affiliation, mailing address, whether you are an ASPT or BSA Systematics Section member, and the field trip title. You could be reimbursed for up to \$100!

For most ticketed events, it's not too late to register! Tickets for these events are easy to add to your conference registration: Find the link to register for the conference at <http://2017.botanyconference.org>, and click "Modify Registration." You can also register for events once you get to the conference, at the registration/welcome booth (but sooner is better, as events can fill up!).

The BOTANY Conference App

- **Schedule Planner:** With so many events occurring during the conference, planning each day can be a challenge! The online BOTANY Conference App gives you the freedom to browse talks and events as well as create your own easily accessible schedule to stay on track. You can download the App at <http://mailchi.mp/botany.org/larbasx317-1521461?cn=cm-V0d2VldA%3D%3D>.
- **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 your conference buddies! Keep an eye on the hashtags to use this year, but be sure to use #BOTANY2017 in your posts!



ANNOUNCEMENTS

Chrysler Herbarium Collections Manager Named Student Employee of the Year

Megan King, Collections Manager in the Chrysler Herbarium at Rutgers, has been named the Rutgers Student Employee of the Year for all of New Jersey.

King was recognized at an April 13 awards ceremony as one of 15,000 student employees who work in more than 200 offices throughout the university's locations in Camden, Newark and New Brunswick.

In her nomination letter, Herbarium Director and BSA member Dr. Lena Struwe described Megan as "brave, courteous, and professional

at all times," and wrote that "her work ethic is impeccable and efficient. Megan leads the work in the Chrysler Herbarium with confidence, positive firmness, and by setting high, but fair expectations for her own work and the students she supervises. She has an engaging, enthusiastic way of working with the herbarium collections that is contagious to the students."

A Student Employee of the Year is recognized only once each year at Rutgers, and the winner at Rutgers then goes on to compete at the state level. This is what make Megan's state-wide award so impressive.

-Text taken from <http://news.rutgers.edu/news/rutgers-celebrates-outstanding-work-student-employees/20170419#.WP93u46ePPf> and http://deenr.rutgers.edu/Megan_King_Rutgers_student_employee_2017.html.

FROM THE *PSB* ARCHIVES

60 years ago: "Pines more than 4000 years old have been discovered growing at timberline in the White Mts. in eastern California by Edward Schulman and C. W. Ferguson, Jr. of the Univ. of Arizona's Laboratory of Tree-Ring Research. These pines exceed the age of the oldest known Sequoias of California by approximately 1000 years."

-OLDEST LIVING THINGS *PSB* 3(2)

50 years ago: A committee has been established, with Dr. William L. Stern of the University of Maryland as chairman, to persuade the United States Post Office Department to issue a series of commemorative stamps in recognition of the XI International Botanical Congress, which is scheduled to be held in Seattle, Washington, in August, 1969.

The present committee is proposing that the Post Office Department authorize one commemorative sheet of 50 stamps in vertical position, with a different design for each horizontal row; five stamp designs on the one sheet. This will permit the production of a stamp bearing a plant motif chosen as typical for each quadrant of the country, plus a fifth depicting the Seal of the Congress.

- News and Notes *PSB* 13(3): 2.

(Editor's note: Four commemorative 6c stamps celebrating the XI International Botanical Congress were produced in 1969.)

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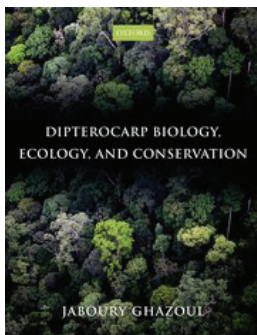
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ECOLOGY

Dipterocarp Biology, Evolution, and Conservation

Jaboury Ghazoul
2016.
ISBN-13 978-0-19-963965-5
Hardcover, US\$89.95; xv + 307 pp.
Oxford University Press,
Oxford



As a North American dendrologist, I have always regarded the dipterocarps, species of the Dipterocarpaceae, as exotic denizens of far-away tropical lands. These behemoth trees of the spectacular forests of Southeast Asia include *Shorea*, *Dipterocarpus*, and

Dryobalanops that are frequently the dominant trees in Malesian forests.

My work in Borneo takes me in to the spectacular dipterocarp forests of Brunei Darussalam and Malaysia. Visiting them is a worshipful experience enhanced by reading this book. It is a very helpful review of past work as well as current research and ecological theory written by a tropical forest ecologist with vast experience with these trees.

Starting the 11 chapters of the book, the introduction is a helpful overview for me, a neophyte with dipterocarp science. Description and Identity, the second chapter, was especially enlightening. I did not know, for example, that the Dipterocarpaceae extend beyond Southeast Asia into the Seychelles,

Madagascar, Indian sub-continent, Africa, and into the Guyana Highlands of South America where only two species occur. I found Ghazoul's overview of systematics very helpful; it includes black-and-white images of many of the important structures, as well as comparative tables of sub-family classification. This is followed by a chapter on communities of dipterocarps throughout their range. I would have put the evolution part of Chapter 4 with the systematics material because it includes the affiliations of the family among the Malvid clades. Chapter 4 also includes biogeography.

Reproduction, including the mysterious phenology of mast years, pollination, diaspore, and seed predation, is presented in Chapter 5, with physiology of light, water relations, and nutrients in the following three chapters. The critical need for conservation is emphasized by consideration of population and disturbance dynamics in Chapter 9, laying the foundation for the final chapter that treats restoration and rehabilitation. (The penultimate chapter covers community ecology.) Alas, as noted, much more research and public awareness are needed for maintenance and restoration of these threatened forests. The last chapter includes human uses, both for wood and for such products as oleoresins, camphor, and dammar.

Dipterocarp Biology is an excellent introduction to this fascinating family of trees and a helpful review of research. Well written and well edited, this book should be on the shelf of anyone working in a region with dipterocarp forests. In addition, Ghazoul's volume will be an indispensable reference for ecology and forestry students.

–Lytton John Musselman, Department of Biological Sciences, Old Dominion University, Norfolk, Virginia 23529-0266.

Plant Biodiversity: Monitoring, Assessment and Conservation

Abid A. Ansari, Sarvajeet S. Fill, Zahid Khorshid and M. Naeem, eds.

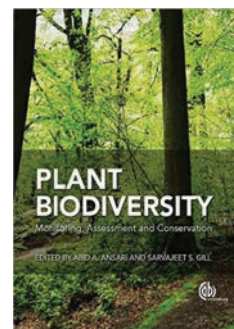
2017.

ISBN-13 978-1-780-64694-7

Hardcover US\$225.00. 614 +

xiv pp.

CABI, Wallingford, UK.



A volume with this promising title evokes expectations of very basic methodological and synthetic treatments of plant biodiversity. Unfortunately, the content does not fulfill such expectations. This is probably thematically the most heterogeneous volume ever reviewed for the *Plant Science Bulletin*. In fact, the only unifying topic for this volume is its dealing with plants.

Seventy-six authors, mostly from India, contributed to this volume. Titles of all 30 chapters can be found on <http://www.cabi.org/bookshop/book/9781780646947>.

