PLANT SCIENCE BULLETIN

SUMMER 2016 VOLUME 62 NUMBER 2

A PUBLICATION OF THE BOTANICAL SOCIETY OF AMERICA

"Plants Move, Plants Matter" at the USA Science and Engineering Festival

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From the Editor

Greetings!

In this issue, we celebrate many of the Society's award winners, including the 2016 Distinguished Fellows and this year's recipient of the Emerging Leader Award (p. 62). Many of our student award winners are listed in this issue, as well (p. 65). Congratulations to all! Look for more award winners in the Fall issue.

I want to take a moment to thank the many people who have contributed book reviews to *Plant Science Bulletin*. These contributors volunteer their time and effort to read and review the newest books in plant science and we could not offer this valuable resource without their commitment. I have added many a book to my own reading list after reading a review. If you would like to write a book review for *PSB,* the current list of available books can always be found at http://cms.botany.org/home/publications/plant-science-bulletin.html.

PSB has had multiple requests from readers looking for advice in choosing textbooks that are successful in incorporating plant biology into more general topics. This spring, my own university considered switching General Biology textbooks, which most of you know, is typically a laborious and contentious process. I would like to call on you, the readers of *Plant Science Bulletin*, to address the need for reviews of textbooks, including General Biology textbooks, from the perspective of botanists.

Textbooks rarely make our list of books available for review and we generally don't have copies available. However, if you currently use a textbook with which you are particularly happy (or unhappy), *PSB* would welcome your review of that text. If you are interested in contributing, please contact me at psb@botany.org.

I hope that many of you are planning to make the trip to Savannah for Botany 2016!

If you have ideas or comments about *Plant Science Bulletin*, please find me or attend "Are You Being Served," a discussion with the editors of BSA publications, on Wednesday, August 3, at 1:30 p.m. in Room 106 of the Convention Center. See you in Savannah!

Mackenzie

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Register now for the conference you don't want to miss!

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Summer 2016 Public Policy Note

This year has kicked off with much excitement for the BSA Public Policy Committee; 2016 marks the fifth year of BSA participation in the annual Biological and Ecological Sciences Coalition (BESC) Congressional Visits Day. Two BSA members participated in the event, held on April 27 and 28: Dr. Krissa Skogen, BSA Public Policy Award winner, and Dr. Morgan Gostel, BSA Public Policy Committee co-chair.

Read about Dr. Skogen's experience, below and stay tuned for next year's Public Policy Award application, which can be found at http://cms. botany.org/home/awards/awards-for-early-career-scientists/publicpolicyaward.html in November 2016.

By Marian Chau *(Lyon Arboretum University of Hawai'i at Mānoa) and* ***Morgan Gostel*** *(Smithsonian Institution), Public Policy Committee Co-Chairs*

Dr. Skogen's Experience

I was honored to have been selected for the BSA Public Policy Award and to participate in the Biological and Ecological Sciences Coalition Congressional Visits Day. I've been interested in the interface between public policy and science for a while and saw this event as a unique opportunity both to learn from scientists who have devoted part of their careers to public policy and to engage with policy makers myself.

The first morning was held at the office of the Ecological Society of America, where a panel of scientists who have transitioned their careers from science to public policy shared their personal stories and provided advice. The speakers included Rich Pouyat (Senior Policy Analyst, Climate Resilience and Land Use, Office of Science and Technology Policy), Nadine Lymn (Communications Director, National Science Board Office, National Science Foundation), Brittany Marsden (Analyst in NOAA OAR's Formulation and Congressional Analysis Division), and Alan Thornhill (Director Office of Science Quality and Integrity, U.S. Geological Survey). I found this session particularly valuable, as the speakers highlighted many of the important aspects of being a liaison between science and policy making. Their advice included many obvious but often overlooked factors important for being effective in such a role, such as recognizing that science is only one of the many considerations taken into account when policy decisions are made. They emphasized

the fact that many of the skills that one gains as a result of becoming a scientist are essential to succeeding as a liaison, including the ability to think critically, write clearly, listen, step outside of your comfort zone, and—one of my favorites—never let a good crisis go to waste.

The afternoon's events were held at the AIBS offices and focused on preparing participants for congressional meetings, including information on federal trends in science funding, tips for successful meetings with policymakers, and an overview of the legislative process. Kei Koizumi (Assistant Director for Federal Research and Development, White House Office of Science and Technology Policy) provided insight on federal spending on science and how it impacts scientists. Julie Palakovich Carr (AIBS) then provided a number of important talking points for our meetings with Congress members, including the fact that 68% of federal funding for non-medical research comes from NSF as well as state-specific funding and benefits. The afternoon ended with an orientation for congressional meetings provided by Alison Mize and Terence Houston (ESA) and mock Capitol Hill meetings. With the goal of asking for support for funding NSF at $8 billion in fiscal year 2017, my team members and I honed our message. As scientists, we represented industry (Nina Richtman – DuPont Pioneer, Iowa), museum (Morgan Gostel – Smithsonian Institution, Washington, DC), and non-profit (myself – Chicago Botanic Garden, Illinois) and provided a great overview of the benefits of science funding at numerous levels: academic, educational, and industry. I left the AIBS office energized, excited, and well-prepared for our meetings the following day.

The second day I joined Morgan Gostel and Nina Richtman on the Hill. We met with Representative David Young (IA – R) and staffers from the offices of Senator Dick Durban (IL - D), Senator Mark Kirk (IL - R), and Representative Bob Dold (IL - R), Senator Joni Ernst (IA – R), Senator Chuck Grassley (IA – R), and Representative Eleanor Holmes Norton (Washington, DC – D). During our meetings, Nina, Morgan and I each took the lead for our home state/district. I felt lucky to share my personal story of the impact that NSF funding has had on my career at pivotal times, including as a graduate student and now as an early-career scientist with post-docs and students of my own. I emphasized the dual role of NSF funding, for both basic research and education, and the value of engaging students at various levels, as the critical thinking, writing, and analytic skills that one learns while pursuing scientific endeavors are essential for nearly every profession. I was also proud to represent my home institution, the Chicago Botanic

Congressional Visits Day, Midwest team inside the Russell Senate Office Building, Washington, D.C. Left to right, BSA Public Policy Committee Co-Chair, Morgan Gostel; BSA Public Policy Award winner, Krissa Skogen; and fellow team member, Nina Richtman.

Science is about telling stories, sharing our passions, and getting others excited about our work. Engaging a new audience—policy makers—is essential to the future of science...

Garden, and the great work being conducted by my colleagues and the students in our Plant Biology and Conservation graduate program, much of which has been funded by NSF. Nina and Morgan's personal stories were a great complement to mine and provided further context for the importance of federal funding for NSF to scientists in academic institutions and industry.

Prior to my trip, I was nervous about how my meetings would unfold and whether I was sufficiently prepared. Thanks to the fantastic coordination by AIBS prior to our meetings, in the end, I was well-prepared and had a great time—it was easy, fun, and exciting. At the end of my visit, three things were striking to me:

- First, I was shocked by how easy it was to ask for $8 billion, and that all Congress members and staffers are expecting you to ask them for something when you meet with them.
- Second, I was encouraged by the fact that the offices we met with were receptive to our message; people are interested in science and they like to hear our stories and learn about the impact we are having.
- Third, I was surprised by how fun it was to share my passion for science and education with people in a position to effect change and to share my personal story, as well as those of students and colleagues with whom I've worked, of how science funding, and NSF funding in particular, has changed our career trajectories and lives.

Science is about telling stories, sharing our passions, and getting others excited about our work. We are accustomed to engaging our students and colleagues. Engaging a new audience—policy makers—is essential to the future of science. However, many scientists and faculty don't know how to become engaged and many don't know just how important—and easy—it is to meet with their representatives in Congress and voice their concerns. While participating in the Congressional Visits Day may be of particular interest to someone considering a career change from a focus on science to a career at the science-policy interface, I'd argue that meeting with one's representatives is an extremely valuable experience for any scientist, and truly is part of the job of being a scientist.

Traveling to Washington DC isn't a requirement for meeting with Congress members; many host district visit days when they are home on recess or may tour your home institution. Many colleges, universities, and non-profits have lobbyists who represent them on the Hill. Find out if you have a lobbyist, connect with them and stay up to date on important science-related policy matters. Call the offices of your representatives when an important vote is approaching and share your concerns—a simple sentence or two stating your request takes only a few minutes but very few citizens, and scientists, pick up the phone. I'm grateful for the opportunity to participate in the Congressional Visits Day and I thank BSA for providing support and encourage others to participate in future years. I left DC inspired and excited about my role in communicating the importance of funding basic science and education and committed to remaining engaged in public policy. the importance of funding basic science and education and committed to remaining engaged in public policy.

Dunn Receives First Annual Botany Advocacy Leadership Award

The BSA Public Policy Committee and the ASPT Environment and Public Policy Committee have selected an awardee for the first annual jointly sponsored Botany Advocacy Leadership Grant. The award goes to Dr. Michael Dunn on behalf of the Southwest Chapter of the Oklahoma Native Plant Society for a seminar and lecture series that will contribute to public policy by supporting outreach and education on native plant conservation and awareness. Congratulations, Michael!

The Botanical Advocacy Leadership Grant is an annual award, so we encourage members to apply next year. You can find more information on the grant at cms.botany.org/file.php?file=SiteAssets/awards/BSA_BAL_Call.pdf. Stay tuned in January 2017 for an update on Michael Dunn's seminar series, and for the 2017 call for applications.

2016 Congressional District Visits

The Botanical Society of America is helping to sponsor the 2016 Congressional District Visits event. Help showcase your science to your elected lawmakers by meeting with them locally in your district! Read a summary about the 2015 CDV event at https://www.aibs.org/public-policy/news/lawmakers_tour_research_facilities.html. Register for this event by July 17, 2016 at https://www.aibs.org/public-policy/congressional_district_visits.html.

FROM THE *PSB* ARCHIVES

60 years ago: Guest Editor George S. Avery, Jr. introduces a special PSB issue on teaching botany: "One hundred years ago botany courses, natural history, or whatever, were chiefly of taxonomic content. A large proportion of the population lived in what we now call "the country." In that different America it was a daily experience for people to see and know wild plants. Today by farthe most of us live in cities or suburbs, and the old approach has become inadequate.". . .

"In the America of today and the growing ever- changing America of the future, botany faces a challenge. Whether we can meet it, or are to continue along the old traditional paths that may lead to extinction-- is the question. The articles in this issue suggest that many teachers are thinking about ways of meeting the challenge. But words alone are not enough, no matter how dynamic and thought-provoking they may be. We need a program that will make general botany courses a more central and vital part of the undergraduate curriculum." (PSB 2(3): 2)

50 years ago: "A request that the Botanical Society of America Archives be deposited in the History of Science Collection at The University of Texas was presented at the Council Meeting on August 23, 1964. This request received the approval of the Council. Since receiving these Archives, our staff has microfilmed the Society records through 1949. Recently Dr. Richard C. Starr, Secretary, Botanical Society of America, has deposited in the Archives the Society's Minutes for 1950 through 1954.

In addition to these official records, the Collection has been receiving manuscripts, photographs and publications related to the Botanical Society of America and also to outstanding U.S. botanists." (PSB 12(2): 8)

Botanical Society of America's Award Winners

2016 Distinguished Fellow Award Winners

The Botanical Society of America Distinguished Fellow Award (formerly known as the Merit 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.

Professor Joseph Armstrong

Joseph Armstrong is a highly praised teacher/educator, a public advocate for botany andevolution, and an active researcher of quitevaried interests. His numerous awards include Outstanding Teacher at Illinois State University and the BSA's Charles E. Bessey award. Well before STEM education came into vogue, he actively challenged and involved students in courses and educational experiences, as reflected in his books and numerous writings. His former students are effusive in their high regard for his teaching and influences on their professional lives; as one of them stated, "he's all about all the students." He has been equally vigorous in his public outreach for botany and evolution, and he has been a major contributor to and tireless worker for the BSA. Professor Armstrong's research has dealt with the whole plant, from root apical meristems through the wood of stems to flowers; his substantial published research articles have included studies on anatomy, morphology, floral development, pollination biology, genetics, systematics, and ecology. As one of his supporters noted, his "studies on the role of floral morphology for the distinction of families in the premolecular era are especially noteworthy." Many have noted that he is a student of the whole plant and its place in ecosystems, as well as a proponent of botany and evolution through teaching and public outreach—Professor Armstrong is "a man of many hats."

Professor Jacob Weiner

Weiner has made important contributions in several areas of ecology, including size variation within plant populations, plant competition at the individual and population levels, plant growth and resource allocation, and the application of ecological and evolutionary knowledge to agricultural production systems. He is associated with a specific approach to plant ecology, which is analytic, mechanistic, and starts with simple models that produce testable hypotheses. Several of his papers are considered "classics" and are used in plant ecology courses around the world because they are easy to read and have a clear logic. He is known for finding non-conventional angles and solutions to difficult problems, and he has often succeeded in discovering simplicity in the seemingly overwhelming complexity of plant behavior. For example, he showed that patterns of allocation in plants that had been interpreted as "flexible reproductive strategies" could be better and more simply explained in terms of fixed allometric trajectories. In the middle of his career, he made a notable shift in focus and location. After serving on the faculty at Swarthmore College for 18 years, where he taught courses in botany and ecology and did research on basic mechanisms of plant competition and allocation, he left for the Royal Veterinary and Agricultural University (now part of the University of Copenhagen) in Denmark in 1996 and began applying theories from plant ecology to the improvement of agriculture. Using ideas from plant population biology and testing the resulting hypotheses, he has demonstrated that the potential for weed suppression by cereal crops is much greater than appreciated, and that this potential can be realized through increased crop density and spatial uniformity. He is currently attempting to apply evolutionary theory to agriculture and plant breeding.

Dr. Michael Barker Receives Emerging Leader Award

Dr. Michael Barker is an Assistant Professor in the Department of Ecology and Evolutionary Biology at the University of Arizona. Barker received his undergraduate degree at Denison University, earned a Master's degree at Miami University, and then obtained a PhD in 2009 at Indiana University with Drs. Loren Rieseberg and Gerald Gastony. After his NSERC-BRITE Postdoctoral Fellowship at University of British Columbia with Dr. Sally Otto, he took his current position in 2011. Over that time, Barker has proven to be a prolific researcher, with more than 50 peer-reviewed publications.

