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THE BOTANICAL SOCIETY OF AMERICA
Leading Scientists
and
Educators
since 1893

BOTANICAL SOCIETY OF AMERICA

How prepared is the U.S. to meet future botanical challenges? This is a question we set out to answer last year when Society members were invited to participate in a survey to determine the Botanical Capacity of the United States. The report is in (p 118) and its recommendations are timely for this issue given the focus of our recent annual meeting in Providence.

At the plenary session Professor Kenneth R. Miller challenged the membership to engage in the attack against science and scientific reasoning , not just the resistance to teaching evolution in our classrooms (p 104). As noted in the article, Professor Miller's PowerPoint presentation is available on the BSA web page.

Bookending the meeting was President Skog's ode to The A.R.O.M.A. of botany (p. 106) presented at the banquet. It is up to us to provide the final "A." - - for Action - - to drive a new "a**SCENT** of Botany" as a scientific discipline. As noted by Skog, this must involve outreach into the schools.

Effectively communicating about plants to school children is the focus of the article by Keppler and Schussler (p. 122). If we are going to have a truely broader impact about plants in the schools, we must collaborate with and apply the principles learned by our professional botanical educator colleagues. Botanists have a tradition of leading science education - - now is the time to follow our leaders.

-the editor

Newest Release of the Plant Ontology Available September 2010

The latest release of the Plant Ontology (PO) will be available at http://plantontology.org by the end of September, 2010. The PO is a structured vocabulary that is designed to facilitate cross-database querying and to foster consistent use of plant terminology in annotations. The main goal of this round of revisions was to create a framework that could accept new terms from all plants, from algae to angiosperms, making it easier to incorporate these terms into future releases.

This release includes an extensive re-organization of the Plant Structure Ontology. New top-level terms were added, new definitions were written for many terms (including all top-level terms), plus the second and third levels of the ontology were extensively re-organized. In addition, some minimal changes have been made to the Plant Growth and Developmental Stage Ontology.

Throughout the revision process, the curators worked to incorporate new advances in ontology design and construction, including the use of logical text and relational definitions and references to external ontologies where appropriate. A more detailed summary of the changes made to the ontology is available at http://wiki.plantontology.org:8080/index.php/Summary_of_changes_to_the_Plant_Ontology.

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P.O. Box 299
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Address Editorial Matters (only) to:
Marshall D. Sundberg, Editor
Dept. Biol. Sci., Emporia State Univ.
1200 Commercial St.
Emporia, KS 66801-5057
Phone 620-341-5605
E-mail: psb@botany.org

News from the Society

News from the Annual Meeting

Awards

Isabel Cookson Award (Paleobotanical Section)
Established in 1976, the Isabel Cookson Award recognizes the best student paper presented in the Paleobotanical Section.

Andrew Leslie of the University of Chicago, is the 2010 award recipient for the paper titled, "*Exploring the Role of Pollen Flotation in the Reproductive Biology of Ancient Gymnosperms*."

Katherine Esau Award (Developmental and Structural Section)
This award was established in 1985 with a gift from Dr. Esau and is augmented by ongoing contributions from Section members. It is given to the graduate student who presents the outstanding paper in developmental and structural botany at the annual meeting.

This year's award goes to **Jessica Budke**, from University of Connecticut, for the paper "*Beneath the Calyptra's Veil: Exploring Cuticle Anatomy during Moss Sporophyte Development*." Co-authors were Bernard Goffinet and Cynthia S. Jones.

Honorable Mention - **Chunmiao Feng**, North Carolina State University, for the paper "*Evolutionary developmental study of inflorescence in* Cornus." Co-authors were Robert G. Franks and Qiu-Yun (Jenny) Xiang.

Maynard Moseley Award (Paleobotanical and Developmental and Structural Sections)
The Maynard F. Moseley Award was established in 1995 to honor a career of dedicated teaching, scholarship, and service to the furtherance of the botanical sciences. Dr. Moseley, known to his students as "Dr. Mo," died Jan. 16, 2003 in Santa Barbara, CA, where he had been a professor since 1949. He was widely recognized for his enthusiasm for and dedication to teaching and his students, as well as for his research using floral and wood anatomy to understand the systematics and evolution of angiosperm taxa, especially waterlilies. (PSB, Spring, 2003). The award is given to the best student paper, presented in either the Paleobotanical or Developmental and Structural sessions, that advances our understanding of plant structure in an evolutionary context.