The length of individual chapters differs substantially (from 7 to 60 pages). “Monitoring” is in the subtitle of this volume; however, only two chapters deal explicitly with this topic and only one includes actual data (in fact, a quite impressive 2241 data points on total phosphorus concentrations and phytoplankton diversity for over 30 years in Neusiedler See, Austria). Surprisingly, many basic references to monitoring and assessment of plant biodiversity (e.g., Condit, 1998; Stohlgren, 2007; Chirici et al., 2011; Magurran & McGill, 2011) are not mentioned.

The second word in the subtitle is “assessment”. Yes, in a broad sense, all chapters would fall under this title. Finally, one can argue that many chapters are somewhat related to the third word, “conservation.” Nine chapters are

dedicated to case studies from India and five chapters to studies from Bangladesh, Portugal, and Turkey. Sixteen chapters deal with more or less general topics (e.g., Maintenance of Plant Species Diversity in Forest Ecosystems, Biogenic Synthesis of Nanoparticles, Plant Diversity Repertoire of Bioactive Triterpenoids, Roles of Secondary Metabolites in Protection and Distribution of Terrestrial Plants under Climatic Stress, Aquatic Plant Biodiversity, Diversity of Plant Parasitic Nematodes in Pulses, DNA Barcoding, Interspecific Chemical Differentiation within the Genus *Astragalus*, Invasive Alien Weedy Species). The professional level of individual contributions would have to be evaluated by many specialists. Usefulness of this volume is questionable. Considering its price, I would recommend it only to major libraries.

—*Marcel Rejmánek, Department of Evolution and Ecology, University of California, Davis, CA 95616*

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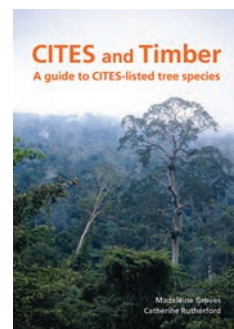
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ECOMONIC BOTANY

Cites and Timber: A Guide to CITES-Listed Tree Species

Madeleine Groves and Catherine Rutherford
2016.
ISBN-13 978-1-84246-592-9
Paperback, US\$68.00/UKP 39.00; PDF free of charge.
Kew Publishing, Royal Botanic Gardens Kew UK.



The Convention on International Trade in Endangered Species of wild flora and fauna (CITES) is a useful although limited aid in the conservation of nature. However, for many botanists interested in CITES-listed plant families such as Orchidaceae or Cactaceae, the Convention can be a nightmare because obtaining permits for cross-border movement of research material—alive or dead—is riddled with pitfalls and the CITES has turned many serious naturalists into petty criminals while trying to bypass its regulations. For CITES-listed timber species, this problem is only a minor one because most of the relatively few CITES-protected species are already well represented in institutional wood collections (xylaria) for international research.

This handsomely produced guide introduces the reader to the complex world of trade regulations for CITES-listed timbers, and to concisely introduce the commercially more important species individually. The introductory chapters on regulating the trade and understanding the various categories of CITES-listing are very useful, but make for hard reading, because of the somewhat legalistic jargon used. The species pages are according to a standard format giving information

on species distribution, major uses, trade, plantations, current trade suspensions, EU Decisions, Scientific and Common names, assorted details on the CITES listing, product pictures and tariff codes. In all, 26 species pages are given—sometimes covering more than one species or even genera (e.g., *Aquilaria* and *Gyrinops*)—both producing Agarwood, and multiple species of, for example, *Cedrela* (Spanish cedars), *Dalbergia* (Rosewoods), *Diospyros* (Ebony) and *Taxus* (Yew). Following the species pages there are brief chapters on identification (correctly emphasizing anatomical and chemical, including DNA, methods), on timber measurement, on CITES and EU documentation, including standard forms, and on Key Resources (directing the readers to informative websites rather than to comprehensive papers in scientific journals).

From several species pages, it becomes apparent how difficult it is and will remain to implement the CITES regulations. Take the Rosewoods, of which only *Dalbergia nigra* (Rio Palisander) is in appendix I, but its timber is easily confused with other *Dalbergia* species that are less strongly protected or totally unprotected by the Convention (Gasson, 2011). Microscopically many of these species are look-alikes, and old and dried heartwood hardly yields any DNA for diagnostic purposes. Mass spectrometry, unavailable to most customs labs, may be the only means to separate the illegal from the legal rosewoods—but then only in terms of probability and not as hard evidence to stand up in a court of law. The CITES listing of *Dalbergia* and *Diospyros* species from Madagascar only opens the door to illegal trade, because geographical provenancing with stable isotopes, although promising, is far from certain enough to convict fraudulent traders who give false provenances on their export documentation.

Although informative, especially concerning the uses and trade in the CITES-listed species, I find this guide somewhat disappointing. This is because the trees and timbers are not really characterized, and the legal trade jargon makes for difficult reading. The authors have used the copy-paste option too often when leaving extensive text blocks on free trade in seeds, seedlings, etc., with extensive reference to Cactaceae and Orchidaceae, which one is not likely to find associated with logs in a timber container. I was surprised that in this Kew Publication, the classical papers by Kew wood anatomist Peter Gasson on the identification of CITES-timbers are left unmentioned in the Key-resources—as well as the InsideWood web database, which has detailed anatomical information on all CITES-listed timbers, and allows researchers to tell them apart from the thousands of non-CITES-listed woody plants.

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Cannabis: A Complete Guide

Ernest Small

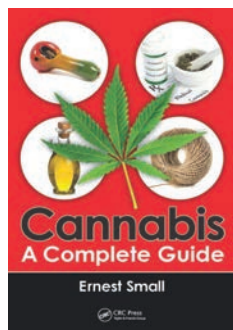
2016. ISBN-13 978-1-

498-76163-5; ISBN-10:

1498761631

Hardcover \$101.96, 597 pp.

CRC Press



In the United States and elsewhere, there have been dramatic shifts in the public perception of marijuana and its uses that have resulted in legalization as well as other changes of the law. This book is an amazing and vast compendium of knowledge about *Cannabis sativa*, the plant that is the source of marijuana. The fact that this work has a single author, Ernest Small, is even more impressive.

Dr. Small is an expert on hemp and marijuana and has worked on this research for decades. He serves as the Principal Research Scientist at the Research Branch of Agriculture and Agri-Food Canada. His credibility is evident by his 40 research papers and two previous books on cannabis. He has received numerous awards for his research and for his work on the marijuana plant.

The book starts with a taxonomic and anatomical description of *Cannabis sativa*. The second chapter is on the early history of this plant in our civilization, and the third chapter is on the ecology of wild cannabis. Other early chapters are on all aspects of the botany and physiology of cannabis, including sexual reproduction, photoperiodism, anatomy, and classification.

The many economic uses of *Cannabis sativa* including as fibers and oils are considered. Another interesting chapter focuses on cannabis chemistry and cannabinoids. The non-medical use of marijuana is covered in an extensive chapter and includes a discussion

of psychological effects and health risks of various marijuana strains.