As an emerging leader, Barker enjoys a national and international reputation for being an expert at using bioinformatics and computational biology to confront enduring evolutionary questions in botany. Barker has successfully focused on developing algorithms for studying ancient and recent polyploidy (whole genome duplications). Taxonomically, he has worked primarily on ferns and members of the sunflower family; however, his novel methods in computational biology have led him to work on many plant groups as now on insects and other lineages of life. His expertise also spans time from macroevolution to microevolution—from the diversification of major lineages to recent hybridization and plant domestication.

Barker has an impressive record of leadership not only in research, but also his dedication to teaching, outreach, and service. Whether coordinating computational workshops or directing campus-wide bioinformatics efforts, Barker has demonstrated a willingness to step up and assume leadership roles in professional societies and at the University of Arizona. He has organized several symposia and colloquia, including a BSA symposium and special issue of the American Journal of Botany (July 2016) on the theme of polyploidy and genome evolution. Given his record of accomplishment and contributions to Botany, Dr. Michael Barker is an exemplary recipient of the BSA Emerging Leader Award.

BSA Public Policy Award

The Public Policy Award was established in 2012 to support the development of tomorrow's leaders and a better understanding of this critical area. The 2016 recipient is:

Krissa Skogen, Ph.D., Conservation Scientist, Conservation and Land Management Internship Program Manager, Chicago Botanic Garden and Adjunct Professor – Northwestern University

The J. S. Karling Graduate Student Research Award

Jonathan P. Spoelhof, University of Florida (Advisor: Douglas Soltis), for the proposal: *Connecting Adaptation and Expression in Neopolyploid* Arabidopsis thaliana

The BSA Graduate Student Research Awards

Ana María Bedoya, University of Washington, Seattle (Advisor: Richard Olmstead), for the proposal: *Andean uplift and the transformation of aquatic ecosystems: Impacts on the evolutionary patterns in aquatic plants of northern South America*

Alexander C. Bippus, Humboldt State University (Advisor: Alexandru M.F. Tomescu), for the proposal: *Exploring the phylogeny of basal Tracheophytes: The early Devonian radiation*

Megan Bontrager, University of British Columbia (Advisor: Amy Angert), for the proposal: *The roles of geography and environment in determining population genetic structure and performance at the northern range edge of* Clarkia pulchella

Matthew Chmielewski, Portland State University (Advisor: Sarah Eppley), for the proposal: *Does local dispersal of bryophytes by birds matter? Testing temporal shifts in bryophyte movement via birds and wind in a Pacific Northwest forest*

Taylor Crow, University of Wyoming (Advisor: Kristina Hufford), for the proposal: *Alternative methods for delineating seed transfer zones*

Timea Deakova, Portland State University (Advisor: Sarah Eppley), for the proposal: *A novel finding: Exploring the role of isoprene emission from germinating* Polytrichum juniperinum *moss spores*

Evan Eifler, University of Wisconsin – Madison (Advisor: Tom Givnish), for the proposal: *Spatial and temporal patterns of diversification in* Geissorhiza *(Iridaceae): Phylogeny, biogeography, and vulnerability in the Cape Floristic Province*

Jonathan A. Flickinger, Florida International University (Advisor: Javier Francisco-Ortega), for the proposal: *Systematics of the Lathberry Clade of* Eugenia L. *(Myrtaceae) in the Caribbean Islands*

Luiz Henrique Martins Fonseca, Universidade de São Paulo (Advisor: Lúcia G. Lohmann), for the proposal: *Systematics, phylogeny and diversification of* Adenocalymma *(Bignonieae, Bignoniaceae)*

Diana Gamba, University of Missouri – St. Louis (Advisor: Nathan Muchhala), for the proposal: *Is speciation faster in the tropics? Effects of seasonality and mutualists on angiosperm genetic structure*

Ian Gilman, University of Idaho (Advisor: David Tank), for the proposal: *Phylogeography of Cordylanthus and Pseudocordylanthus: A framework for assessing the role of niche evolution and conservatism in the process of speciation*

Nathan Paul Hartley, Duke University (Advisor: Paul Manos), for the proposal: *Diversification of a neotropical litter-trapping epiphyte clade (Anthurium section Pachyneurium): A preliminary assessment of phylogenetic niche conservatism*

Caitlin Maraist, Portland State University (Advisor: Sarah Eppley), for the proposal: *Effects of phyllospheric fungi on sexual effort and chemical cues in the dioecious moss,* Ceratodon purpureus

F. Nicolas Medina, Claremont Graduate University, Rancho Santa Ana Botanic Garden (Advisor: J. Travis Columbus), for the proposal: *Phylogenetic insights into the New World strangler figs (Ficus subgen.* Urostigma *sect.* Americana*): Testing for hybridization and introgression*

Chelsea Miller, University of Tennessee, Knoxville (Advisor: Charles Kwit), for the proposal: *Does the presence of entomopathogenic fungi on myrmecochorous seeds affect seed-handling and dispersal behaviors in* Aphaenogaster *ants?*

Andre A. Naranjo, University of Florida (Advisor: Pamela Soltis), for the proposal: *The comparative phylogeography of Eastern North American wetland forest species*

Chathurani Ranathunge, Mississippi State University (Advisor: Mark E. Welch), for the proposal: *Elucidating the adaptive role of microsatellites in natural populations of* Helianthus annuus *(Asteraceae)*

María Adolfina Savoretti, Universidad Nacional de La Plata and Instituto de Botánica Darwinion (Advisor: Alexandru M.F. Tomescu), for the proposal: *Systematic affinities of Early Cretaceous mosses of western North America – an inquiry into the deep history of bryophytes*

Katelin D. Stanley, Florida State University (Advisor: Austin R. Mast), for the proposal: *A comparative anchor for anchored phylogenomics: Systematic discovery of* Elephantopodinae *(Asteraceae) from within the "Evil Tribe"*

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.

Christopher Nelson, Florida Museum of Natural History (Advisor, Dr. Nathan A. Jud), for the Botany 2016 presentation: "*A new species of* Mammea *(Calophyllaceae) from the lower Miocene of Panama*" Co-author: Nathan A. Jud

Adam Ramsey, University of Memphis (Advisor, Dr. Jennifer R. Mandel), for the Botany 2016 presentation: "*Patterns of cyto-nuclear disequilibrium and the influence of heteroplasmy in wild carrot,* Daucus carota *(Apiaceae)*" Co-author: Jennifer R. Mandel

Amanda Salvi, University of Michigan, Ann Arbor (Advisor, Dr. Selena Y. Smith), for the Botany 2016 presentation: "*Effect of canopy shading on morphology, anatomy, and self-shading in spiral gingers (Costus)*" Co-author: Selena Y. Smith

Rachel Schwallier, Naturalis Biodiversity Center (Advisor, Dr. Barbara Gravendeel), for the Botany 2016 presentation: "*Evolution of wood anatomical characters in Nepenthes and close relatives in Caryophyllales*" Co-authors: Barbara Gravendeel, Hugo de Boer, Bertie Joan van Heuven, Anton Sieder, Sukaibin Sumail, Rogier van Vugt, Stephan Nylinder, and Frederic Lens

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 2016 award recipients are:

Christie Dang, Creighton University (Advisor, Dr. Mackenzie Taylor), *Post-pollination development in the hydrophilous species* Stuckenia pectinata *(Potamogetonaceae)*

Anna Hakkenberg, University of Richmond (Advisor, Dr. Carrie Wu), *Genetic patterns of introduction during the emerging invasion of wavyleaf basketgrass (*Oplismenus undulatifolius*) into U.S. Mid-Atlantic forest understories*

María del Pilar Herrera, San Marcos University (Advisor, Dr. Julien Bachelier), *Comparative development of extremely dimorphic male and female reproductive structures in* Orthopterygium huaucui*, a very rare and highly endemic dioecious genus of Anacardiaceae*

Elizabeth Leo, Towson University (Advisor, Dr. Laura Gough), *Bioavailability and trophic transfer of heavy metal soil contaminants in urban gardens in Baltimore, MD.*

Nathan Luftman, Bucknell University (Advisors, Drs. Christopher T. Martine and Jason Cantley), Chenopodium *"Moloka'i" (Amaranthaceae): A potential new species on the Hawaiian Island Moloka'i*

Kendall Major, University of Memphis (Advisor, Dr. Jennifer Mandel), *Genetic diversity and population structure in the clonal plant* Trillium recurvatum

Yu-Ling Shih, Da-Yeh University (Advisors, Dr. Pei-Luen Lu), *Botanical biodiversity of Long Lellang, Sarawak, Malaysia*

Austin Szubryt, Southern Illinois University – Carbondale (Advisor, Dr. Kurt Neubig), *The golden rule for goldentops: Using phylogenetics to classify* Euthamia *(Asteraceae)*

The BSA Young Botanist Awards

The purpose of these awards is to offer individual recognition to outstanding graduating seniors in the plant sciences and to encourage their participation in the Botanical Society of America. The 2016 "Certificate of Special Achievement" award recipients are:

Kevin Bird, University of Missouri (Advisor: Dr. J. Chris Pires)
Katie Brown, University of Guelph (Advisor: Dr. Christina (Chris) Caruso)
Carmela Buono, Rutgers University (Advisor: Dr. Myla F.J. Aronson)
Alice Butler, Bucknell University (Advisor: Dr. Chris Martine)
Wade Dismukes, University of Missouri (Advisor: Dr. J. Chris Pires)
Ashley Donnel, Eastern Illinois University (Advisor: Dr. Scott J. Meiners)
Benjamin Durrington, Hillsdale College (Advisor: Dr. Ranessa Cooper)
Zoe Feder, Oberlin College (Advisor: Dr. Michael J. Moore)
Meghan Garanich, Bucknell University (Advisor: Dr. Chris Martine)
Cazandra Koonce, St. Louis Community College (Advisor: Dr. Scott D. Gevaert)
Erin Johnson, Oberlin College (Advisor: Dr. Michael J. Moore)
Evan Kilburn, Auburn University (Advisor: Dr. Robert S. Boyd)
Ian Medeiros, College of the Atlantic (Advisor: Dr. Nishanta "Nishi" Rajakaruna)
Jacob Mreen, St. Louis Community College (Advisor: Dr. Scott D. Gevaert)
Julia Olivieri, Oberlin College (Advisor: Dr. Michael Moore)
Becca Otoole, University of Florida (Advisor: Dr. Douglas Soltis)
Madeline McClelland, Willamette University (Advisor: Dr. Susan R. Kephart)
Sebastian Mortimer, Willamette University (Advisor: Dr. Susan R. Kephart)
Margo Paces, Fort Lewis College (Advisor: Dr. Ross A. McCauley)
Amanda Salvi, University of Michigan (Advisor: Dr. Selena Y. Smith)
Jake Summers, Connecticut College (Advisor: Dr. Chad Jones)|
Anna Talcott, Hillsdale College (Advisor: Dr. Ranessa Cooper)
Imena Valdes, Florida International University (Advisor: Dr. Suzanne Koptur)
Rebecca Valls, Florida International University (Advisor: Dr. Eric von Wettberg)
Scott Van De Verg, University of Hawai'i (Advisor: Dr. Cliff Morden)
Kayla Ventura, University of Florida (Advisor: Dr. Pamela S. Soltis)
Lauren Walter, Hobart and William Smith Colleges (Advisor: Dr. Shannon C.K. Straub)

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.

Timothy Batz, California State Polytechnic University (Advisor: Dr. Bharti Sharma)
Janet Mansaray, Howard University (Advisor: Dr. Janelle Burke)
Corey Milligan, Harris-Stowe State University (Advisor: Dr. Thomas Brown)
Brooke Palmer, Colorado State University (Advisor: Dr. Stacey Smith)
Vivianna Sanchez, Mount St. Mary's University (Advisor: Dr. Adriane Jones)
Jaime Schwoch, Portland State University (Advisor: Dr. Mitch Cruzan)
Evelyn Valdez-Rangel, University of Houston-Downtown (Advisor: Dr. Michael Tobin)
Rebecca Valls, Florida International University (Advisor: Dr. Eric von Wettberg)
Nathan Vega, California State University-Fullerton (Advisor: Dr. Joshua Der)
Monica Warner, California State University - Dominguez Hills (Advisor: Dr. Kathryn Thiess)
Shan Wong, Florida International University (Advisor: Dr. Hong Liu)

Genetics Section Student Research Awards

Genetics Section Student Research Awards provide $500 for research funding and an additional $500 for attendance at a future BSA meeting.

Ben Merritt, University of Cincinnati (Advisor: Dr. Theresa M. Culley), for the proposal titled "*Questions of genomic and geographic scales: Characterization and assessment of molecular tools in* Sedum lanceolatum *Torr.* (Crassulaceae)"

Megan Bontrager, University of British Columbia (Advisor: Dr. Amy Angert), for the proposal titled "*The roles of geography and environment in determining population genetic structure and performance at the northern range edge of* Clarkia pulchella"

Genetics Section Student Travel Awards

Adam Ramsay, University of Memphis (Advisor, Dr. Jennifer R. Mandel) for the Botany 2016 presentation: "*Patterns of cyto-nuclear disequilibrium and the influence of heteroplasmy in wild carrot,* Daucus carota *(Apiaceae)*" Co-author: Jennifer R. Mandel

Charles Foster, University of Sydney (Advisor, Dr. Simon Ho) for the Botany 2016 presentation: "*Evaluating the impact of genomic data and priors on Bayesian estimates of the angiosperm evolutionary timescale*" Co-authors: Herve Sauquet, Marlien van der Merwe, Hannah McPherson, Maurizio Rossetto and Simon Ho

Monica Warner, California State University, California State University, Dominguez Hills (Advisor, Dr. Kathryn E. Theiss) for the Botany 2016 presentation: "*Evaluating species differentiation in endangered rush lillies using population genetics*" Co-authors: Kathryn E. Theiss and Susan Kephart

Developmental & Structural Section Student Travel Awards

Muhammad Akbar Abdul Ghaffar, Ohio State University (Advisor, Katrina Cornish), for the Botany 2016 presentation: "*Histological study of Laticifer and rubber particle ontogeny in* Taraxacum kok-saghyz *roots*" Co-authors: Tea Meulia and Katrina Cornish

Bridget Giffei, Creighton University (Advisor, Mackenzie Taylor) for the Botany 2016 presentation: "*Post-pollination development in* Ruppia maritima *(Ruppiaceae, Alismatales)*" Co-authors: Christie L. Dang, Kristine M. Altrichter, Ana E. Wilden and Mackenzie Taylor


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Eat Your Weeds:
Edible and Wild Plants in Urban Environmental Education and Outreach[1]

Abstract

Edible weedy plants are ubiquitous in human-dominated areas and provide opportunities to combat plant blindness and improve citizens' local ecological knowledge in formal and informal urban environmental educatio (UEE) programs. Weeds exemplify intriguing ecological, cultural, and ethnobotanical concepts, making them ideal resources for hands-on, socially relevant, and personally meaningful educational activities. Cosmopolitan, spontaneous, weedy plant species are often freely accessible for use in the curricula of many grade levels in varied educational venues as well as in extra-curricular activities for all learners, given that proper safety and legal precautions are taken. We developed and hosted a UEE outreach activity based on edible weedy plants at Rutgers University as part of an annual, university-wide event attended by over 80,000 people in the spring of 2014. Incorporating edible weeds into such programs teaches plant identification skills and ecological appreciation in settings that are "close to home" for most people.