Natalie Pabon Mora, from the Graduate Center CUNY/ New York Botanical Garden, is the 2010 Moseley Award recipient, for her paper "*The role of* APETALA1/FRUITFULL *genes in non-core eudicots*." Her co-author was Amy Litt.

Emanuel D. Rudolph Award (Historical Section)
The Emanuel D. Rudolph Award is given by the Historical Section of the BSA for the best student presentation/poster of a historical nature at the annual meetings.

This year's award goes to **Philip Marshall**, Yale University, School of Forestry & Environmental Studies, for his presentation: "Pinus strobus *L. and the historical utilization and management* *of southern New England forests, 1600-1938*."

A.J. Sharp Award (Bryological and Lichenological Section)
The A.J. Sharp Award is presented each year by the American Bryological and Lichenological Society and the Bryological and Lichenological Section for the best student presentation. The award, named in honor of the late Jack Sharp, encourages student research on bryophytes and lichens.

This year's A.J. Sharp Award goes to **Juan Carlos Villareal**, University of Connecticut, for his paper "*Thousands of years without sex: The case of the Southern Appalachian* Nothoceros aenigmaticus."

Edgar T. Wherry Award (Pteridological Section and the American Fern Society)
The Edgar T. Wherry Award is given for the best paper presented during the contributed papers session of the Pteridological Section. This award is in honor of Dr. Wherry's many contributions to the floristics and patterns of evolution in ferns.

This year's award goes to **Susan Sprunt**, Miami University of Ohio, for her paper; "*Of genes, scales and venation: Detecting patterns of variation in the* Pleopeltis polypodioides *species complex (Polypodiaceae)*"

Developmental & Structural Section Best Student Poster Award

Hugo Martinez Cabrera, University of Connecticut, for the poster, "*Integration of wood traits and height in trees and shrubs: Many ways to be a shrub, but only one way to be a tree*?" Co-authors: H. Jochen Schenk and Cynthia S. Jones

Ecology Section Award, Best Student Presentation

Amy Davidson, from Kansas State University, for the paper "*Invasive species demonstrate higher phenotypic plasticity but native species have greater resilience to worsening conditions.*" Co-author, Adrienne B. Nicotra.

Ecology Section Award, Best Student Poster
Amy Campbell, of Ohio State University, for her poster, "*Fitness-Related Traits of Cultivated vs. Wild Switchgrass (*Panicum virgatum*): Implications for Widespread Planting of Biofuel Cultivars*." Co-author, Allison Snow.

Southeastern Section - Association of Southeastern Biologists, Asheville, North Carolina, April 9, 2010 Poster/Paper Awards

Best Paper Award $300 - **Chris Stoehrel**, Western Carolina University, Cullowhee, NC - presentation:
"*Phylogeny of the* Trillium erectum *complex*."

Best Poster Award $300 - **Mae Kile**, University of Tennessee at Chattanooga, TN - presentation:
"Scutellaria Montana *(Lamiaceae) 2009 Monitoring at the Volunteer Training Site, Tennessee Army National Guard, Catoosa Co., Georgia*."

Plenary Lecture, Botany 2010 Darwinian Grandeur, Darwininan Conflict: America's Continuing Problem with Evolution.

Kenneth R. Miller.
Professor of Biology, Brown University.

http://www.millerandlevine.com/talks/Botany-2010-KMiller.ppt

Dr. Miller is a cell biologist who focuses his research on cell ultrastructure but who also has become a spokesperson for teaching evolution in the schools. This began with a challenge by a former student, Joe Levine, to write a high school textbook with a strong treatment of evolution. Levine and Miller is now in its third edition. He is also the author of two popular books on evolution in America.

Teaching evolution in America inevitably brings up the image of the Scopes trial, but as Miller pointed out, the outcome suggested by the play and film "Inherit the wind" is incorrect - - creationism won. The real hero of science was a second-year high school teacher in Arkansas, Susan Epperson, who in 1965 sued the state (and won) when the law required that she not teach evolution in her biology class. Miller noted that after meeting her for the first time, he asked for a photo. Later she sent the one illustrated on ppt slide 3, with her and John Scopes after her trial decision.