The author spends several chapters on medical marijuana and covers many topics, including the history, the highlights of the controversies, THC (tetrahydrocannabinol, the principal psychoactive constituent) doses, the production of medical marijuana, and the commercial aspects involving the plant. Each chapter in the book ends with a section titled “Curiosities of science, technology, and human behavior.” As an example of the type of information, this section points out that both George Washington and Thomas Jefferson encouraged the growing of hemp, but they both lost money on the crop. Another fascinating tidbit is that hemp garments were worn by wealthy Japanese more than a thousand years ago.

The book is scholarly in the sense that a thorough analysis of the literature with about 1700 citations is provided. The text is complemented by the use of 280 color illustrations that are very informative and make for a beautiful book. As mentioned, I am impressed that a single author can pull together all of this information.

By the end of the book, the author carefully considers the conflicting claims between both the medicinal value and the toxicological vices of the marijuana plant. This book has the potential to be used as a supplemental text in a number of plant biology courses, including ethnobotany, and it is accessible to graduate students as well as to undergraduates. In my opinion, it also can be appealing both to botanists and to non-specialist audiences given the current high level of interest in medicinal uses of *Cannabis sativa*.

—John Z. Kiss, Department of Biology, University of North Carolina—Greensboro, Greensboro, NC, USA; jzkiss@uncg.edu

Medicinal Orchids of Asia

Eng Soon Teoh

2016. ISBN-13 978-3-319-

24272-9; (eBook), DOI

10.1007/978-3-319-24274-3

Hardcover \$249.00, eBook

\$189.00, i-x + 752 pp.

Springer International Publishing, Switzerland.



Orchids have been and still are being used for herbal medicines all over the world (for a review, see Lawler, 1984). Some species are collected to near extinction for use by herbalists. More recently, good peer-reviewed papers (mostly from China) are being published on the medical effects of orchids and their chemical constituents. These papers show that some of the herbal uses seem to have a solid pharmacological basis. Publications on scientific nomenclature and common names of the orchids, the species being used, geographical distribution of the taxa, locations of use, general ethnobotany, parts of the plants that are employed in herbal medicines, modes of preparation, phytochemistry, pharmacology, current scientific findings, and other information are in several languages and widely scattered in the literature.

Reviews and synthesis of what is known do not exist because work in the area is carried out by specialists in different disciplines (general botany, herbal medicine, phytochemistry, ethnobotany, pharmacology, plant physiology, modern medicine, conservation, plant taxonomy, horticulture, and phytogeography). A practicing physician, a medical researcher, and a student of orchids who is familiar with (but does not endorse) their herbal uses and who has traveled extensively in pursuit of information, Dr. Teoh has the knowledge and information to synthesize the available information and did it in his book. As an

Asian by birth (in what is now Malaysia) and domicile (Singapore), Dr. Teoh chose to write only about Asian medicinal orchids. Even with this “limitation,” the book is a massive 752 pages of text.

This book (which reflects Dr. Teoh’s broad expertise in orchids and medicine, both modern and herbal) is intended for several audiences: orchid scientists and growers (who are usually interested in everything about orchids), physicians and medical researchers (both may not be very familiar with orchids), herbalists (at least those who may want to know something about the chemistry of their potions), ethnobotanists (whose expertise in plants, medicine, and herbal preparation may vary), and plant scientists (a group with various areas of expertise). This is reflected in the content of the book and the organization of sections, which deal with specific plants. It also reflects Dr. Teoh’s broad expertise in orchids and medicine (both modern and herbal).

Part I of the book provides general information. Chapter 1 deals with the use of orchids in medicine, food, talismans, and aphrodisiacs, and their chemical constituent. For those who know orchids, this chapter is a refresher. Those who are not familiar with orchids will learn much from it. Chapters 2-4 deal with traditional herbal medicines in China, Korea, Japan, and India and the processing of medicinal herbs. Much can be learned from these chapters, especially since they probe well into what to many are mysteries bordering on magic. Chapter 5 discusses the chemical constituents of plants and places the subject in the context of orchids. The chemicals are well known, but the fact that orchids produce a great variety of interesting compounds will be news to some. Chapter 6 covers the discovery, testing, and improvement of the production of new herbs and new drugs. I learned much from it. So will others.

The second part of the book (pp. 85-688) covers the medicinal orchids in Asia by genus and species from *Acampe* to *Zeuxine*. Information provided for each species includes scientific name, local names, distribution, and herbal use and preparations. Most species are illustrated by photographs (many by Dr. Teoh), paintings, or line drawings. When available, information is provided about the phytochemistry of orchids including chemical formulae and structures. The herbal uses, chemical constituents, pharmacology, and medicinal effects and potential of some orchids have been and are now studied in great detail (mostly in China). An example is *Gastrodia elata*, a mycotrophic orchid that lacks chlorophyll, for which Dr. Teoh presents an extensive and illuminating review (pp. 380-409).

Part III consists of two chapters. Chapter 23 elaborates on sources of medicinal orchids and their conservation and discusses propagation and cultivation. The last chapter points to the need and methods of clinical studies of medicinal orchids. The book concludes with a glossary and an index.

I find this to be an amazing, very informative and excellent book that should be of interest to a wide and varied audience. My hope is that it will generate interest in what orchids have to offer to modern medicine. I was impressed by the manuscript while going over it with Dr. Teoh in Singapore and am awed by the finished product. The book is one I enthusiastically recommend to physicians, botanists, researchers in pharmaceutical companies, and those in search of new medicines that can cure many ailments. It is a book that should be read, studied, and enjoyed.

Do I have complaints? Yes, two. One is that every chapter and some sections have their own list of references. This makes it difficult

to find a specific reference. I would have preferred a complete list of references at the end of the book, but this is a matter of preference and convenience and does not detract from the excellence of the book. My second complaint is more serious. The index lists only plant names. There is no general and detailed index that lists preparations, ailments that are treated with orchid herbal medicines, and/or chemicals that are derived from the Orchidaceae. Thus, researchers who would like to search for a particular ailment treated by orchids or specific chemicals produced by them must search through the entire text. Indexes that do not present sufficient detail bedevil some of my own recent books and some others because indexes are now prepared by publishers who do not want to bear the cost (probably substantial) of a good detailed index. For this book I suggest the preparation of a detailed index, which should be posted as a PDF document in the publisher's website. A note announcing the existence of this should be included in advertisements. The second edition (and I hope that there will be one) must include a detailed general index. If it will allow searches, the e-book may offer a solution to this problem. I have not seen it. Inadequate index or not, this is still a very informative, intriguing, and unique book that deserves attention and inclusion in university and private libraries. I treasure mine.

Full disclosure: Dr. Teoh and I have been good friends since 1974 and spent much time together during my frequent visits to Singapore. I saw, read, and commented on parts of the manuscript in his home before it was submitted for publication but did not see the final version.