By Lauren J. Frazee[2]
Graduate Program in Ecology and Evolution, Department of Ecology, Evolution, and Natural Resources, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ

Sara Morris-Marano
Mohican Outdoor Center, Appalachian Mountain Club, Blairstown, NJ; Department of Ecology, Evolution, and Natural Resources, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ

Jennifer Blake-Mahmud
Graduate Program in Ecology and Evolution, Department of Ecology, Evolution, and Natural Resources, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ

Lena Struwe
Department of Ecology, Evolution, and Natural Resources, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ; Department of Plant Biology and Pathology, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ

Key Words

botanical education; ecological knowledge; food; informal education; K-99 education; place-based learning; plant blindness; species identification; urban environmental education; urban vegetation

Footnotes

[1] Manuscript received 26 January 2016; revision accepted 31 March 2016.
[2] Corresponding author email: lauren.frazee@ rutgers.edu

doi: 10.3732/psb.1500003

Introduction

Positive human-nature interactions are vital to counteract modern day environmental problems, yet urbanization and development continue to threaten our connection with and understanding of the biosphere (Miller, 2005; White et al., 2010; Liefländer et al., 2012). Current generations are becoming increasingly estranged from living organisms except other humans, supermarket food plants, and pets (Miller, 2005). As of 2014, 82% of the population of the United States lived in urban areas (United Nations, 2014); native species diversity and abundance have declined in cities (Gaston, 2010; Duncan et al., 2011); and the ease of accessibility to green space tends to diminish as city populations grow (Fuller and Gaston, 2009). Together, these phenomena may prevent much of the world's population from experiencing and observing nature in a positive light (Morrone and Meredith, 2003), ultimately leading to a widespread lack of environmental concern (Chawla, 1998). Therefore, developing effective materials and curricula for urban environmental education (UEE) that target a broad audience is necessary to create an ecologically and socially responsible society for the future (Tidball and Krasny, 2010; Ardoin et al., 2012).

Spontaneous urban plants (also known as "weeds") are ubiquitous in cities worldwide; they inhabit every crack and corner of the cityscape. The omnipresence of weeds in modern cities and their suburbs makes them some of the most universally accessible wild species available for study and observation. These weedy plants, whether native or non-native, have traits that make them well suited to highly disturbed human-dominated environments such as suburban lawns or pavement cracks (e.g. Cheptou et al., 2008; Del Tredici, 2010). The sheer prevalence of weeds makes them convenient and effective tools for combatting plant blindness, defined as "the inability to see or notice the plants in one's own environment, leading to the inability to recognize the importance of plants in the biosphere and in human affairs" (Wandersee and Schussler, 1999; Smith, 2014). Learning about weeds has the potential to encourage people to notice the abundance of plant life that surrounds them on a daily basis (Allen, 2003), even within cities. Studying weeds is also a way to encourage learners of all ages and backgrounds to appreciate, respect, and inquire about nature in all of its diverse forms (e.g., useful versus not useful plants, or attractive versus "ugly" species).

Weedy plant foraging and city herbalism have experienced a resurgence in popular culture in the West in recent years (e.g. Wong and Leroux, 2012; Lerner, 2013; Vorass-Herrera, 2013; Blair, 2014). However, the fact that most urban, weedy plant species have ancient ethnobotanical histories and cultural relevance for diverse human groups is not well known today (Zimdahl, 2013). Chickweed, for

example, is one of the most common vascular plants, found in over 100 city floras worldwide (Aronson et al., 2014). Chickweed has a well-documented ethnobotanical record in traditional South American, European, and Asian cultures: the young shoots and leaves are used as ophthalmic and anti-inflammatory medicines in Patagonia; used as fodder to increase egg-laying in poultry in central Italy; and cooked along with cabbage for human nourishment in southwest China (e.g. Guarrera et al., 2005; Weckerle et al., 2006; Molares and Ladio, 2009). Yet, most wellknown and beloved plants in today's Western cultures are showy horticultural ornamentals and garden crops—not the wild, weedy plants historically used for medicinal or food purposes. Exposing people to the edible, medicinal, and other cultural or historical uses of weeds can stimulate people's interest and curiosity in wild organisms. Furthermore, using edible urban weeds as study organisms roots UEE in the socio-ecological nature of the city by connecting students and the public to the natural world via cultural, culinary, biological, ecological, and historical references and provides a truly interdisciplinary framework for formal and informal education (Tidball and Krasny, 2010; Blanchet-Cohen and Reilly, 2013).

Using edible weedy plants in environmental educational initiatives also supports the development and maintenance of plant identification skills. Being able to identify a species and giving it a unique name is not only important for educational efforts in combatting plant blindness, but it is also a crucial pre-requisite to foraging for wild foods. Along with the ease and accessibility of incorporating edible weedy plants into UEE, a strong emphasis must be placed on safety precautions. A strong foundation of botanical identification skills and morphological knowledge is necessary for the success and safety of any edible wild plant program. Many plants are edible, but many others are toxic. Foragers, instructors, and learners must be aware of toxic "lookalikes" and should not consume any plant product until the identity of the collected species is certain. New foragers may choose to begin with a mentor or guide to learn the basics of plant identification. Thorough, reliable field guides and repeated field identification practice are essential for cautious foraging and can help remind even the most experienced field botanists of subtle yet potentially important morphological differences between specimens. In urban settings, in particular, educators must also ensure that foragers are careful to avoid potentially toxic urban sites that have been contaminated by pesticides, fertilizers, automotive fuel, heavy metals, or animal waste, among other pollutants. The possibility of individual reactions to allergens in common plants should be discussed prior to foraging. In addition to safety precautions, foragers should always acquire permission from landowners to access and remove plant materials from a given site.

We recognized the potential of using spontaneous weedy plants as an exciting and relevant way to engage the public, so we organized an outreach table featuring edible weedy plants for our local community. We held our outreach event at the annual Rutgers Day—a university-wide open house for Rutgers University in New Brunswick, New Jersey—that engages and informs the extended local community through activities provided by university students, clubs, and departments. The local and state-wide impact of this celebration is significant: in 2013, this event was attended by nearly 80,000 people. For Rutgers Day 2014, our environmental education table was entitled "Eat Your Weeds:

How to Safely Savor Wild Edible Plants." Our overarching teaching goal was to encourage community members to make meaningful connections not only with living wild plants, but also with ecological processes and associated biodiversity in urban and suburban areas through eating weeds (Table 1).

Activity Description

Plant species selection

Six edible urban weeds that are locally abundant were chosen to be showcased at our outreach table during Rutgers Day 2014 (Table 2): *Taraxacum officinale* (common dandelion), *Allium vineale* (field garlic, wild onion), *Alliaria petiolata* (garlic mustard), *Stellaria media* (common chickweed), *Cardamine hirsuta* (hairy cress), and *Rumex acetosella* (sheep sorrel). Although not as common in suburban and urban areas, and not always strictly weedy in our part of the world, we also included *Rosa canina* (wild rose) and *Sambucus nigra* (elderberry) as highlighted species due to the commercial availability of food products using these plants (see Table 2). We also served two prepared food products: Elderflower Lemonade from a syrup concentrate ("Flädersaft," IKEA Foods, Sweden) and Rose Hip Soup (cold) from a smoothie mix ("Nyponsoppa," Ekströms, Eslöv, Sweden).

Fact sheet preparation

Consuming and foraging for wild foods involves certain risks, such as injury while foraging, plants growing in polluted soils, and poisoning due to eating misidentified plants. To address these potential risks, we incorporated safety information into our activity plan in the following ways: (1) the back of each recipe card listed foraging tips and species-specific advice for plant identification; (2) we supplied a general handout to provide information on how to safely collect and consume edible, weedy plants; and (3) we chose to highlight plants that grow commonly in the lawns, gardens, and along the sidewalk edges of homes, where legal and informed foraging is most likely to occur (with information about pesticides, soil quality, and other risk factors). Preparation of recipe cards and handouts on safe foraging required approximately 8 person hours.

Teaching Goals	Learning Outcomes
To inspire enthusiasm in a wide range of participants To enable people to enjoy, risk- and cost-free edible weedy plants	For participants across age ranges to express excitement and enthusiasm in trying new culinary dishes featuring weeds
To disseminate information regarding the safe identification, procurement, and preparation of weedy plants	For participants to collect resources enabling effective plant identification, collection, and preparation with the intent to use them in the future
To broaden perspectives and attitudes about-weedy plants	For participants to entertain wider viewpoints regarding the usefulness of spontaneous vegetation

Table 1. "Eat Your Weeds" educational outreach goals and outcomes.

Plant species name	Recipe(s) created	Role(s) in activity
Alliaria petiolata Garlic mustard (Brassicaceae)	Garlic Mustard Hummus	Sample tasting, recipe handout, and live plant display
Allium vineale Wild garlic or onion (Amaryllidaceae)	Cream Cheese Spread with Wild Garlic Shoots	Sample tasting, recipe handout, and live plant display
Cardamine hirsuta Hairy cress (Brassicaceae)	Hairy Cress Salad with Goat Cheese, Walnuts, and Honey-Dijon Vinaigrette	Recipe handout and live plant display
Rosa canina Wild rose (Rosaceae)	Rose Hip Soup*	Sample tasting and live plant display
Rumex acetosella Sheep sorrel (Polygonaceae)	Fresh Fruit Salad with Sheep Sorrel and Sweet Whipped Cream	Recipe handout
Sambucus nigra Elderberry (Adoxaceae)	Elderflower Lemonade*	Sample tasting
Stellaria media Chickweed (Caryophyllaceae)	Sautéed Chickweed with Ginger, Garlic, and Soy Sauce	Recipe handout and live plant display
Taraxacum officinale Dandelion (Asteraceae)	Dandelion Flower Lemonade†; Deep-Fried Dandelion Flowers; Orecchiette Pasta with Italian Sausage, Dandelion Greens, and Lemon Zest	Sample tasting, recipe handouts, and live plant display

Table 2. Food and drink featured plant contents and role.

Notes:
**Rose Hip Soup and Elderflower Lemonade are not original recipes; these beverages are available commercially. †Dandelion Flower Lemonade was used as the sample tasting dish for* T. officinale.

Recipe preparation

Over several weeks we developed eight original recipes based on six of our highlighted weedy plant species. We selected three of the eight original recipes to feature in our free tastings, using three species of the most easily accessible and identifiable weeds: *Alliaria petiolata, Allium vineale*, and *Taraxacum officinale.* For ingredients we spent approximately 3 hours foraging for plant material locally in areas where pesticides and herbicides had not been applied. We prepared Cream Cheese Spread with Wild Garlic Shoots (Fig. 1), Garlic Mustard Hummus, Elderflower Lemonade, Rose Hip Soup, and Dandelion Flower Lemonade in bulk to offer as samples on crackers and in small tasting cups at our table (see Table 2). Food preparation prior to the event required approximately 6 hours to prepare the necessary quantities (i.e. two gallons of Rose Hip Soup, two gallons of Dandelion Flower Lemonade, two gallons of Elderflower Lemonade, and 64 ounces each of Garlic Mustard Hummus and Cream Cheese Spread with Wild Garlic Shoots).

Event day set-up

With set-up teams consisting of two people and two handcarts, we set up three tables along one of the major pedestrian paths on Cook Campus, Rutgers University during Rutgers Day. Our outreach area was equipped with a large, custom-designed overhead sign reading "WEEDS" made from clear plastic tubing filled with a variety of dried weedy plant parts (Fig. 2). A newly developed, original logo that read "EAT YOUR WEEDS" appeared on all outreach materials (Fig. 3). Outreach materials included recipe cards with a picture of its featured edible weed and specific foraging tips; new, illustrated field identification guides

Figure 1. *Cream Cheese Spread with Wild Garlic Shoots and hairy cress garnish (center) and Garlic Mustard Hummus (either side) on crackers. These recipes were prepared in bulk to distribute sample tastings at our "Eat Your Weeds" table at Rutgers Day 2014. Photo: cc // Lena Struwe, 2014.*

to 34 local weeds; and handouts on safe foraging practices. We dug up and potted over 20 living examples of weedy species featured in our field guide and displayed these on one of the tables (see Fig. 2). We also incentivized food sampling by handing out stickers about weeds to all tasters with fun and informative messages such as "I eat weeds," "Weeds are also made of stardust," "I drink weeds," "Weeds are superevolutionary," and "Without humans, no weeds." All of our materials (recipe cards, field guide, and foraging safety handout) are freely available as PDF files on our website and blog (Struwe, 2014; http://4weeds.blogspot.com). We staffed our table with two to four rotating volunteers throughout the day.column.}

Results

At the 8-hour-long Rutgers Day event on 26 April 2014, we distributed over 2000 free samples of weedy food and beverage items

Figure 2. *A memorable sign, reading "WEEDS" and made out of dried plant material in tubes, sits above potted weedy plant example specimens at our "Eat Your Weeds" table at Rutgers Day 2014. Pictured from left to right are Lauren J. Frazee, volunteer Zachary Bunda, and Dr. Lena Struwe. Photo: cc // Jennifer Blake-Mahmud, 2014.*

at our outreach table. We estimate that we communicated directly or indirectly (though visuals, handout materials, or "sticker interactions") with 2000 to 3000 visitors about the public misconceptions and overlooked virtues of weeds in today's society, including but not limited to edibility. We also handed out over 400 recipe cards and about 500 field guide pamphlets. Almost 84,000 people attended Rutgers Day 2014 overall (Szteinbaum et al., 2014).