The result was "scientific creationism" which has now morphed into "intelligent design (ID)." As Miller noted in his earlier afternoon session, the real target in not just evolution, it is science itself. Their goal is to bypass the scientific process itself. Recently this again came to a head as the result of the courage of high school teachers in Dover, PA, who refused to teach intelligent design or to read a statement on intelligent design written by and mandated by their school board. This again led to trial in which Miller was a star witness. By random draw, the judge assigned to the case, John E. Jones III, was a strong conservative recently appointed to the federal bench by George W. Bush. The ID proponents viewed this as a gift from God. Unfortunately for them, it was quickly apparent to the judge and the public that ID is not science. In particular, the scientific evidence presented repudiated all of the "icons" of the ID arguments.

Miller recommended viewing the PBS NOVA special, Judgement Day, for an account of the trial. He also noted, to his chagrin, that although he is an award winning teacher at Brown, his student reputation has nothing to do with the classroom. Rather, he is the professor who was on the Colbert Report - - twice!! Never-the-less, the public remains hostile to evolution because it, and science in general, is portrayed as a threat to the values of America and the underlying cause of ALL of our social problems. For more details, go to the "Answers in Genesis" website and www.whoisyourcreator.com.

Fourteen percent of Americans are literal creationists and they have created a compelling story – "Your have a right to be here."

How can we win the evolution wars? 1. By focusing on the evidence for evolution and 2. By stressing the distinction between science and belief. "We have the fossils"; we have the evidence. We must present the evidence in a clear, factual, and logical way. And we must distinguish between science and belief. Miller points out that he begins his section on evolution with the statement that he DOES NOT BELIEVE IN EVOLUTION! Belief has nothing to do with it. He is satisfied that the available evidence provides overwhelming scientific support for the theory of evolution.

Miller pointed out that most powerful weapon possessed by proponents of ID is religious fear of evolution – that science says humans are merely a mistake of nature. The "mistake," as Miller pointed out, is the misconception that mutations are merely mistakes. Mutation, as an underlying component of evolution by means of natural selection, is "an essential element of nature itself."

What are the lessons for BSA and other scientific societies?

1. Participate - - both educationally and politically. Be involved with your local school board and support your local teachers.

2. Engage, don't lecture. The most effective way to engage with the ID folks is one-on-one. Be conscious of, and avoid, the professorial (egg head) stereotype.

3. Bring science home by explaining how science works in everyday situations.

4. Cultivate allies, especially your local school teachers.

5. Don't assume that your allies must be "liberals" (remember Judge Jones).

6. Know your resources. The National Center for Science Education is a clearing house for help and information and has members in every state.

7. Cultivate the effective communicators in the societies. Two notable examples of scientists "shooting themselves in the foot" are the past negative attitudes of professional societies to the outstanding communicators of science Carl Sagan and Stephen J. Gould.

8. Approach evolution with delight and enthusiasm. "There is grandeur in this view of life…"

-the editor

2010 President-Elect's Address
The *A.R.O.M.A.* of Botany

Judith E. Skog
Department of Environmental Science and Policy
George Mason University, Fairfax, VA 22030

In last year's presidential address, Kent Holsinger noted we needed to do a better job of selling our science and getting the public to understand what we do and why we have enthusiasm for doing it. He stated that a Pew survey indicated that we were doing pretty well in educating students but not so well for the public at large. While this is true, we also have problems in the job we are doing for undergraduate education. Last summer I had just finished a three-year-long effort at the National Science Foundation which examined critically undergraduate education in biology, and all indications are that we are not inspiring our students very well in introductory courses, not providing the rationale for understanding science, nor giving the students the tools to go out and communicate a love of science effectively. So speaking about undergraduate education in biology/botany seemed to be a good follow-up topic for me immediately after last year's meeting. I decided I would give that some thought and did actually ask several of you for opinions. No panic, I had a year…. However, no one told me at the time that in March a message from Johanne would appear in my inbox requesting an abstract and title. That message began a frantic search for a way to pull together a number of disparate publications, thoughts, and notes from the NSF effort. Then I found an article written by Harry Fuller (1956) who is a former president of BSA entitled "The Odor of Botany" which is a review of the previous 50 years of undergraduate education in botany and the progress that has been made. Fuller begins with a quote from a member of the National Academies of Science, "Botany is in bad odor in American universities. I am mad about plants and would never wish to be anything else but a botanist. If anything could stop me, however, it would be…. the average general botany course."