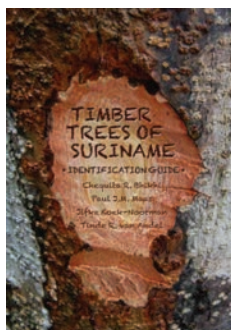
–Joseph Arditti, Professor Emeritus, University of California, Irvine.

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Timber Trees of Suriname: An Identification Guide

Chequita R. Bhikhi, Paul J.M. Maas, Jifke Loek-Noorman, and Tide R. van Andel
2016. ISBN-13 978-9-460-22391-4
Paperback, US\$39.50. 287 pp.
LM Publishers, Volendam, the Netherlands



There are over 5100 vascular plant species and over 600 tree species in Suriname. Forests still cover about 90% of the land area of this country. In Suriname, forest area per capita is the second highest in the world (after French Guiana): 33 ha/capita (Werger, 2011). As in any other country with tropical forests, tree identification guides are highly desirable. The book under review includes 100 commercially important trees native to Surinam. They represent 71 genera and 25 families. Morphological and wood anatomy descriptions of all 100 species are detailed and extensive. Also, each species is illustrated by line drawings of twigs, leaves, flowers, fruits, and, in many cases, trunk bases. Color photographs of flowers and fruits are provided for many species. Color slash photographs are presented for 53 species. Photographs of wood samples are provided for all 100 species. Each wood image is reproduced from a 35-mm slide that was taken at 5x magnification. All photographs are of high quality. Ecology and distribution of each species are specified in a

few sentences. Vernacular names are provided for all species. An extensive list of over 200 relevant references concludes this publication.

On the back cover, the book is characterized as a “second edition” of *Bomenboek voor Suriname* by Lindeman and Meunega (1963). This is somewhat inaccurate. *Bomenboek* included 375 species from 186 genera of trees. Line drawing illustrations were provided for 123 species, and photographs of wood cross-sections of 96 species were also presented. Moreover, vegetative keys leading to at least one species in each of 186 genera were included. Vegetative keys are extremely helpful for identification of woody species in tropical forests (Rejmánek & Brewer, 2001). It is possible to argue that with only 100 extensively described and illustrated tree species, a key may be not necessary. That may be true, but even for 83 major timber trees of Guyana or 151 timber tree species of Jamaica, such keys are available (Polak, 1992; Parker, 2003). Several important families included in *Bomenboek* (e.g., Euphorbiaceae, Rosaceae, Rubiaceae, Rutaceae, Sapindaceae) are not represented in this new book. Apparently, there are no commercial species in these families in Suriname. For identification of trees not included in *Timber Trees of Suriname*, one should try a multi-access electronic key for the identification of 389 forest tree genera occurring in French Guiana forests (Engel et al., 2016). In spite of mentioned shortcomings, *Timber Trees of Suriname* will be very useful for foresters and, as a first introduction to the rich tree flora of Suriname, for all botanists, ecologists, and amateurs interested in flora of the Guiana Shield.

–Marcel Rejmánek, Department of Evolution and Ecology, University of California, Davis, CA 95616.

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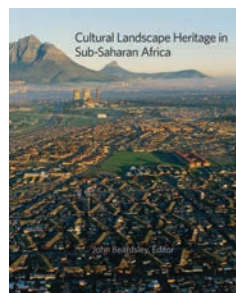
Cultural Landscape Heritage in Sub-Saharan Africa

John Beardsley, Ed.

2016. ISBN-13 978-0-884-02410-1

Hardcover \$60.00, £47.95, €54.00. 486 pp.

Dumbarton Oaks Colloquium on the History of Landscape Architecture 37. Dumbarton Oaks Research Library and Collection, Trustees for Harvard University, Washington, DC.



Sub-Saharan Africa is the longest occupied landscape on earth. Previous scholarship has focused primarily on representations of natural history by early explorers and settlers and to colonial era scenery, but insufficient investigation into areas created by and for Africans themselves. Essays presented at the symposium “Cultural Landscape Heritage in Sub-Saharan Africa,” held at the Dumbarton Oaks Research Library and Collection in May 2013, contribute pioneering, interdisciplinary work that can appeal to African and architectural historians, anthropologists, artists, and botanists with broad interests. Extracts to interest the latter audience are the focus of this review.

The Introduction and Grey Gundaker's ethnographic assessment, “Design on the world: blackness and the exclusion of Sub-Saharan Africa from the ‘global’ history of garden and landscape design,” establish historical groundwork. Opening with an African proverb, “A forest with one kind of tree is but an orchard,” Gundaker suggests that the diversity of the forest outweighs that of the controlled orchard in a dynamic balance. Gundaker submits that in practice, the European and American love affair with an ideal Garden helped shape deeply exclusionary accounts of civilization and culture. Colonial enterprise commonly

described African landscapes as unplanned, disorderly, dirty, and disease-ridden. Another barrier to appreciating African landscapes was modernization of these same landscapes, whereby sacred and ordinary trees were cut down, roads straightened out old paths, rectangular shapes replaced meandering ones, and whole “tribes” were created out of loosely affiliated groups. Gundaker proposes three reasons why Africa has been excluded from strict definitions about landscapes: lack of flower gardens, absence of perspectival views, and defiance of definitions expressed within European languages.

The grouping “Monument and Environment” contains “Cultural landscapes in Mali: historical antecedents and future trajectories,” by Charlotte Joy, featuring the masons of Djenné’s monumental citadel and urban landscape. Before colonial times, the masons made hand-molded bricks from a mixture of mud, rice husks, a powder made from the Shea tree (*Vitellaria paradoxa* C.F. Gaertn.), and a powder made from baobab (*Adansonia digitata* L.) fruit. The mixture was mashed with animal urine and dung until it was fit to be molded, then baked in the sun; old masons remember these bricks to be sturdier than contemporary bricks. Changes in agricultural practice—mechanical rice dehuskers—reduced the binding power of rice husks. Decreased fish stocks, leading to fewer fish bones in the mud, also contributed to weaker bricks.

“Great Zimbabwe as power-scape: how the past locates itself in contemporary Southern Africa,” by Innocent Pikirayi, focuses on the Zimbabwe Plateau, a highland region dominated by plains, rolling hills, and mountainous terrain carved by the Zambezi, Limpopo, Shashi, and Sabi Rivers. It is a savanna biome, primarily miombo woodland, with *Julbernardia* Pellegr. and *Brachystegia*

Benth., occupying moist higher altitudes, and *Colophospermum mopane* (J. Kirk ex Benth.) J. Léonard, characterizing the lower, drier basins. The monumental Great Zimbabwe edifice was appropriated by Europeans in the late 19th to early 20th centuries; they shifted an African cultural and political landscape into a European tourist destination, largely free of indigenous people. Their activities (uncontrolled excavations, etc.) are responsible for significant conservation problems today.

“Landscape and architecture in the central highlands of Madagascar,” by Randall Bird, introduces the relationship between ancestors, tombs, and land. Rituals involving water are prominent in their significant living landscape, the ultimate source of belonging, as people connect to one another by engaging with their ancestors.