Although Rutgers Day attracts community members of diverse backgrounds, there were common themes in responses from the public. While we conducted no formal assessment of visitors to our table to evaluate our learning goals and outcomes, volunteers jotted down notes of interesting stories and interactions during the event. Five to six table volunteers then discussed these anecdotes during our reflection and debriefing process, and here we present and interpret that information. Table visitors included faculty members, students, friends, and parents as well as local families with elderly relatives and toddlers in tow. Most people were very interested in the sample tastings, and some returned to the table twice or more that day. The most popular recipe cards were for Deep-Fried Dandelion Flowers and Cream Cheese Spread with Wild Garlic Shoots. Many visitors quickly recognized our example specimens and sample ingredients (see Table 2; Fig. 2) as plants that are common in their own yards or neighborhoods. The most common question for plant identification was about *Lamium purpureum* (deadnettle), a common weed in many front yards at that time of the year (i.e., early-mid spring), and many people wanted to know how to rid their yards of it.

Children as well as adults added the stickers to their clothing and wore them around campus for the remainder of the day, potentially providing (and provoking) interactions on weedy plant topics with additional visitors that not yet had visited (or could not visit) our

Figure 3. *An original logo created for our "Eat Your Weeds" table at Rutgers Day 2014 appeared on all outreach materials. Image: cc // Lena Struwe, 2014*

table. Many adults reminisced with us about what they or their older relatives used to eat earlier in their lives and told us (and children, if present) about foraging for wild plants as children, drinking older relatives' dandelion wine, and where the best spots were for finding certain species. A disabled veteran told us about foraging for stinging nettle in New Jersey and that he appreciated our effort to educate the public about edible plants.

Discussion

Using edible weeds in UEE is an effective way to stimulate curiosity in plants, to broaden perspectives on spontaneous weedy vegetation, and to encourage plant identification skills. This activity combats plant blindness by encouraging participants to observe and experience weedy plants, which are often overlooked and underappreciated. The intended take-home message for festival-goers and visitors to our table was: "Notice these plants, all plants, and all life, for that matter; experience them; enjoy them; and find out what they do and represent" (see Table 1). This type of activity strengthens connections between the people of the New Jersey–New York metropolitan area and their local, urban flora.

We attribute our success in implementing our outreach program on edible, urban weeds to three factors. First, utilizing local, urban weeds in UEE is a means of outdoor, place-based learning (Theobald, 1997; Kolb, 2014). In place-based learning, students make use of nearby resources to study both the natural world and the community; all such lessons come directly from the context of the local environment (Gruenewald and Smith, 2014). Place-based curricula have also been found to increase student motivations for scholastic achievement (Powers, 2004). Moreover, the opportunities (or "places" themselves) for studying weeds occur at every point in time and space along the urban-rural gradient. The cityscape itself is transformed into a living laboratory when weeds become study organisms. Students can uproot local weeds, bring them to their classroom, and interact with them directly. Getting students out and into their surroundings to experience wild organisms will help combat the ongoing trend of human disconnection from nature through direct contact with plants (Miller, 2005).

Second, the edible weeds that we presented at our activity have traditional significance for many ethnic and cultural groups and are highly recognizable. Simply put, humans both love and hate weeds. In general, weeds have been and continue to be associated with all human settlements in urban, suburban, and rural environments worldwide; weeds are a universal human phenomenon. All of the weedy plants featured in this activity are economically important as sources of flavoring agents, medicine, vegetables, fruits, and/or serve as ornamental species (see Table

2; Wiersema and León, 2013). In modern cities, weedy plants are considered important in the provisioning of ecosystem services such as habitat for wild species, microhabitat regulation, and air filtration (Robinson and Lundholm, 2012). The connections between metropolitan areas, people, and weeds are a result of the complex sociopolitical ecology of urban development (Gaston, 2010). In this way, we presented social as well as biological and cultural contexts for learning about each plant.

Third, our tasting opportunities, take-home recipes and guides, thought-provoking stickers, and weedy plant example specimens encouraged an active, multisensory, kinesthetic, and engaging experience (Stern et al., 2014). Eating, in itself, is a personal action that can translate into multi-sensory, experiential learning. Visitors to our outreach table could choose to partake in learning and exploration by any or all of the following methods: eating or drinking free samples; smelling plants, choosing favorite recipes for future use; perusing species guides and safety pamphlets; observing live plants labeled with species names; talking to us and asking questions; and even sharing their own experiences with fellow visitors.

In all, food is inherently motivating and, perhaps most importantly, eating weeds is a novelty in today's society. We tend to care about and remember the texture, tastes, and smells of certain foods, thereby encouraging connections with personal experiences. Using edible plants and food preparation methods in educational activities such as the Food, Math, and Science Teaching Enhancement Resource Initiative developed at East Carolina University (USA) has shown to increase students' abilities to retain information in the life sciences (Duffrin et al., 2010; Hovland et al., 2013). Moreover, both accompanying students in local foraging activities and encouraging members of the public to engage in independent wild plant foraging and then preparing wild plant foods promotes learning-by-doing, or experience-based learning. Outdoor, field-based experiences in general can be highly memorable and beneficial to learners (Dillon et al., 2006). Similarly, schoolyard vegetable gardening activities have been touted as a key method for improving children's environmental attitudes and aptitude in the sciences (Waliczek and Zajicek, 1999; Williams and Dixon, 2013).

Weeds are natural choices for use in urban environmental education due to their relative abundance in cities and suburbs, interesting ecological niches, and strong historical associations with a diversity of cultural practices. These are globally accessible resources with broad appeal for informal public outreach as well as formal nature education.

Risk is an inherent part of foraging and consuming wild plant species, but the design of this activity helps to minimize those risks. We chose to highlight certain species for

sample tastings (i.e., dandelion, wild onion/wild garlic, and garlic mustard) that are easy to identify by characteristic leaf morphology and have no poisonous "look-alikes." Dandelion flower heads and their tufted, wind-blown fruits are well-recognized in modern culture, and their use as a decorative motif—in stationery, interior design, and even tattoos—has recently surged. Wild onion and garlic mustard leaves have distinct, pungent scents when broken. All of these species are usually found in high density and abundance where they are present and generally do not cause allergic reactions in humans. (However, people with food allergies should remain cautious.) In addition, these species look strikingly different from the most common poisonous plants in the mid-Atlantic and northeastern United States, such as jimsonweed, nightshade, and poison ivy, which can cause symptoms such as gastric irritation and painful rashes. We strongly discourage consuming or serving any foods made with wild plant species unless their species identities have been confirmed with 100% accuracy. All plant species used in this activity can be harvested up to two weeks before food preparation, refrigerated, and verified with a specialist ahead of time. Local botanical societies or institutions of higher education may be able to assist with verification. Learning to forage for edible plants, or simply knowing the toxic plants in your environment, necessitates a strong knowledge in botanical identification of species and their morphologies and provides an excellent argument for improved botanical education at the K-99 level.

Using urban edible plants in informal public education easily lends itself to formal lesson planning in the plant sciences and UEE as well as to other informal contexts in diverse venues and seasons. These activities could be prepared for small or large crowds anywhere there are wild edible plants, but the accessibility of edible weeds in city and suburban environments makes them especially meaningful for UEE. In the mid-Atlantic and northeastern urbanized United States, educators can typically forage during much of the growing season for plant materials or sample specimens of the species used here (after asking permission from property owners or land managers, where necessary). Wild onion grows prolifically in lawns in the early spring and late fall in this region, whereas dandelion and garlic mustard have leafy growth in lawns and suburban woods, respectively, from the early spring through the fall. Moreover, there are numerous other edible urban plant species available for harvest and study outside of temperate zones. Of the 17 most common urban plants in cities around the world (Aronson et al., 2014), all but four have well-described edible and/or medicinal uses (Wiersema and León, 2013).

We recommend that educators account for certain logistical factors when hosting large-scale outreach events based on foods and beverages made from urban weeds. The limiting factor in making this activity successful for large crowds (such as Rutgers Day) is simply the number of volunteer hours needed for bulk food preparation and "plating" or serving during the event. Crackers topped with Garlic Mustard Hummus and Cream Cheese Spread with Wild Garlic Shoots were taken up by visitors at a rate exceeding the speed at which we could prepare them. Various strategies could be implemented to relieve volunteers from this burden, such as using squeeze bottles to dispense toppings onto crackers, planning to serve less labor-intensive samples, or simply doing more preparatory work ahead of time. Furthermore, we suggest serving at least one drink and at least one solid food and choosing recipes that are palatable across a wide range of tastes

(e.g. sweet and savory) to diversify the menu. Tasters should have easy access to ingredient lists to avoid problems with food allergies and intolerances. Another important planning consideration is seasonality. For example, the herbaceous weedy species harvested for this event are not available in late fall and winter in temperate areas. However, we do see the potential for educators to develop seasonal edible weed activities that reflect the change in plant species composition throughout the year, especially in temperate climates.

Conclusions

Our "Eat Your Weeds" outreach table at Rutgers Day 2014 in New Brunswick, NJ, is an example of how to incorporate plant- and place-based learning, socioecological connections, and direct contact with wild organisms in urban environments in a practical and fun way. We have evaluated our outreach activity as highly successful in encouraging community members to become more familiar with local, wild plant biodiversity in an urban setting (see Table 1). We received overwhelmingly positive feedback and recognition from visitors, observers, and university media (Szteinbaum et al., 2014). Edible urban weeds are an easy and economical teaching tool for active, culturally relevant, place-based learning in UEE and in combatting plant blindness. Weeds are natural choices for use in UEE due to their relative abundance in cities and suburbs, interesting ecological niches, and strong historical associations with a diversity of cultural practices. These are globally accessible resources with broad appeal for informal public outreach as well as formal nature education.

Acknowledgements

The authors thank Aishwarya Bhattacharjee, Zachary Bunda, Leif Albert, Natalie Howe, Carlos Olivares, and Julia Perzley for preparing and serving food and volunteering at our table on Rutgers Day 2014. We are also grateful to Laura Shappell for designing the field guide pamphlet, which was illustrated by Bobbi Angell. The "Eat Your Weeds" project was sponsored by the Chrysler Herbarium, and our Rutgers Day table was arranged through Department of Ecology, Evolution, and Natural Resources and Department of Plant Biology and Pathology at The School of Environmental and Biological Sciences at Rutgers University. This project was supported by a USDA-Hatch grant (NJ17145) and a USDA planning grant (WERA1015) awarded to L.S.

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Shakespeare, Plant Blindness and Electronic Media[1]

Abstract

"Plant blindness" is lack of botanical awareness. In Shakespearean London, knowledge of plants among the general public can be characterized as extensive. Allusions to dozens of wildflowers, weeds, and plant-derived potions were immediately understood by Shakespeare's audiences. By comparison, in modern London, a published study showed that secondary level students, graduates, and a substantial portion of biology teachers, could scarcely recognize ten common wildflowers. Eight of these ten are referenced in Shakespeare, and all appear in British folklore. This comparison of historical versus contemporary plant knowledge in a given locale appears unique, but studies focusing on comparisons of contemporary rural versus urban environments are available. Both categories of comparisons support the conclusion that contemporary urban life promotes plant blindness. Disconnection from agricultural and natural environments ("nature deficit disorder"), not zoocentrism, is likely responsible for "plant blindness." Electronic media with botanical themes offer one potential venue for re-establishing awareness of plants.

By Frank M. Dugan[2]
USDA-ARS Plant Introduction, Washington State University, Pullman, WA.

Key Words

botanical literacy; nature deficit disorder; plant blindness; Shakespeare; video games

Footnotes

[1] Resubmission received 25 March 2016; revision accepted 26 March 2016.

[2] Corresponding author email: fdugan@wsu.edu

doi: 10.3732/psb.1600002

Introduction: The Bard's Botany

In the preface to Roy Vickery's (2010) volume on British and Irish plant lore, a tale is told of the great ethnobotanist Richard Evans Schultes (1915-2001). "The great man" in conversation with Vickery makes the pronouncement, "The British Isles have no ethnobotany." The majority of Vickery's 226 pages document the opposite. It is true that we don't think of peoples of the British Isles as using plant-derived body paint in ceremonies and rituals, nor as consulting shamans intoxicated on plant hallucinogens, so in this sense Schultes was correct. But that the Isles host centuries-old plant lore is beyond dispute. Although Vickery (2010) deserves a careful read from any persons interested in plant lore of the European tradition, an alternative source for much of this lore is found in more widely read literature: Shakespeare. This plant lore is highly pertinent to the current concept and debates regarding "plant blindness."

Most readers will recall in Shakespeare's plays allusions to plant products, such as a love potion:

> The juice of it on sleeping eyelids laid
> Will make man or woman madly dote
> Upon the next live creature that it sees.
> (*Midsummer Night's Dream* II.i.)

Or, plant poisons:

> … I would the milk
> Thy mother gave thee when thou suck'dst her breast
> Had been a little ratsbane for thy sake!
> (*1 Henry VI* V.iv.)

Such themes are abundant in Shakespeare. Tabor (1970) provided a catalog of abundant instances of plant poisons and potions in Shakespeare.

Shakespeare also had knowledge of weedy plants, and attributed to them symbolic as well as agronomic significance (Archer et al., 2012). Thus we have Lear's daughter Cordelia:

> Alack 'tis he: why, he was met even now
> As mad as the vext sea; singing aloud;
> Crown'd with rank fumitor and furrow-weeds,
> With bur-docks, hemlock, nettles, cucko-flowers,
> Darnel, and all the idle weeds that grow
> In our sustaining corn.
> (*King Lear* IV.iv)

Or, the Duke of Burgundy:

> …her fallow leas
> The darnel, hemlock, and rank fumitory,
> Do root upon …
> …and nothing teems
> But hateful docks, rough thistles, kecksies, burs
> (*Henry V* V.ii)

Figure 1. *Lear's crown of weeds (from Clarke and Clarke, 1864). Alternative representations of Lear's crown as containing attractive daisies, clover, wildflowers, even roses, etc., miss the bard's intent (Archer et al., 2012).*

Leaving aside for the moment the botanical identity of such plants as kecksies and cucko-flowers, it seems apparent that weeds such as "rank fumitory" are both symptom and symbol of things going badly (Fig. 1), and that Shakespeare could specify quite a few weeds (Archer et al., 2012). However, most analyses of Shakespeare's botany have focused on the Shakespearean flowers.