“Stories of stone: the transformation and reinvention of Swahili coast pillar tombs,” by Sandy Prita Meier, highlights the relationship between funerary architecture and religious practice on the Swahili coast. Architects used the coral bedrock and soft coral of underwater reefs to build cities of stone. Meier explores the least understood form of coral stone architecture, remarkable pillars, some reaching over 9 m in height, featuring luminous white facades produced by burning coral rock and shells, to create a milky lime plaster.

“Gardener kings: the formality of politics and palace forests among the Gbe kingdoms of West Africa,” by Neil Norman, reveals Gbe palace gardens at the interface of connoisseurship, cosmopolitanism, religion, and political action. Modern visitors encounter assemblages of kapok [*Ceiba pentandra* (L.) Gaertn.], baobab, and iroko (*Chlorophora regia* A. Chev.) trees that are 150 to 300 years old. Ritual specialists maintain

sacrificial altars in front of specific trees that acquire a patina of sacrificial blood and palm oil.

The second grouping, “Pathway and Grove,” includes “Places and paths of memory: archaeologies of East African pastoralist landscapes,” by Paul Lane, describing settlements as “portable landscapes” used by nomadic peoples; ethnobotanical details include mobile huts constructed from a series of curved branches and stems lashed together with string made from wild agave and dyed red with an extract from *Acacia* bark, then covered by a sequence of overlapping mats, or branches and palm leaves.

“Cultural capital and structural power in African landscapes: the social dynamics of sacred groves,” by Michael Sheridan, is a comparative review of the African sacred groves literature. “By viewing sacred groves as sites of capital exchange and power transformation, the dynamics among these sites’ ecological, sociopolitical and symbolic aspects” (p. 239) are understood. Anthropogenic or managed forests are consecrated to ritual purposes of various kinds. These landscape features are most closely associated with Africa’s mixed-forest areas and its forest-savanna transition zone. Scholarship shows two clusters, in the West African forest belt and in the Rift Valley region. Socially significant trees tend to be culture-specific symbols that feature in particular ritual contexts such as Xhosa use of wild olive tree in ancestral sacrifices, and use of hollowed-out baobabs as tombs for the griot bards significant in Senegalese society.

“Good bush, bad bush: representing our natures in historical southern Nigerian landscapes,” by Ikem Stanley Okoye, illustrates the capacity of forests, once seen as ominous places because of the sheer difficulty of traversing them, to be designated as “dangerous,” in contrast to

sacred spaces. At the edge of a community, they became dumps for real and symbolic unpleasantness. Farming was absolutely prohibited within their boundary, although such “fearsome forests” did occasionally serve as places to grow rare herbs and roots, or to preserve them for use in extraordinary medical-spiritual situations.

“A multiplex landscape: explorations of place and practice in Osun Grove, Nigeria,” by Akinwumi Ogundiran, explains various uses of sacred groves. They serve as abodes for spirits, deities, and ancestors; they are royal burial places and are critical for political community identities; and they were destroyed following modernization projects. Four-hundred fifty plant species belonging to 63 families were documented. *Dracaena fragrans* (L.) Ker Gawl., is a sacred plant with powerful magical and healing properties that is very tolerant of neglect and frequently found at sacred sites such as temples and shrines.

“Rain, power, sovereignty, and the materiality of signs in southern Zimbabwe,” by Joost Fontein, opens the section, “Rethinking Landscape,” tackling the politics of rain-making. “Nature’s regions’: the mobilization of cultural landscapes for conservation,” by Maano Ramutsindela, probes a critical debate: Whose culture defines the landscape to be preserved?

“From Table Mountain to Hoerikwaggo: re-imagining Africa’s ‘first landscape,’” by Jeremy Foster, considers South Africa’s unique Cape flora: its endemism, diversity and antiquity, investigating how these landscapes were understood in the colonial era, against how they are being recuperated today for nation building, identity formation, and cultural affirmation.

As with other books in this scholarly series,

the volume uncovers significant historical figures: maps and singular color illustrations; each article is well-referenced, with ample footnotes and extensive bibliographies; and the book closes with a 16-page index and each contributor's biography.

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

Technology and the Garden

Michael G. Lee, Kenneth I. Helphand, Eds.

2014. ISBN-13 978-0-88402-396-8

Paperback \$50.00, £39.95, €45.00; 304 pp.

Dumbarton Oaks Colloquium on the History of Landscape Architecture 35. Harvard University Press, Cambridge, MA



Offering essays presented at the colloquium “Technology and the Garden” held at the Dumbarton Oaks Research Library and Collection, May 2011, this tome is innovative, since it’s the first instance to explicitly answer the question: What is technology in the garden? The Editors’ Introduction and many essays herein mention Leo Marx’s innovative *The Machine in the Garden* (1964).

The essays are arranged in four groupings, on various topics representing multiple points of view and disciplines. “Visualizing and shaping the landscape” contains two essays. The first, “The engineer-poet and his garden-poem: Ronsard’s Bocages,” by Tom Conley, explores the role of engineering and knowledge of the practical arts, underscoring the ways in which homeowner and gardener qualify as engineers. Ronsard’s poetic imagination constructs a garden through the interweaving

of words and images; the handyman’s poetry “speaks” through objects.

“Optical instrumenta[liza]tion and modernity at Versailles: from measuring the earth to leveling in French seventeenth-century gardens,” by Georges Farhat, invokes science and technology as converging factors in the formation of the early modern landscape at Versailles. Historians regarded the processes of excavating, terracing, and grading those large-scale gardens as benefiting from the same technology as did astronomy and cartography.

“Horticultural technologies” includes two contributions. “Greenhouse technologies and horticulture: the 1st Duchess of Beaufort’s Badminton florilegium (1703-5) and J.J. Dillenius’s *Hortus elthamensis* (1732),” by Mark Laird, describes a particular episode in the history of greenhouses in the early 18th-century English garden, to underscore complexities within technological advances in greenhouse construction. The construction style of “stoves” is of critical importance, for tender *Aloe*, *Cereus*, *Euphorbium* and other succulent plants. The lesson that “plants of different geographies and climates are put into separate cultural units” (p. 59) reveals appreciation of adaptations: cacti and pineapple should be grown in separate houses.

“Much better contrived and built then [sic] any other in England’: stoves and other structures for the cultivation of exotic plants at Hampton Court Palace, 1689-1702,” by Jan Woudstra, extends attention to tropical exotics and the indispensable greenhouse stove. Early Dutch exploration and collections of tropical plants, including nutmeg, black pepper, white pepper, pepper betle, cubeba pepper, and mangoes advanced Dutch greenhouse technology.

“Landscape construction: hydraulics, labor,

and infrastructure” contains two related essays: “Garden hydraulics in pre-Sistine Rome: theory and practice,” by Katherine Rinne, and “‘L’anima del giardino’: water, gardens, and hydraulics in sixteenth-century Florence and Naples,” by Anatole Tchikine, featuring legendary fountains animated to flow from elaborate underground water-lifting devices.

Alison Hardie’s “The practical side of paradise: garden-making in Ming Dynasty China,” and “Infrastructure as landscape embellishment: Peter Joseph Lenné in Potsdam and Berlin,” by Michael G. Lee, are studies of specific early technologies, instruments, and materials involved in those gardens’ creation.

“Emerging technologies and landscape experience” introduces “Gardens of the moon: the modern cine-nocturne,” by Scott M. MacDonald, and “Mesocosm (Northumberland, UK) and heraldic crests for invasive species (photo essay),” by Marina Zurkow, visual presentations to immerse audiences in a cinematic experience involving framing, lighting, pacing, sequence, and duration.

“Green-roofs and the idea of the wild thing: the economics of manipulating nature,” by Claudia Dias and Ross von Burg, features an opportunity in contemporary landscape design at the vanguard of active research and innovation, with new techniques and materials. Current green-roof technology provides immediate benefits: lowering temperatures within cities, providing insulation, reducing runoff, and filtering the water outflow. Active modular phytoremediation is a building skin that scrubs the urban atmosphere of pollutants and particulate matter. Authors urge green-roofs to be an integral part of urban landscape and architectural design, and encourage implementation of long-term

scientific monitoring to measure the air- and water-related benefits generated by parks such as the High Line, a unique aboveground park built on a formerly abandoned elevated rail line on the west side of Manhattan, in New York City.

“The robot in the garden,” by Nikolaus Correll, argues that advances in robotics can decrease the detrimental effects of farming by precise administration of water and nutrients along with intercropping, while also bringing agriculture closer to consumers. One thing not mentioned in this essay, but directly relevant to robots in garden maintenance, that this writer advocates is widespread use of robots in lawn care to reduce the carbon footprint of lawn mowers. Much of this country’s air pollution comes from harmful un-combusted hydrocarbons emitted into the atmosphere by inefficient lawn mower internal-combustion engines found in gasoline-powered small engines. Nowadays, most summers, residents in urban centers as well as in small villages are warned against mowing during “smog alert days,” evidence that gas lawn mowers are partially responsible and should be replaced.

As with other books in this scholarly series, the volume presents meaningful illustrations: historical architectural drawings and exceptional color graphics; each article is well-referenced, with ample footnotes and extensive bibliographies; and the book closes with a 16-page index and each contributor’s biography.

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

Food and the City: Histories of Culture and Cultivation

Dorothee Imbert, Ed.

2015. ISBN-13 978-0-884-02404-0

Hardcover \$55.00, £43.95, €49.50. 388 pp.

Dumbarton Oaks Colloquium on the History of Landscape Architecture 36. Harvard University Press, Cambridge, MA



Food studies and urban agriculture are increasingly popular subjects among students and the citizenry, as food security and farming infrastructure are scrutinized. A “Food and the City” symposium held at Dumbarton Oaks in May 2012 “sought to historically contextualize the current discourse on urban agriculture... It identifies multiple themes and ideologies of productive landscapes in the physical, political and poetic relations between food production and urban living. Contributors examined the garden, market, city, and beyond through the lenses of modernism, technology, scale, social justice, and fashion” (Imbert, p. 1).

Editor Dorothee Imbert is the head of landscape architecture programs at Ohio State University. Following her architecture and landscape architecture degrees from Paris and Berkeley, she taught at Harvard University, then founded the landscape architecture program at Washington University in St. Louis. Imbert’s design and research interests include urban interventions and productive landscapes; she has carried out extensive research on landscape modernism with an emphasis on Europe and California. Her books include *Between Garden and City: Jean Canneel-Claes and Landscape Modernism* (2009); *Garrett Eckbo: Modern Landscapes for Living* (2005); and *The Modernist Garden in France* (1993). She

opens new avenues for understanding the relationship of modernism to gardens, nature, and the city.

Thirteen essays are organized into sections, adhering to sessions of the symposium.

Import-Export explores the transfer of ideas and ideology. David Haney’s “Three acres and a cow’: Small-scale agriculture as solution to urban impoverishment in Britain and Germany, 1880-1933,” provides case studies within mainstream and alternative cultural contexts. Botanists can appreciate Peter Kropotkin’s 1910 illustration (p. 23) of a rye plant, with more than 100 stems emerging from a single seed, an example of results possible with intensive horticulture. Tal Alon-Mozes’ “Food for the body and the soul: Hebrew-Israeli urban foodscapes,” features urban farms in Israel, a short-term solution to problems of food shortages that eventually collapsed. David Rifkind’s “Consuming empire: Colonial agriculture under Italian fascism,” identifies new settlements in Ethiopia, where grain cultivation played an ideologically symbolic role.

Rural Urbanism and Urban Agriculture covers agriculture and modern transport. Mary McLeod’s “‘The country is the other city of tomorrow’: Le Corbusier’s Ferme Radieuse and Village Radieux,” reveals Le Corbusier’s plan for the Radiant City (1930), that originated as a response to the Green City competition earlier that year for a workers’ ‘leisure city’ northeast of Moscow. Time allowed Le Corbusier’s views to ripen, finally acknowledging the necessity of small family farms. Zef Hemel’s “Landscape of Dutch IJsselmeer Polders: Amsterdam and its food supply system, 1930-69,” explores greenbelts in the polders as Dutch engineer Van Eesteren, having been influenced by studies in the

American Midwest (Oklahoma) and Soviet Union (Ukraine) recommended.

Laura Lawson and Luke Drake's "From Beets in the Bronx to Chard in Chicago: discourse and practice of growing food in the American city," may resonate most directly with US readers; notable, a photograph of an urban farm in Newark NJ with plants raised in grow pots due to soil contamination; Victory Garden campaigns. Luc Mougeot recognizes food insecurity zones from Accra to Addis Ababa, in "Urban agriculture in cities of the global South: four logics of integration."

Production Rights addresses land tenure and land rights, codified socially, geographically and ethnically. Donna Graves' "Transforming a hostile environment: Japanese immigrant farmers in metropolitan California," transmits a treasure trove of seldom-seen archival photographs of successful Japanese farm and greenhouse workers, tragically disrupted by World War II "federal policies shaped by racism and war hysteria" (p. 217). Jordan Sand's exquisitely illustrated "How Tokyo invented sushi," shows that the distribution of fish in Imperial Edo was an essential factor in shaping both city and surroundings. Margaret Crawford's illustrated exposé, "Urban agriculture in the Pearl River Delta," bears witness to the changing, chaotic landscape in China, characterized by high population densities, rapid growth of nonagricultural activities, extreme fluidity and mobility of populations and intense heterogeneous land uses surrounding large cities (*desakota*), in which urban and agricultural land use and settlement coexist and are intensively intermingled, mixing agriculture with cottage industries, industrial estates, suburban development and commercial activities. These gardens for food security proceed unplanned, in an ad hoc fashion, demonstrating a variety of agricultural practices in fragmented

fields resulting from epic land seizures by corporations for factories. Co-existing with industry, air, water and soil pollution have risen to alarming levels.