Over decades, there have been reams written on flowers and their connotations in Shakespeare (e.g., Ellacombe, 1884; Grindon, 1883; Savage, 1923; Thiselton Dyer, 1884; Willes, 2015). For example, we have Oberon, on scenic beauty:

> I know a bank where the wild thyme blows,
> Where oxslips and the nodding violet grows;
> Quite over-canopied with lush wood bine,
> With sweet musk-roses, and with eglantine
> *(Midsummer Night's Dream II.i.)*

Or, Autolycus, singing for joy:

> When daffodils begin to peer,
> With hey! the doxy over the dale,
> Why, then comes in the sweet o'the year
> *(Winter's Tale IV.ii)*

The whole point of this foray into potions, weeds, and flowers is that Shakespeare was familiar with many plants, their significance, and their products. Approximately 190 plant names appear in Shakespeare (Rydén, 1978). Given the time and changes in language that separate us from Shakespeare, and given that he wrote well in advance of Linnaean taxonomy, it's understandable that some names remain ambiguous for us. It's difficult to determine with precision exactly which Linnaean species were intended by some names, such as "lady-smocks" (Lever, 1952). However, when Shakespeare used flowers as symbols, he assumed his audience would understand. Various sources strongly affirm that Shakespeare's audiences understood his botanical allusions and were otherwise familiar with numerous plants and their properties: "It is essential to remember that the flower symbolism had to be understood by an ordinarily intelligent audience, or the scene would be meaningless" (Lever, 1952). Shakespeare's use of these symbols was "familiar and meaningful to Elizabethan theatre-goers" (Rydén, 1978). Occasionally the significance of a name for a given plant, or herbal potion, may have eluded some of his audience, but this was very unlikely to happen consistently. "With their virtues and properties (real or imagined) plants were, to an extent unknown today, in the centre of everyone's life" (Rydén, 1978). "Town and country dweller alike knew the names of herbs and flowers used in cookery, household remedies and gardens" (Boas Hall, quoted in Rydén, 1978). Although correspondence between Shakespearean plant names and their Linnaean counterparts may sometimes be in doubt, there is no doubt that "Each plant would 'speak' to Shakespeare's audience" (Thomas and Faircloth, 2014). "Shakespeare's botanical references are not mere literary devices; they take us to the very heart of social life in Elizabethan and Jacobean England" (Willes, 2015). We can reasonably assume that most of his audience recognized several dozen plant names and their contextual allusions in the plays and sonnets.

Remember also that Shakespeare's London (the growing urban center, plus neighboring villages later subsumed into greater London), although rapidly expanding, was about 200,000 inhabitants at the end of the 16th century (Porter, 2009). He or any other inhabitant could walk out of densely populated neighborhoods into the countryside (or if equipped with horse or carriage, ride out even more quickly) and no doubt a high proportion of Londoners often did: "Nature was close at hand for any Londoner with eyes to see" (Tuan, 1978). They, far more often than modern city dwellers, became familiar with the plants, livestock, and wildlife of the countryside even if these persons had not originated from rural areas. Moreover, those who were literate were exposed to an increasing array of cheap, printed herbals and agronomic tracts (Dugan, 2015). Also, with the National Health Service being non-existent in those days, most people in London or elsewhere, when ill (or when in need of love charms, spells, etc.), turned to what was known as cunning folk (usually "wise-women" or "herb-wives"), or to the apothecaries to whom the herb-wives sold plants, for plant-based therapies (Allen and Hatfield, 2004; Beith, 1995). Neither countryside nor plants were far away for the common Londoner.

The Bard's Audiences Compared to the Modern Urban Public

Assuming that the hypothesis of high botanical literacy amongst Shakespeare's audiences is well supported by the above arguments, it seems irresistible to compare this situation with that of today's urban populations. Such comparisons are methodologically problematic, given differences in gender, age, and ethnicity between audiences of Shakespeare's time and populations in today's London. And studies addressing the botanical literacy of modern, London populations are, to put it mildly, rare. I've found one: Bebbington (2005). In this study, 812 A-level biology students (essentially the equivalent of high school seniors in the United States), another 92 persons who had graduated from A-level, plus 21 biology teachers, were presented with a color sheet illustrating ten very common British wildflowers (ragwort, cow parsley, foxglove, red campion, germander speedwell, primrose, lesser celandine, common dog violet, common daisy, and greater plantain). Although considerable latitude was given in naming (e.g., any form of "violet" would do for "common dog violet"), no A-level students were able to name eight or more plants, 10% could name none, and 93% could name only four or fewer plants. Recent graduates of A-level, still enrolled in some form of schooling, exhibited slightly greater competence: 3% to 5% could name eight or more plants, but 81% to 91% of graduates could name only four or fewer plants. Biology teachers fared best, with only 5% able to name none, 10% were able to name all ten plants, 34% could name only four or fewer plants, and 38% could name eight or more. (On the online pdf, gray scale with deplorable resolution [okay, we all have our excuses], yours truly, the plant scientist, initially recognized seven: cow parsley, foxglove, campion, primrose, violet, daisy, and plantain.)

How many of these ten plants can be documented as relevant to Shakespeare's audiences? Rydén (1978) does not index ragwort, foxglove, speedwell, or celandine, but has numerous entries for primrose, daisy, and violet; considers cow parsley one of the contenders for "kecksies" along with other umbelliferous plants; ties campion to "Cuckow flower" (probably *Lychnis,* "a much-vexed problem"); and specifies plantain as a medicinal plant in Shakespeare. Rydén's list of Latin (Linnaean) names is much shorter than that for common names, reflecting ambiguities in assignment, and some of the Latin names below are absent in Rydén (1978).

Name assignment, sometimes encompassing Latin names, is collectively more extensive in other relevant sources, but not necessarily more accurate: Of the ten plants, Savage (1923) indexes primrose (*Primula vulgaris*), violet (*Viola odorata*), daisy (*Bellis perennis*) and plantain (*Plantago major*) as occurring in Shakespeare, as did Ellacombe (1884), but with the latter sometimes lacking (or with differing) specific epithets. Cook (1940) provides references (play, act, scene, and line) for primrose, violet, and daisy. Cow parsley, or *Anthriscus sylvestris* (Darbyshire et al., 1999) is probably Shakespeare's "kecksies" (above), used to refer to weedy plants in the Apiaceae in general, and sometimes cow parsley in particular (Thomas and Faircloth, 2014). Ellacombe (1884) and Thiselton Dyer (1884) thought kecksies to be dried stalks of hemlock, but this opinion is discounted by Thomas and Faircloth (2014) on the basis that hemlock is otherwise designated in Shakespeare. The "cucko-flower" in Shakespeare is very likely

the red campion (Elton, 1904), a name applied to various reddish or pink-tinted flowers in *Silene* (*Lychnis*).

Foxglove (*Digitalis purpurea*) is a different case because, "Strangely enough, the foxglove … is not mentioned by Shakespeare"—"strangely" because the plant is striking and was common in Shakespeare's British landscape (Grieve, 1931). It was recorded as used by common folk, topically (as a bath), against fairy changelings (Lamb, 2007), and was in 17th-century London sought by gardeners (Clayton, 2003), so it is highly probable that Shakespearean audiences knew it well. Bebbington's (2005) "germander speedwell" (*Veronica chamaedrys*) is a bit more slippery. Speedwell or "Fluellen" ("members of the Veronicaceae family") seem represented only by the name of a character in Shakespeare, Captain Fluellen (*Henry V* IV.i.), in which the name of the plant seems to indicate the character's status (Thomas and Faircloth, 2014). Lesser celandine (*Ranunculus ficaria*, one of the yellow buttercups) is suggested for one of Shakespeare's somewhat ambiguous references, cuckoo-bud (differing from cuckoo-flower, according to Thomas and Faircloth, 2014). "Cuckoo-buds" are denoted simply as *Ranunculus* in Savage (1923), or what moderns often call buttercups, an opinion seconded by Ellacombe (1878) and Willes (2015). A remaining challenge is "ragwort" (usually *Jacobaea vulgaris,* syn. *Senecio jacobaea*, but sometimes related species), and I could find no direct reference to it in Shakespeare. The poet John Clare, an ardent admirer of Shakespeare, wrote a sonnet, "The Ragwort" (1832), in which "tattered weed of small worth held" (Shakespeare's second sonnet) is presented as "tattered leaves" of Clare's first line. Ragwort was, in the British Isles of the 16th century and later, thought to be used by fairies as a "riding stick" (Simpson, 1995), implying a popular awareness of the plant. "Gerard [the famed herbalist, contemporary with Shakespeare] noted that the ragwort or St. James's wort (*Senecio jacobaea*) was known by country people as 'stagger-wort'" (Drury, 1985).

So, Shakespeare very probably alluded to eight of Bebbington's (2005) ten plants (cow parsley, campion, speedwell, primrose, celandine, violet, daisy, plantain; or their closest relatives, very similar in appearance and perhaps indistinguishable at the time), and the other two (ragwort, foxglove) are clearly indicated as common in Shakespeare's day, and were embedded in folklore. All ten plants are further documented in British folklore (Vickery, 2010). It must be remembered that there were no folklorists *per se* in Shakespeare's day. Folklore was collected and published by folklorists much later (Artese, 2015). Shakespeare himself "was the first great folklorist who went to the very source of the learning of the folk.… He was a conscientious collector who did not invent, but saw the inherent beauty of the popular mythology, and then presented it to the world" (Wheatley, 1916). The most reasonable assumption, given evidence above for widespread botanical literacy in Shakespearean London, given that Shakespeare's botanical allusions were intended to be understood by his audience, and given that all these plants are well documented in British rural folklore, is that Shakespeare's audiences and other intelligent people of the general public were familiar with all or most of these ten plants and capable of recognizing them. They would have scored highly on Bebbington's (2005) test, certainly better than the modern A-level students and A-level graduates (the overwhelming majority of whom could name only four or fewer of the ten common wild flowers), perhaps better than Bebbington's biology teachers (more than a third of whom could name only four or fewer). And probably better than me (at only seven)!

The most plausible conclusion is that by comparison with Shakespeare's day, botanical literacy of the general populace has gone downhill in modern London, and by extension, other urban environments. Given the proximity of Shakespearean audiences to nature, and the lack of such proximity in modern urban populations, this isn't a shocking conclusion. Common sense dictates that rural populations will, collectively, have a more extensive knowledge of nature than urban populations, and you can take your pick of academic studies that support this conclusion. For example: Among 507 modern German adolescents, urban settings and preferences had a negative correlation with knowledge of trees and herbs relative to settings and preferences closer to nature (Lückmann and Menzel, 2014). In general, urbanization results in lower population exposure to natural biodiversity (Turner et al., 2004). These processes have bearing on a current, much discussed perspective regarding botanical literacy, "plant blindness."

Plant Blindness

First introduced as a pedagogical term in education (Wandersee and Schussler, 1998), the term "plant blindness" soon evolved to a theory (Wandersee and Schussler, 2001). Essentially, it's held that current learning about organisms is zoocentric, resulting in diminished knowledge about plants relative to knowledge about animals (Hershey, 2002; Strgar, 2007; Schussler and Olzak, 2008), although there may be deeper explanations: "Instead of invoking zoological biases as the root cause, there may well be a visual-cognitive-societal basis for why plants … are frequently ignored or undervalued" (Wandersee and Schussler, 2001). But whether by conspiracy, design, or social evolution, it's usually held that animals are more engaging than plants.

A variety of strategies including online learning, plant-based learning modules and laboratory exercises (Fig. 2) have been designed to counteract plant blindness (Hemingway et al., 2011; Uno, 2009). The idea is that somehow, there must be a way that teachers can make fir trees or pampas grass as exciting as baby pandas. For example, an intensive survey of 1299 Viennese secondary students (grades 5-12) strongly indicated that medicinal plants and "stimulant herbal drugs" (sage and belladonna are later specified, but one can guess about some others) are of greater interest than ornamental or edible plants (Pany, 2014). To successfully build on the children's interest, plants in the first two categories should be emphasized for teaching: "No time should be wasted on plants considered as uninteresting" (Pany, 2014). This is not great news for agronomists wanting to reach out to young urban students, but it probably accurately reflects views of city kids. Unsurprisingly, the most consistent interest across grades was in stimulants, a somewhat problematic teaching vehicle.

Figure 2. *Students, well-recovered from plant blindness, inspect one of their chlorophyllous friends (from Washington State University Department of Plant Pathology, http://plantpath.wsu.edu).*

There are also studies of children's knowledge of animals (e.g., Balmford et al., 2002; Genovart et al., 2013; Westervelt, 1984). Moreover, historical folklore collected in broad or restricted locales at specified dates can be examined for ethnozoological or ethnobotanical relevance. But comparisons with contemporary knowledge about animals seem even more fraught with difficulty than the comparison above. I know of no published source enabling comparison of historical ethnozoological knowledge with that of contemporary knowledge in a specific locale, analogous to use of Shakespeare in making comparison to Bebbington (2005). Based on experience, I assert that urban children are more likely to have diminished knowledge of animals (as well as plants) relative to children who have grown up experiencing the zoobiota of farms, fields, and forests, an assertion commensurate with Lückmann and Menzel (2014) and Turner et al. (2004). Accordingly, a very legitimate hypothesis is that separation from nature and agriculture—"nature deficit disorder" (Louv, 2008)—is the factor primarily responsible for plant blindness. Unsurprisingly, the connection between nature deficit disorder and plant blindness is explored in education literature (e.g., Frisch et al., 2010).

Electronic Media

The closest most kids get to genuine enthusiasm for botany is the video game *Plants vs. Zombies* (Popcap Games, Seattle). (If you don't know what this is, kids will think you're mentally deficient.) You may have noticed that despite the attraction of children to video games, there is virtually *no* deployment of analogously colorful, fast-paced, interactive gaming for legitimate learning in chemistry, biology, history, etc. Admittedly, there are a few tentative steps, e.g., Klopfer et al. (2012), on a game with cartoon characters and competition for understanding weather data, or see Sadler et al. (2013) on a "game-based curriculum" in high school biology. Typical is Herrero et al. (2014), who advance claims that playing the commercial videogame *Spore* (Electronic Arts, Redwood City, California) promotes understanding of biological evolution.