Paris et Environs stresses the essential relation between urbanism and food production, both in gardens and agriculture during colonial expansion and modernist planning. Florent Quellier reveals innovations (e.g., espaliered trees along rubble and plaster walls; heated greenhouses) to establish self-sufficiency of fruit and vegetable production for kitchen gardens of urban consumers in pre-revolutionary, 16th-century Paris. Susan Taylor-Leduc details a symbiotic relationship between market gardeners and the city in "Market gardens in Paris...ca 1790-1900," wherein sellers recover piles of refuse that under their care, become fertilizer, unifying sustenance with decay. Meredith TenHoor's "Markets and the food landscape in France, 1940-72," describes the means by which the National Wholesale Market network transformed how food was sold and distributed in France, although its true target was Paris, specifically its overcrowded central wholesale food markets at Les Halles.

Food and the City represents a unique collaboration of social scientists around the theme of food, underscoring the symbiotic connection between productive landscapes and urban form across time and geographies. Each stand-alone chapter in this well-bound tome concludes with academic reference notes; it contains 69 color photographs, 16 color illustrations, 85 halftones, 6 line illustrations, and a 16-page index. The result is commendable, bringing diverse fields together that otherwise live separate lives in specialty journals, because there is rarely an outlet in the primary literature that would consider such a project. The disciplinary focus of journals in fact discourages badly needed

collaborations across disciplines. It will appeal to those concerned with agricultural history, architectural and landscape history, geography, urban planning, policy, and practice.

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

EVOLUTION

Plant Evolution: An Introduction to the History of Life

Karl J. Niklas

2016. ISBN-13 978-0-226-

34214-6

Paperback, US\$45.00, 560

pp.

University of Chicago Press,
Chicago, IL



Although it appears to be a large book at 560 pages, *Plant Evolution: An Introduction to the History of Life* is, in fact, not much larger than my Kindle, at 6 x 9 inches. It is still a hefty book, though, but it is certainly smaller than other textbooks on evolution, so it is quite portable. The “Preface” states that the book is intended to serve as a text for an upper-level undergraduate or graduate course, and I believe it would serve that purpose quite well. There are e-book, cloth, and paperback versions, each for a surprisingly low price through the website of the University of Chicago Press (and less still from several other online retailers), which is a bonus for many students. The book begins with the origin of life and ends with the emergent properties of evolution and ecology, but it presents these topics in an easy-to-read, jargon-light style.

From the early experiments of Urey and Miller to the heritability of ecologically important

traits, this book has a wide range of topics in which to delve. Niklas states his intention is to steer students towards studying plants, and I believe teaching evolutionary concepts from a plant-based approach is an excellent way to do so, as it serves the dual role of teaching students about evolution and about plants—he clearly does so here. Certainly, there is not a strict need for students to have a botany background, since the book offers a ground-up take on plants through their evolution. However, a laboratory component to a course using this book might be recommended to give students hands-on familiarity with the diversity of plant morphology. There are only 9 chapters, although they average 56 pages. I think this makes it an easy book for students to read and professors to teach over a standard semester. Each chapter has an introductory section that states what will be covered in the chapter, and topics include the origins of life, colonizing the land and air, population genetics, development, speciation, macroevolution, multicellularity, and ecology. This is an impressive list for a single author, although Niklas is an accomplished author because he has published several other books through the University of Chicago Press.

I suspect that many students who would use this textbook have probably been introduced to evolution before—likely from an animal-centric point of view. The plant-centric view presented here would open the eyes of many of these students. For instance, in “Speciation and Microevolution,” it is stated that between a quarter to a half of all plant species evolved from allopolyploidy, many of which are economically important crops (p. 289). This is in stark contrast to animal evolution, of course. That might lead a curious student to further investigate allopolyploidy, which, incidentally, is the first entry in the glossary (p. 537) and is nicely illustrated in Figure 5.8

(p. 291). Said student may then go on to read about plant genetics, which, when including the mitochondria and chloroplasts, often exhibit so-called “exceptions” to the rules of evolution taught in other evolution courses.

The figures and tables within the book are just as variously diverse as the topics. There are 144 color plates, 16 halftones, 24 line drawings, and 20 tables that add to the text and help illustrate various phenomena or geologic timescales. They are placed appropriately and are generally basic in their design with sometimes lengthy captions to help explain them. There are also boxes within the chapters, such as “Box 9.1. The Poisson Distribution,” which elaborate on extra information or give more information on specific examples. Unfortunately, there is no index or listing of the figures, tables, or boxes, so one must come across them as one reads.

I find very little to criticize within this book. Niklas is surely up-to-date on the literature, even though the topics are very diverse. From my own knowledge and research, I found no glaring inconsistencies or errors. It is common for multiple competing hypotheses to exist, especially concerning events that occurred millions or billions of years ago or of the age of certain taxa, and the book does its job of highlighting a fair number of them when doing so adds to the dialogue, such as the endosymbiotic and autogenous hypotheses of the origin of organelles (Chapter 1; Figure 1.13). Although the glossary and index are generous, there is a lack of references, yet each chapter does have a “Suggested Readings” section. For example, Chapter 4, “Development and Evolution”, has only 9 suggested readings for its 64 pages. There are a few minor typos that could easily be overlooked, and they’re few and far between. Who hasn’t added a “d” to the word “an” before, through a typing mistake?

Overall, this is an excellent book. The easy-to-read style of the book makes for a comfortable read-through of the chapters, and the tables and figures quickly emphasize key concepts. It will stay on my bookcase for quick references, but I would also be happy to teach from this book one day and will keep it in mind when I begin to develop my own courses in a few years.

–Adam J. Ramsey, *Department of Biological Sciences, University of Memphis, Memphis, TN, USA*

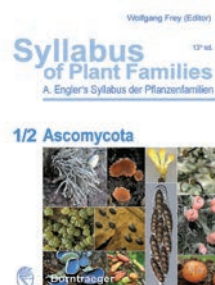
MYCOLOGY

Ascomycota. Part 1/2, Syllabus of Plant Families (Adolf Engler’s Syllabus der Pflanzenfamilien), ed 13

Walter Jaklitsch, Hans-Otto Baral, Robert Lücking, and H. Thorsten Lumbsch (Wolfgang Frey, series editor)
2016. ISBN-13 978-3-443-01089-8

€119.00. 322 pp.

Borntraeger Science Publishers, Stuttgart, Germany



The ascomycota comprise the numerically most important phylum of the fungal kingdom. They constitute well over 60% of the nearly 100,000 species of fungi known, and likely represent an even greater proportion of the estimated million(s) yet to be described. They are saprotrophs, parasites, lichen-formers, mycorrhizal symbionts, endophytes, and predators of invertebrates. A few are human pathogens, whereas others are sources of antibiotics used in combatting human pathogens. The ascomycota also include the fungus of greatest cultural and economic impact on humankind, the bread and beverage

yeast *Saccharomyces cerevisiae*. The present volume offers an updated systematic scheme for this phylum extending below the level of order, with detailed descriptions of families and lists of included genera for each. With the infusion of molecular sequence data over the last couple of decades, the classification of fungi has undergone major rearrangements. That process is certainly not finished, but the broad scheme of higher taxa in ascomycota has reached sufficient stability to make a detailed treatment of this kind timely and useful. The authors of this volume are major figures in the phylogenetic and systematic study of the organisms in question and have collaborated with a great many mycologists worldwide. They are therefore well positioned to provide a consensus snapshot of the current state of the science.