It is conceivable that video games could, instead of constituting a distraction from nature, actually teach serious botany. Xylem transport could be illustrated in a manner similar to our own innards in *Fantastic Voyage* (1966), but of course faster-paced. Sort of like Harvard University's and XVIVO's *Inner Life of the Cell* series, (e.g., 2006 www.xvivo.net/animation/the-inner-life-of-the-cell/; 2013 www.xvivo.net/animation/harvard-protein-packing/) but with elements of competition. Of course, there has to be funding. And something in the game has to explode. If this can be done, there is a chance that significant numbers of the younger set will voluntarily use technology to actually look at *living* plants. Some might even want to become botanists.

Conclusions

The disconnect between modern urban life and nature (including agriculture) seems ubiquitous and persistent, resulting not only in "plant blindness" but in a broader "nature deficit disorder." The inability of a contemporary urban population to recognize common wildflowers familiar to a much earlier urban population of the same locale is a symptom of this disconnect, as is the gap between rural and urban populations in familiarity with products of nature. Thus far, electronic media beloved of urban youth represent a distraction from nature, but also represent a potential venue to restore interest in the world of nature and agriculture.

Acknowledgements

The author thanks Lori Carris and Sian Ritchie for constructive harassment on the manuscript.

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USA Science & Engineering Festival: "Plants Move, Plants Matter" Booth Draws Thousands of Visitors

This April, BSA joined the U.S. Botanic Garden, the American Society for Plant Biologists, the Donald Danforth Plant Science Center, Society for Economic Botany, and Rutgers University in a large, five-part, 600 square foot "Plant Presence" booth at the USA Science and Engineering festival (USASEF). Over the course of three days, over 365,000 people attended the festival, and thousands stopped by the plants booth to explore hands-on activities and demonstrations around seeds, flowers, roots, stems, and leaves.

The BSA "leaf" part of the booth included a working model of a Venus flytrap with trigger hairs created by Rutgers Mechanical Engineering undergraduate students Adam Burrous and Valeria Saro-Cortes (Figure 1), a leaf adaptation origami game developed by Jennifer Blake Mahmud (Rutgers) and Catrina Adams (Figure 2), and a chloroplast movement "leaf print" demonstration implemented with help from Holly Gorton (St. Mary's College of Maryland) and Terry Woodford Thomas (Donald Danforth Plant Science Center).

Visitors loved seeing our model Venus flytrap and learning more about its sophisticated triggering mechanism, as well as taking a closer look at the live Venus flytrap on display, courtesy of the U.S. Botanic Garden. The origami game was very popular with upper elementary and middle school students, and many teachers took full sets to use in their classrooms. The leaf print and video of chloroplast movement fascinated many by showing a kind of plant movement of which few were aware.

We could not have pulled off the event without help from many D.C. area volunteers. Thanks to Monica Carlsen, Betsy Collins, Greg Perrier, Caroline Puente, Jonathan Singer, and Martha Weiss for your help at the event!

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.

The activities that were developed and piloted at USASEF will be added to U.S. Botanic Garden programming, and the model Venus flytrap will continue to be used at the U.S. Botanic Garden.

Botany Booth in a Box Outreach Competition

We are looking forward to the first BSA outreach competition at this year's Botany Conference in Savannah. We had over 20 submissions and are looking forward to live demonstrations by the semifinalists during the opening reception in the exhibit hall this year. If you will attend this year's annual meeting, please join us to see what outreach activities your colleagues have developed, and cast your votes for this year's winners!

PlantingScience Seeking 100 New Mentors for Fall 2016 as Improved Website Launched

PlantingScience, our online science mentoring program, is looking for 100 new scientist mentors to join the program to work with middle- and high-school students on student-designed projects around eight themes in plant biology, from seed germination to Arabidopsis genetics. We are in the process of launching a new and improved PlantingScience website, http://dig.plantingscience.org, which has a much bigger capacity to serve more teachers and students each year.

We are very excited to finally be growing our capacity to help more students, but it means that we now have an increased demand for scientist mentors to work with those students.

Figure 1. *Rutgers mechanical engineering undergraduate student Adam Burrous shows visitors how trigger hairs work using the working Venus flytrap model that he and Valeria Saro-Cortes built as their senior capstone project*

Mentoring a team or two takes only about an hour a week, can be done from anywhere with an internet connection, and is a great way to connect with middle- and high-school students to share your passion for plants and science. If you have not mentored before, please consider giving it a try this fall. If you have been mentoring already, please share this opportunity with your colleagues! Sign up to be notified when registration opens on the new website at: https://dig.plantingscience.org/community/joinplantingscience/becomeamentor.

For graduate students and post-docs, we also offer an opportunity to serve as a Master Plant Science Team (MPST) member. Members of this team serve in enhanced roles, both mentoring and serving as liaisons between a teacher and his or her other mentors. In exchange for a larger role, we offer MPST members a free BSA membership and 50% off meeting registration for the following year. The deadline for MPST applications is August 8, 2016.

Digging Deeper Together: Collaborative Teacher/Scientist Professional Development Launches this Summer

We are looking forward to two exciting weeks of professional development this summer in Colorado Springs, CO. As part of a collaborative NSF grant, we are bringing together 34 high-school teachers and 20 early-career scientist "PlantingScience Fellows" to work collaboratively over the summer and into the fall to improve students' PlantingScience projects and the way students think about photosynthesis, plants, and science and what it means to be a plant scientist. This team will be working closely together during the fall PlantingScience session, co-mentoring students through their PlantingScience projects.

Congratulations to this year's PlantingScience Fellows: Steven Callen, Julia Chapman, Kevin Dorn, Chloe Drummond, Kate Eisen, Kate Eisen, Nathanial Frein, Ben Gahagen, Julie Herman, Kevyn Juneau, Kelly Ksiazek, Jacob Landis, Jesse Mayer, Alex Pilote, Jerald Pinson, Devesh Shukla, Andries Temme, Amanda Tracey, Erika Valek, Catherine Vrentas, and Martha Zwonitzer. Thanks also to scientist mentor leaders Susan Bush and Eric Jones, and teacher leaders Kim Parfitt and Kara Butterworth.

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http://botanyconference.org/

An exciting number of education, outreach and training offerings for you to consider:

Workshops on:

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Symposium "The Importance of Communicating Science"

Professional Development workshops for students:

- Botanical Career Panel
- Applying to Graduate School: Tips for Success
- We are All Plumbers Now: Toolboxes for Building Unconventional STEM Career Pipelines

Don't miss the Teaching Section presentations and posters, and the PlantingScience mixer.
Check the website for updates and schedule.

STUDENT SECTION

Getting the Most out of BOTANY 2016: A Guide for Students

The BOTANY conference is quickly approaching! With 6 days of lectures, field trips, workshops, socials, and more, where does one start and how can you get the most out of your experience? Check out our tips and links below for some ideas!

*By **Angela McDonnell and Becky Povilus**, BSA Student Representatives*

Travel and Lodging

Travel Grants. Although it is too late to apply for this year, you can take advantage of the many travel grants next year. Keep these on your radar next spring! You can find them online at http://www.botany.org, then click Awards, scroll to Travel awards for students, then 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 meeting.
- **Triarch Botanical Images Awards** provide acknowledgement and travel support to BSA meetings for outstanding student work in the area of creating botanical digital images.
- **Section Awards** are worth checking out. 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

Find a Roommate. Split your hotel costs by sharing a room with a roommate! Take advantage of the 2016 BOTANY Housing Partner Finder: http://images.botany.org/roommate.shtml. Besides saving you $$$, it can be a great way to connect with your peers and make new friends and contacts.

Volunteer at the Conference. Did you know that you can earn back your early registration fee by volunteering your time at the conference? The conference couldn't happen without the help of students to run the registration booth, help at ticket events, and make sure that sessions run smoothly. These opportunities are limited each year and are actually unavailable for BOTANY 2016, but keep this in mind next spring for next year's conference!

Highlights for Students

Workshops: There are so many to choose from! Two are specifically aimed at students:

- **"Applying to Graduate School: Tips for Success,"** led by Anna Monfils, is a panel discussion designed to introduce undergraduate students to the specific requirements for applying to graduate programs in plant biology. *(Free)*
- **"Crafting an Effective Elevator Speech and Communicating Broader Impacts of your Work,"** led by your friendly neighborhood BSA student reps. The workshop features tips from Doug Soltis, and time with your peers to help you create an elevator speech of your own, just in time for use during the conference. *($10)*

Student Luncheon: A Focus on Careers in Botany. What can you do with a degree in botany? Come find out at the Student Luncheon! Pam Diggle will speak about publishing, and then you'll get a chance to talk to representatives from various career paths in a "speed-dating" format. You'll even get a delicious catered lunch! *($5)*

Botanical Career Panel. Organized by Susan Pell from the US Botanic Garden, this panel will be held Monday afternoon and includes professionals with botanical degrees who will discuss their professional experiences and answer participants' questions. The moderator will facilitate an open discussion designed to address opportunities in the post-undergraduate and post-graduate job markets. (*Free*)

Poster Session. Whether you are presenting your own work or just there to see what 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 August 1 and 2. Be sure to check out a detailed schedule on the web at http://2016.botanyconference.org/engine/search/ or via the Botany Conference App, which will be available soon! *(Free)*

Celebrating 10 years of BSA Student Reps: Come Meet your Reps! Time flies—it's already been 10 years since the first BSA student reps were appointed as board members to help the Society meet the needs of student members. Come meet the past and present reps, and learn about what we do for the society… and why you might want to become one! We'll be meeting 1 hour before the Student Social and Networking Event (see below), at the Moon River Brewing Company, which is walking distance from the conference center at 21 W Bay St, Savannah, GA 31401. (*Free*)

Student Social and Networking Event. A favorite event for many! This year we'll be at the Moon River Brewing Company… reportedly one of the most haunted buildings in Savannah! Come catch up with old friends and meet new ones while enjoying craft brews, munchies, and a gorgeous beer garden. It's easy to add a ticket for this event (which includes a drink ticket!) to your conference registration: Find a link to register for the conference at 2016.botanyconference.org, and click "Modify Registration." A special thanks to our sponsor,

International Journal of Plant Sciences, for making this event possible! *($5)*

Field trips. Savannah has a rich history and diverse local ecosystems, and you can explore it first-hand with local experts! This year, 11 different field trips are being offered; you can choose from tours of history sites, kayak trips, and hiking trails that showcase the flora and fauna. Also be sure to check out the Botany in Action trip—you can help give a beloved urban park some TLC! *(cost varies by field trip)*

A special note about field trips and student members of the BSA Systematics Section: Did you know that ASPT and/or BSA Systematics Section members are eligible for field trip grants? Send Jim Cohen an e-mail message (jcohen@kettering.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 on the web at botanyconference.org, and click "Modify Registration."

The BOTANY Conference App!

Schedule Planner. With so much going on during the conference, planning your days can be a challenge. The online BOTANY Conference App lets you browse talks and events and then add the ones you want to a schedule that you can check online, so you can stay on track. BSA members can download the app at https://dl.doubledutch.me/download.aspx?appId=a9832a5e-fd6a-4fee-9c76-fde1f8e41ba3&region=us.

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 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! Use the #BOTANY2016 hashtag when discussing the conference!

ANNOUNCEMENTS

Linnean Society of London Meeting at the Arnold Arboretum

On May 6-8, 2016, 60 Fellows of the Linnean Society met at the Arnold Arboretum for a historic meeting of the Linnean Society—the first in North America since its founding in 1788. Ned Friedman, Director of the Arboretum, together with Linnean Society Past-President Dianne Edwards, planned the meeting as an opportunity for American members to participate in a "Burlington House" type of meeting with scientific papers and an induction of new Fellows (who ordinarily must travel to the annual Anniversary Meeting in London to formalize their election by signing the Fellows roll).

The botany was well represented with papers presented by: BSA Corresponding Member Diane Edwards, Ned Friedman, Robin Hopkins, Sandy Knapp, Jan Salick, Dennis Stevenson, and Marsh Sundberg. Other Fellows in attendance, with BSA connections, included: Peter Crane, Pamela Diggle, Vicki Funk, Cynthia Jones, Ed Schneider, Lena Struwe, Barry Tomlinson, and Joe Williams.

BSA Member Erika Edwards Receives Presidential Early Career Award

Erika Edwards, associate professor of ecology and evolutionary biology at Brown University, was awarded the Presidential Early Career Award for Scientists and Engineers. Edwards was among 105 honorees who received this, the U.S. government's highest award for engineers and scientists in the early stages of their independent research careers, at the White House in May.

The National Science Foundation nominated Dr. Edwards for her "innovative research

President Barack Obama greets Erika Edwards at the White House.

leading to exciting breakthroughs in understanding the drivers of plant evolutionary innovation, and particularly the evolution of plant form and photosynthesis systems, and for engaging public outreach on plant biology."

"What makes this so special for me is that we do not work on human health, or medicine... we are not engineers; we are botanists," Edwards said in a press release from Brown University. "My lab is an evolutionary biology lab, and our primary focus is on understanding how different plant species are related to one another, and how they have adapted to climate change and the emergence of new environments over deep evolutionary time. It is wonderful to have this type of science recognized as important for humanity and relevant to our current challenges. We have a lot to learn from history, and that certainly includes natural history - nature is full of inspiring and elegant solutions to big problems."

Marshall Sundberg Named 2016 Roe R. Cross Distinguished Professor

Long-time BSA member Marshall Sundberg was named the 2016 Roe R. Cross Distinguished Professor at Emporia State University. This award, established in 1979 to honor the ESU professor who "best demonstrates teaching excellence, professional activities, fostering of intellectual atmosphere, service to the university outside the classroom and status as a student mentor" is the highest teaching award given by the University.

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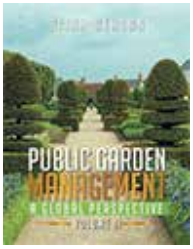
BOOK REVIEWS

Economic



Public Garden Management: A Global Perspective, Vols. 1 and 2
Bijan Dehagan
2014.
ISBN-13: 978-1-4931-6178-2 (Vol. 1); 978-1-4931-6181-2 (Vol. 2)
Vol. 1: Paperback, US$148.99. 396 pp.
Vol. 2: Paperback, US$162.99. 442 pp.
Xlibris LLC, Bloomington, Indiana, USA

These two volumes are a beautiful compilation of pictures with accompanying explanatory text. They would be a wonderful addition to anyone's personal library and can serve as a "go-to" when one needs quick information about a certain type of garden. Figures (with their captions) are grouped together at the end of each chapter. The pictures are excellent depictions of different gardens around the world and show the many ways in which these gardens serve the public. Images capture the particular concept being discussed in each chapter and provide a supportive visual explanation. The books exemplifies the saying, "A picture is worth a thousand words."

The author, Bijan Dehgan, is well traveled and the pictures—most of which are taken by him—attest to this. The captions are quite detailed and add to the information already provided in the text. It is akin to sitting through a presentation, with the captions providing the reader with the descriptions that the presenter would provide with each slide. It is meant to serve as a garden design textbook but is also suitable for real estate developers, home owners, and others who are interested in making our urban environment a pleasant place for humans to interact with nature in close proximity with the different urban structures that are an integral part of human societies. It would be interesting to see how this book might contribute to gardens in the future as technology and social media connectivity continue to increase in importance.

Chapters 1 and 2 are good introductory chapters. Chapter 1, titled "Why Do We Need Public Gardens?," is a perfect beginning to this two-part series on public garden management. This chapter is very well written, with a variety of quotes from religious and fictional books

from different time periods and in different languages. The chapter covers the evolution of human society, industrialization, urbanization, and the physical and psychological benefits derived from public gardens. The chapter refers to gardens as "living museums" and concludes by promising to discuss the position of public gardens in cultural, educational, and research institutions across the globe. Chapter 2, "Public Gardens and Their Functions," introduces us to the different types of gardens and their definitions. Chapter 3 provides a historical overview that takes the reader back in time through ancient Egypt, the Persian "Paradisio," the garden of Aristotle's Lyceum, Oriental gardens and their cultural significance, monastic and physic gardens including details of medicinal plant collections in India, and then moves on to cover the extensive history of European gardens. The pictures accompanying this chapter present the evolution of gardens, garden design, and their significance in human culture.

Chapters 4A through 4G get into the details of garden development and design, including detailed landscaping plans and pictures of gardens illustrating different landscaping elements and garden design. Designs and pictures of formal and informal gardens, Asian gardens and the inclusion of bonsai, layouts of flower and butterfly gardens, rock gardens, historical and present-day rose gardens, and water gardens and the intricacies involved in designing them are all described in detail and illustrated with examples from all over the world. Lastly, the inclusion of children's gardens—featuring learning activities, planting of vegetables and flowers, and natural playground equipment—adds an interesting dimension to the purpose of gardens in our society. All gardens involve plant collections from different regions, and the chapter on "Plant Collecting Expedition and Herbarium" describes historical perspectives on this process, including expeditions, famous collectors, and data sheets used for recording location details for collections. This, the final chapter in Volume 1, also addresses the importance of herbarium collections and the relevance of ethnobotany in today's world.

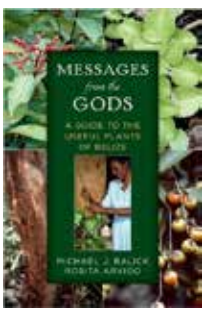
Volume 2 moves from the plant collection expeditions and building of herbarium collections to the development of *in situ* preservation such as conservatories and greenhouses. In this chapter, the pages with pictures outnumber those with text, and feature botanical gardens around the world, the University of Vienna greenhouses, the Phipps conservatory collections, and the United States National Conservatory, along with many other global conservatories. Chapter 7 discusses the inclusion of plants in zoological gardens and the ecological and horticultural issues concerning zoos. It is stated very explicitly that this chapter is not about animals, their importance, or zoo management, but specific aspects of "codependence of plants and animals" are discussed. The chapter on art in gardens elaborates on the inclusion of structures, sculptures, and other forms of art related to plants in gardens. Chapter 9 discusses the importance of interpretive signs in public gardens, especially as a source of learning activities. Examples of well-designed information panels allow the reader to appreciate their importance.

Beginning with an apt proverb, "Man strides over the earth and deserts follow in his footsteps," in Chapter 10 the author describes the important role public gardens play in conservation. The chapter defines biodiversity and elaborates on a case study of cycad conservation. It also includes some details of the Endangered Species Act and different conservation organizations. Chapter

11 discusses people-plant interactions in gardens, focusing on the importance of garden elements and design that work with humans and potentially serve as a psychosocial route to better mental and physical health. The chapter on turf grass in public gardens is a text by Professor Laurie Trenholm adapted to this book. The writing in this chapter is much more technical in comparison with the rest of the book; the chapter addresses some of the concerns of the expanding turf grass acreage in the United States. The last two chapters touch upon two important issues—funding for maintaining public gardens and career opportunities in public gardens. The epilogue describes clearly the purpose of the chapters in these two volumes, which is mainly to provide background information to assist in the creation of new and ingenious landscape designs for public enjoyment. These two volumes will make an excellent addition to library collections and would also be useful as coffee table books in academic departments dealing with landscape architecture.

–H. S. Arathi, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, Colorado, USA

Messages from the Gods: A Guide to the Useful Plants of Belize

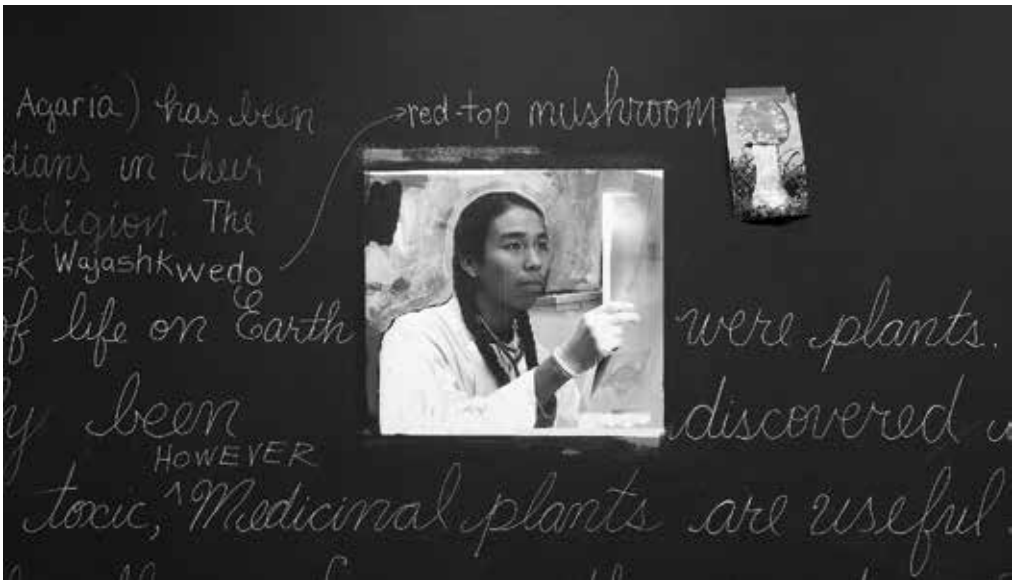


Michael J. Balick and Rosita Arvigo
2015.
ISBN-13: 978-0-19-996576-2
Paperback, US$49.99. 560 pp.
Oxford University Press (New York, New York, USA) and New York Botanical Garden (Bronx, New York, USA)

This book provides (in three chapters) a brief overview of Belizean ethnobotany, together with a 421-page account of the Belizean flora as it is used for food and medicine. My interest in this book arose from making it the basis for a lecture in an ethnobotany course, but its real value will lie in its usefulness for anyone traveling in Belize, or working with specimens from that country, who is also interested in ethnobotany, traditional healing, or drug discovery.

For pedagogical purposes, the book, like Belize itself, is especially valuable because of the light it sheds on the relationship between people and the plants they find around them where they live and work. Belize is particularly important in this regard because of the way its geography and history have conspired to make it a more or less politically stable enclave, within which more than one culture has found room to exist and interact peacefully with others. The authors refer to a population of 333,000 that comprises Maya, Afro-Creole, Garifuna, South Asian, Chinese, Lebanese, European, and mestizo, and write that a "… purist would only find disappointment in searching for 'true' Maya healing among today's practitioners." Instead, they describe at some length the process by which the discovery of the therapeutic properties of plants is still taking place. For example, they describe how, when in 1988 the first patients with HIV/AIDS returned to Belize for care by their families, Belizean traditional healers had little to offer them. Ten years later, the scene had changed, and healers were using treatments made from local plants to relieve the symptoms of these patients.

After describing the origins, objectives, and methodology of the Belize Ethnobotany Project, the authors go on to provide a knowledgeable discussion of different aspects of Belizean ethnobotany, including a description of how forest conversion and habitat loss have reduced the availability of many plant species, making it necessary for



The central portion of the right panel of "Potato Peeling 101 to Ethnobotany 101" by Jane Ash Poitras shows a First Nations youth doing the science that explains an aspect of their traditional knowledge. Installed in the Daphne Cockwell Gallery of Canada: First Peoples, of the Royal Ontario Museum. Courtesy of the Royal Ontario Museum, photo credit Brian Boyle.

healers to go further and further to reach sites at which they can still collect the plants they use. This second chapter also includes a profile of the Mayan healer Don Eligio Panti, who was the teacher of Rosita Arvigo. It was her interest in documenting Don Eligio's knowledge that led her to collaborate with Michael Balick, and this, in turn, led to the larger Belize Ethnobotany Project. In the third chapter, the authors present 11 more healers, representing different backgrounds, traditions, and practices. They then provide edited transcripts of conversations with eight of these healers that let the reader see, in their words, the different ways in which they understand their work.

The account of the useful plants in the Belizean flora in the fourth chapter is arranged taxonomically in four sections (ferns and fern allies, gymnosperms, monocotyledons, and dicotyledons), following the arrangement of the earlier checklist of the flora (Balick et al., 2000). Flowering plant family alignments follow Angiosperm Phylogeny Group III. Families, genera, and species are arranged alphabetically. The authors attempt to provide at least one illustration (most of which are excellent color photographs) for each genus. Species treatments vary in length, according to the number of uses listed. Under each species, the lead for each ailment or other use is set boldface, making it easy for the reader to see the variety of uses and range of detail available. References to voucher specimens and to the relevant literature are provided. What I did not find was a consistent indication of which species are introduced in Belize. Some are obvious, like the food plants introduced by Europeans (e.g., breadfruit, coconut, rice). This is too bad, as it would be interesting to see the extent to which healers have taken advantage of cosmopolitan weeds and other introduced species. Evidently, the interest is there, as one healer, the late Percival Hezekiah Reynolds, asked Balick for dandelion seeds.

The remaining two chapters are found online, together with three appendices, at the publisher's website (http://global.oup.com/us/companion.websites/9780199965762/). Chapter 5, by Robert Heinzman and Conrad Reining, with Michael J. Balick, describes the timber and non-timber forest products of Belize in historical, statistical, and economic, as well as botanical detail. Chapter 6, by Gordon M. Cragg and David J. Newman, is a report on Belizean plants evaluated by the U.S. National Cancer Institute as part of its approach to the discovery and development of new drugs for the treatment of cancer and AIDS. This chapter concludes with its authors' reflection on the HIV and anti-tumor assay results. Only a small fraction of the species documented showed appreciable anti-tumor activity, and only one species was shown to contain compounds (guttiferones) with known anti-HIV activity. The authors note the difficulty of inferring therapeutic potential from ethnobotanical data when the diseases in question, like cancer and HIV, are generally outside the diagnostic and therapeutic experience of traditional healers.

The book concludes with a literature cited section and a 21-page index in fine print. Overall, it is a wonderfully balanced work that respects the healers and others who shared their knowledge with the authors and, at the same time, respects the scientific traditions in which the authors operate, one as an ethnobotanist and the other as a naprapathic practitioner. This is important, because we should recognize that the reason why the authors attach so much importance to the role of their book in helping Belizeans preserve their traditional knowledge is that, when Belize is able to provide adequate modern health care to all of its citizens, their dependence on traditional therapies is likely to diminish. This is as it should be, because so many illnesses have their origins in interactions with bacteria, viruses, and parasites, or in pathologies resulting from accumulated genetic mistakes or environmental insults, all of which are best understood in a scientific context. North Americans and Europeans, the majority of whom have ready access to sophisticated medical interventions, forget this at their peril—witness the needless recent death of the child whose parents chose to treat his meningitis only with herbal remedies.

–T. A. Dickinson, Senior Curator Emeritus, ROM Green Plant Herbarium (TRT), Department of Natural History, Royal Ontario Museum, Toronto, Ontario, Canada

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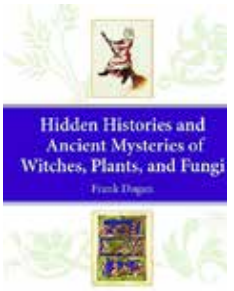
Balick, M. J., M. H. Nee, and D. E. Atha. 2000. Checklist of the vascular plants of Belize, with common names and uses. *Memoirs of the New York Botanical Garden* 85: 1–246.

HISTORICAL

Hidden Histories and Ancient Mysteries of Witches, Plants, and Fungi



Frank Dugan
2015.
ISBN-13: 978-0-89054-465-5
Paperback, US$69.95. 180 pp.
APS Press, St. Paul, Minnesota, USA

The précis to Mr. Frank Dugan's recent book—*Hidden Histories and Ancient Mysteries of Witches, Plants, and Fungi*—describes "convergent new findings" and "congruent datasets" as the impetus for a revisionist view of both crop-pathogen and plant-human interactions in European history and prehistory. It is, of course, common practice for scholars to revise their views when confronted with new evidence. What makes Mr. Dugan's approach unique, however, is that his writing is at once a revision of our understanding of crop plant migration; an intriguing introduction to the relationship between folklore, fakelore, and literacy; and a finely woven tapestry of source material that spans the fields of archaeology, linguistics, agricultural science, and cultural geography. His writing is concise and yet his view is expansive, making *Hidden Histories* a valuable reference for both the expert in and the student of agricultural history.