The authors recognize 18 classes of ascomycota, subdivided into about a hundred orders containing a total of 406 families, within which about 4000 genera are listed. Somewhat surprisingly, there is no cladogram or similar diagram to summarize the systematic framework employed. Nor is there a unified reference list. Instead, a separate bibliography follows each of the 18 fungal classes treated, a format that can make the search for a particular reference somewhat frustrating. Since the book consists mainly of descriptions of families and orders, it will serve the user primarily as a reference tool. No glossary is included, so a reader not well versed in the terminology will need to refer to the *Dictionary of Fungi* or a mycology textbook. Seventeen color plates with numerous photographs, mostly of fruiting bodies and lichen thalli, provide valuable illustrations of representative taxa, while also off-setting the inevitable dryness of the character descriptions. The images are all of superb quality and contribute substantially to the book's overall appeal.

Future editions might usefully expand on this feature, particularly by including more images of the microscopic characters that figure so prominently in the family descriptions. Following the format of many classic works in the German scientific textbook tradition, digressive text is set off as short paragraphs in smaller type. Here, however, these paragraphs provide the real commentary amidst the lists of characters, and so might preferably be highlighted rather than relegated to a format of lesser prominence.

This volume forms part of a series with a long and venerable history in botanical science reaching back to the 19th century, revived recently in a new edition brought out by Gebrüder Borntraeger, an equally long-standing institution in German scientific publishing. The series was initiated by the botanist Adolf Engler, whose *Syllabus der Pflanzenfamilien* encompassed all groups of organisms considered plants at that time, including the fungi, cyanobacteria, algae, and myxogastria. Nowadays, of course, the bacteria are classified in a separate prokaryotic domain, while among the eukaryotes, the plantae, fungi, myxogastria, euglenoid algae, chlorarachniophyte algae, alveolate algae and stramenopiles are all placed in different supergroups (with a broad relationship among the latter three lately recognized). Obviously, Engler's original concept of "plant" cannot be sustained in any conceivable sense, and especially not in a work dealing with biosystematics grounded firmly in contemporary phylogenetic principles. Well aware of this, the publisher and authors repeatedly acknowledge that fungi are clearly not plants under present concepts. But they do not say explicitly why they have chosen to retain the original series title in unaltered form. A less problematic option would have been to recast the new edition as simply

Engler's Syllabus, or Syllabus of Biodiversity, or even Engler's Syllabus of Plants, Eukaryotic Algae, Cyanobacteria, Fungi, and Slime Molds [etc.].

That issue aside, the decision to place the current series within the great tradition of its predecessors is commendable. Too often, the rapid pace of scientific advance tends to make us insecure and overanxious to prove our modernity by ignoring or rejecting the past. Yet we cannot fully appreciate the significance of concepts in their present incarnation without considering their historical context, in the same way that we would not attempt to understand a structure or a taxon without considering its trajectory through time. The last edition (12th) of Engler's Syllabus was published in the 1950s, not only well

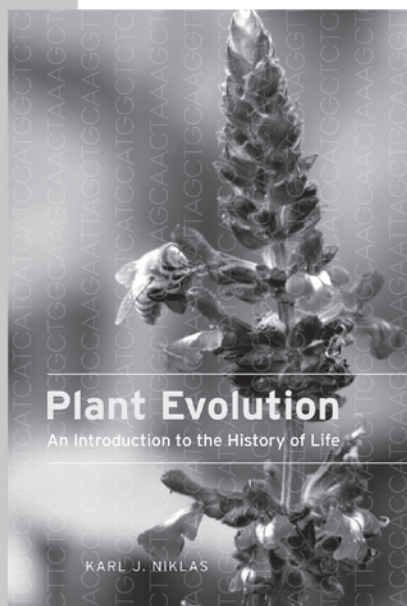
before the advent of molecular sequence data, but also before phylogenetic principles were consistently and rigorously applied to classification. The systematic scheme presented in this edition will therefore likely differ more profoundly from its immediate predecessor in the series than did any other previously.

Syllabus of Plant Families: Ascomycota is a significant reference work that research libraries and herbaria will wish to acquire, as will many mycologists and plant pathologists who study these organisms in a biosystematic context.

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

BOTANY

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Plant Evolution

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Karl J. Niklas

"In a true tour de force, Niklas assays the mechanisms and patterns of evolution, from molecules to ecosystems, using plants as examples. Must-reading for plant scientists, *Plant Evolution* will both delight and challenge everyone who peers into the heart of biology."—Andrew Knoll, Harvard University

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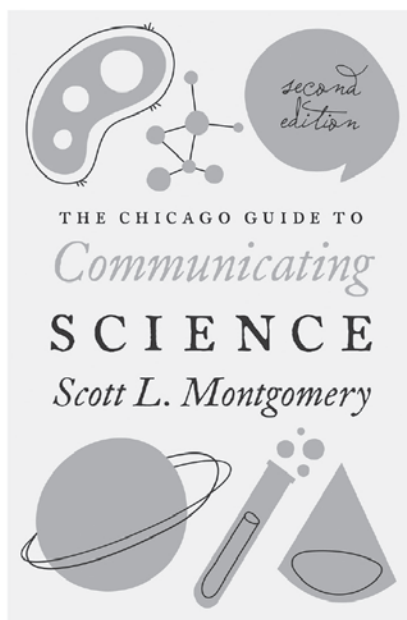
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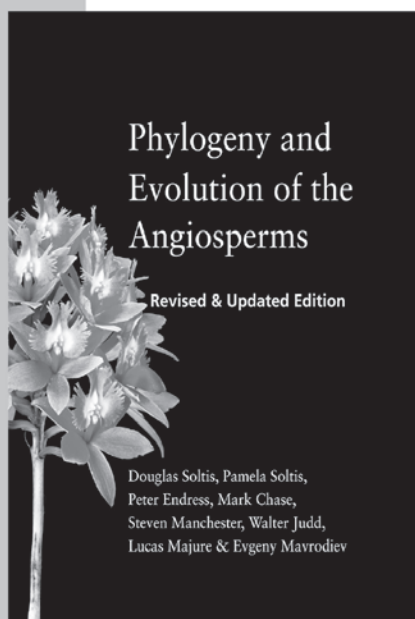
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Mackenzie Taylor, Editor
Department of Biology
Creighton University
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Plant Science Bulletin

Featured Image



This image, by Ya Min (Harvard University), won first place in this year's TRIARCH "Botanical Images" student travel award contest.

This award, established by Dr. Paul Conant and supported by TRIARCH, Inc., provides acknowledgement and travel support to BSA meetings for outstanding student work in the area of creating botanical digital images.

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