Despite a bibliography of nearly 700 sources, *Hidden Histories* is a small book that uses a narrative approach to outline a rigorously investigated and sound intellectual framework. The author has cleverly organized the material around broad and encompassing themes: the spread of crop plants and fungal pathogens; the exchange of ethnobotanical information between oral and literate sources; the impact of New World plants on Old World folklore; the transformation of traditional knowledge following land use change and the commercialization of plant materials; and new forms of pagan customs originally intended to protect crops and livestock. Each chapter can be read on its own as a lengthy review. Together, they represent an example of the rare kind of multidisciplinary scholarship that seeks to unify rather than divide.

In the opening chapter, which references the title of a work by Hesiod—Shadows of *Works and Days*—Mr. Dugan demonstrates his scientific expertise as he considers molecular-genetic evidence that alters our previous understanding of crop-pathogen interactions, the timing of crop plant introductions, and the impact of these on the health and habits of the European rural poor. Linguistic evidence also plays a large role in the author's analysis. We are convincingly shown that weather and existing pathogens repeatedly led to famine in medieval and premodern Europe as scald and rusts moved between domesticated and wild plants. We learn of the migration of legumes and their importance, along with pathogen-resistance vetches, as alternate forms of sustenance. Foraging for wild plants and fungi is described as a necessity during "need years." The complexity of securing adequate nourishment in premodern times is contextualized by being placed alongside the early plant science to which the experience of scarcity gave rise.

Subsequent chapters continue tracing the role of women as the primary foragers and keepers of orally transmitted plant knowledge. The tired, albeit revealing, contrast between oral and literate societies, folklore and ethnobotany, herbalism and patented medicine is present in Mr. Dugan's writing but is thankfully downplayed. Instead, the author seems to favor a view that suggests that one form of

social interaction and knowledge transfer was necessarily eclipsed by another as writing became the dominant form of communication among those interested in plant lore. A novel part of his analysis is the effect of enclosure of the commons on rural, especially female, interactions with wild plants. The impact of "women … sundered from wild and common spaces" is visible today as a nearly complete loss of intergenerational knowledge of mushrooms. Folkways of information transfer are interpreted as important sources of ethnobotanical knowledge when they can be juxtaposed with other evidence and as fakelore, or invented traditions, when they cannot. Mr. Dugan is quick to remind us, however, that fakelore often contains accurate information about plant uses and should not be entirely discounted as its own avenue worthy of study.

Despite the book's emphasis on traditional knowledge, the reader who is seeking information on the "ancient mysteries of witches" mentioned in the title might be disappointed. Gone are the days when women who gather and work with plant materials are given the moniker "witch." As *Hidden Histories* demonstrates, the revival of interest in such topics as Wicca and the occult can mask a more practical and durable synthesis that is taking place: that between scientific and popular approaches to botanical knowledge. The uncommon and eclectic illustrations provided by Mr. Dugan support the view that plants and human culture are inextricably joined and the evolution of one is not entirely distinct from the development of the other. One travels across time and space and back again while reading this intriguing review, and despite the fact that one's journey is organized more by theme than chronology, the end result is invigorating rather than disorienting. A trail of open doors remains.

–Andrea Kornbluh, Department of Biological Science, Rowan University, Glassboro, New Jersey, USA; kornbluh@rowan.edu

SYSTEMATICS

Keys to Lichens of North America
Irwin M. Brodo
2016.
ISBN-13: 978-0-300-19573-6
Paperback, US$29.95. 424 pp.
Yale University Press, New Haven, Connecticut, USA

Surely lichens are an underappreciated life form, often overlooked as just growths on tree trunks. These symbiotic organisms composed of a fungus and alga have been shown to be able to decompose rock, given enough time. They also are capable of surviving in very inhospitable conditions while also being useful in determining air quality. Lichenologist Dr. Irwin Brodo has championed this often-ignored but ecologically significant group of organisms, particularly in the 2001 book *Lichens of North America* (LNA). Now lichen enthusiasts and general naturalists have an accompanying key to identification.

Brodo indicates in the preface that this volume came about at the request of many readers of the LNA book who indicated a need for a spiral-bound, no-extras guide that could incorporate the identification keys from the original book. Certainly this volume seems like a great addition to a herbarium, classroom, or lab. It lies completely flat and contains a huge amount of information at one's fingertips. However it seems unsuitable for excessive use in the field, as the cover is paper and the interior stock rather flimsy. This must be a concession to the expense of printing such an extensive work for an admittedly narrow audience. It would not resist tears or moisture well.

The key includes just a few photos in an appendix, but this must be expected in a book

including over 2,000 species, nearly double the species covered in LNA. Brodo mentions there are 4,881 lichen species recognized as of 2014, and the key incredibly covers nearly half of them. There are 10 pages of figures illustrating lichen morphology and concepts necessary for use of the key, a most helpful inclusion even for experienced lichenologists, and certainly vital for students and enthusiasts. The glossary is absolutely essential, as it clarifies terminology used in identification. It's fortunately very clear, and I referred to it constantly.

Keys A through K cover major types of lichen, including fruticose, crustose, squamulose, umbilicate, foliose, jelly lichens, and variations like dwarf fruticose. So, for example, if I know I have a fruticose lichen, in Key A, Fruticose lichens, we find "1. Thallus pale greenish yellow, yellowish green, green, white, gray, brown, olive, or black…6." Following this to 6.(1) and 6., I choose 6.(1) "Thallus pendant or almost pendant," etc. This leads to 7., where I must choose between "Thallus greenish yellow or yellowish green (containing usnic acid in the cortex)" or "Thallus shades of white, gray, brown, olive, or black (lacking usnic acid)." I choose the first, which refers me to 8.

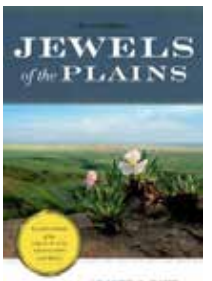
Now I must choose between microscopic characteristics: do the branches contain a tough, single, central cord, or no? In this hypothetical case, I can choose the former, which tells me I have the common *Usnea*, a.k.a. old man's beard lichen. Now I can go further, to the section on *Usnea* species on page 348. Further characteristics, some requiring at least a hand lens to determine, may lead to my particular species.

By using these diagnostic characteristics, and sequence of steps, one should be able to "key out" ideally to species. But lichen, like the fungi and algae that compose them, are not the easiest organisms to identify to species; doing so with certainty may often require microscopic examination of spores or other internal characteristics.

This is a utilitarian book, and should be preceded by study of the LNA. It is intended for use alongside the LNA. This is not a beginner's book, and to avoid frustration, users should at least familiarize themselves with terminology used in morphology, etc. This key not only revises identifications since the publication of LNA, but is a major expansion. Species covered in greater detail in LNA are helpfully in boldface, so one can easily seek further detail. This volume is a fantastic addition to the masterwork of lichens that is *Lichens of North America*.

–Kenneth Setzer, Fairchild Tropical Botanic Garden, Coral Gables, Florida, USA

Jewels of the Plains: Wildflowers of the Great Plains Grasslands and Hills, revised edition



Claude A. Barr, edited by James H. Locklear
2015.
ISBN-13: 978-0-8166-9801-1
Hardcover, US$27.95. 288 pp.
University of Minnesota Press, Minneapolis, Minnesota, USA

According to the dustjacket flap, "Claude A. Barr did not set out to be a writer." This re-released and updated classic work shows that we are all lucky that he became one. Barr (1887–1982) homesteaded 160 acres of land in South Dakota in 1910, which, through a stroke of luck, ended up becoming an acclaimed nursery. Barr became known for cultivating native plants (and developing cultivars) from the Great Plains. His Prairie Gem Ranch operated for four decades, sending plants all over the United States and the world. As

his name grew (thanks to his submission of photos of native plants to various gardening journals), people from around the country began contacting him asking how to grow these wonderful prairie plants. Barr began writing about the plants as well, and here lies the body of this work.

This work was originally published posthumously in 1983 and has since gone out of print. University of Minnesota Press has done everyone who enjoys native wildflowers a great service in updating and re-releasing it. James Locklear (who recently published a work on *Phlox*) has updated all of the nomenclature in the original book and otherwise left the text untouched. Also included are an Introduction, Notes, Glossary, and Bibliography. Locklear has not only updated the species names for each taxon that Barr covered but also included the "old" name so that people who are unfamiliar with the newer names can understand what plant is being described. The over 500 species covered are arranged alphabetically by genus. Each genus has at least one species described, sometimes many more. Barr not only wrote about each plant's physical characteristics, but its distribution, cultivation, and ecology. Here the text really shines. Barr does a fantastic job of describing the plants and writes about them in a way that is not often seen. I will quote a few nice passages:

Referring to *Hypoxis hirsuta:* "…it puts up its miniature reflections of the sun, singly or in clusters, over a long season…"

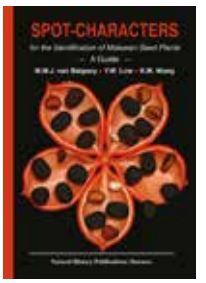
Writing of *Antennaria*: "Many are the low, gray mats of ladies'-tobacco, many the varied leaf forms and patterns in different regions, and many the attitudes of gardeners toward these useful and beautiful subjects in garden design."

Arctostaphylos uva-ursi: "It delights in modeling the irregular surface of rocks with its advancing stems, and there displays at their best, in early spring, its brief clusters of tiny, pendant urns of pink and white. Is there a finer four-season, low shrub to be found?"

I had never heard of this book before now, and I am very grateful that it has been reprinted for younger generations to enjoy.

–John G. Zaborsky, Botany Department, University of Wisconsin–Madison, Madison, Wisconsin, USA; jzaborsky@wisc.edu

Spot-characters for the Identification of Malesian Seed Plants: A Guide



M. M. J. van Balgooy, Y. W. Low, and K. M. Wong
2015.
ISBN-13: 978-983-812-159-0
Paperback, US$29.63. 288 pp.
Natural History Publications (Borneo), Kota Kinabalu, Sabah, Malaysia

Asia is one of the most biodiverse continents, with six megabiodiverse countries— namely China, India, Indonesia, Malaysia, the Philippines, and Papua and New Guinea. Due to the tropical and subtropical climate regimes, Southeast Asia is particularly rich in plant resources, with over 40,000 seed plants known to science; this biodiversity is comparable to the rich plant diversity of the Neotropics (Central and South America) and the Afrotropics (Sub-Saharan Africa). *Spot-characters for the Identification of Malesian Seed Plants* is a spectacular guide book exploring the rich plant diversity of the Malesian region. Malesia represents a phytogeographically rich part of Southeast Asia, comprising the countries Brunei, Indonesia, Malaysia, Papua and New Guinea,

the Philippines, Singapore, and Timor-Leste. It is important to note that four countries within the Malesian region are designated as megabiodiverse countries, suggesting the spectacular floral diversity of the region. This comprehensive, colorful volume lists, discusses, and analyzes 119 spot characters of Malesian seed plants and includes color plates highlighting various identifiable seed plant characters. The authors have painstakingly included every possible taxonomic detail necessary for clearly identifying the local seed plants, and the volume nicely translates their decades of cumulative experiences in seed plant identifications under the challenging field conditions of Southeast Asia.

The plant characters include various growth forms, distinctive vegetative characters (like stem and branch patterns as well as foliar characters such as stipules, petioles, rachis, leaf arrangement or phyllotaxy, leaf forms, shapes, margins, venation, coloration, indument, leaf surface, textures), and reproductive characters (e.g., different forms of floral arrangements or inflorescences, flowering habits, life cycles, forms of flowers, fruits and seeds). Quick field characters such as plant exudates (saps and resins) and characteristic smells that a collector or surveyor would notice during field collections are also included. The authors focus on important diagnostic characters that can be easily detected both in well-preserved herbarium specimens and in newly collected specimens to facilitate quick and comprehensive identification of local seed plants. A number of easily detectable field characters are also included in this unique and comprehensive guide. The authors elegantly explain that the "spot characters" devised by them are not an attempt to replace conventional taxonomic keys, but are simply to assist in the process of identification of plant families, genera, or species for a "specific floristic set."

This volume will be useful for field biologists, professional botanists, ecologists, herbarium curators and conservators, phytogeographers, environmentalists, researchers, academics, and students specializing in the seed plants of Southeast Asia both within and adjacent to the Malesian phytogeographic region. It will also interest amateur botanists and plant enthusiasts, particularly those interested in the seed plants of the vast, biodiverse Indo-Malaya ecozone. I particularly recommend the volume to aspiring taxonomists who wish to learn how to systematically describe a plant in the most comprehensive fashion in the classroom. The numerous colored plates, micrographs, and images—along with the accompanying texts—will enable budding taxonomists to develop expertise on important plant diagnostic characters in the laboratory, as well as while scanning herbarium specimens before formal field exposure.

–Saikat Kumar Basu, University of Lethbridge, Lethbridge, Alberta, Canada

Plant Science Bulletin

Botanical Society Of America

ISSN 0032-0919
Published quarterly by
Botanical Society of America, Inc.
4475 Castleman Avenue
St. Louis, MO 63166-0299

Periodicals postage is paid at
St. Louis, MO & additional
mailing offices.
POSTMASTER:
Send address changes to:
Botanical Society of America
Business Office
P.O. Box 299
St. Louis, MO 63166-0299
bsa-manager@botany.org

The yearly subscription rate
of $15 is included
in the membership
Address Editorial Matters (only) to:
Mackenzie Taylor, Editor
Department of Biology
Creighton University
2500 California Plaza
Omaha, NE 68178
Phone 402-280-2157
psb@botany.org

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Plant Science Bulletin Featured Image

This April, BSA joined the U.S. Botanic Garden, the American Society for Plant Biologists, the Donald Danforth Plant Science Center, Society for Economic Botany, and Rutgers University in a large, five-part, 600 square foot "Plant Presence" booth at the USA Science and Engineering festival (USASEF). Over the course of three days, over 365,000 people attended the festival, and thousands stopped by the plants booth to explore hands-on activities and demonstrations around seeds, flowers, roots, stems, and leaves.

Above, BSA member Monica Carlsen, Research Associate - Center for Plant Conservation at Missouri Botanical Garden, shows a young visitor how to play the a leaf adaptation origami game developed by Jennifer Blake Mahmud (Rutgers) and BSA Education Director Catrina Adams.

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