Fuller continues noting the state of introductory botany and some changes that have occurred. As I examined these, it seemed that he should have moved on to discuss the ***A.R.O.M.A.*** of botany. (This is one result of serving for four years in two different positions at NSF – the incubator of acronyms as well as research.) Fuller mentions the following changes in botany courses: **A**dvances in visual aids (such as Kodachrome slides, charts and models, time-lapse motion picture films); **R**esources better (Readable textbooks, microscopes); **O**rganisms' physiology and behavior emphasis; **M**ethods of teaching (Machine grading, labs); **A**ccumulating numbers of students in courses whose exposure to plants is only in the introductory course. One could say that many of these changes are mirrored in today's 'innovations' in teaching, such as Power Point presentations, YouTube videos, SEM, TEM, molecular sequences, clickers, hands-on experimentation, online information with and without review, abundant students in required courses and more students who receive their introduction to biology/botany at a different institution such as community colleges. Fuller ponders whether progress is being made or whether change is confused with progress and he discusses problems with the changes he has seen because improvement in teaching is not happening.

Next he notes some faults of botanists: **A** failure to realize majority of students will only have one botany course, **R**emained slaves to tradition in course presentation, **O**verly concerned with insides of plants, **M**entor botany graduate students who are extremely specialized and not broad thinkers, and **A**llowed lab study to become too mechanical/restrictive/stereotyped with no independent thought. He concludes with calls for activities on the part of botanists, noting they should lose their 'excessive meekness' in requesting needed support, introduce the whole plant in courses, encourage creativity, make plants pertinent, and he ends by hoping that things will become more fragrant over the next 50 years. Well, how are we doing?

There are some signs that botany is not doing so well as an area of study – one could be pessimistic and look at the 'foetid' side of today's education activities. There are fewer botany departments and fewer botany courses than there were in 1956. Resources for undergraduate teaching are still few. NSF for example supports graduate research fellowships and postdoctoral fellowships to help students craft a career in biology, but programs that support undergraduates to do their own research are few and the main funding supports new pedagogy. Botany is being taught by others who do not have the breadth of training across all of the plant sciences, is often taught only in its applied aspects rather than the basic science information source critical to understanding life, or conversely taught as a litany of facts with no relevance to reality, as Fuller decried in his article. So are we are going further down the road he warned against?

Well, I am not convinced that we are doing quite so badly, and I think there is definitely a sign that the 'fragrant' side is progressing, not just changing. For example, just examine the abstracts, symposia, workshops, presentations, discussions and posters at the 2010 meeting for indications that we care about plants in the classroom, use of new technologies and innovations in teaching and outreach activities. Botany/biology is now everywhere and not confined to individual departments, integrated studies are becoming more critical and the role of plants in this integrated understanding of life is strongly recognized and biologists are uniting to promote all biology as a unified science. There is increasing public awareness of environmental issues and 80% of the public is interested in scientific discoveries (even if they don't accept parts of scientific fact). National issues often listed as critically important to the current administration require botanical knowledge: health, water, food, energy, climate change. Every one of these priorities requires some basic understanding of plant biology.

Furthermore there have been several reports on improving introductory biology/science education and reports on the critical challenges in science for the next century. I want to mention three of these because they all comment on educating the next generation of scientists and they all indicate a strong role for biological societies in this effort. BSA can point to several ongoing efforts where we are already offering opportunities similar to ones noted in the reports and to our success in attracting increasing numbers of student members. One example is the new PLANTS program (Producing Leaders and Nurturing Tomorrow's Scientists) which is a follow-on activity to the previous Undergraduate Mentoring in Environmental Sciences NSF award for increasing participation of undergraduate students from groups not well represented at the BSA meetings or in botany in general. Our goal is to put this new program on a stable financial basis so that it will continue to attract more undergraduate students to the study of plants.

The first recent report (www.visionandchange.org) I will discuss is an outcome of the Vision and Change meeting on Undergraduate Biology Education, held July 2009 by AAAS and sponsored by a number of partners, including NSF. The final report from the meeting will be published this fall. Many of you probably do not realize that leading up to the large summer meeting were a yearlong series of "conversations", run by AAAS and sponsored by NSF, held at several sites around the country. Those of us at NSF who attended these conversations and listened carefully to the faculty and students heard several themes repeated again and again. Here are some of the ideas, issues, and examples we heard, all examples of the **A.R.O.M.A**. diffusing across biology. Faculty comments were: **A**ctive science and not just passive facts, **A**ssessment rigor, **A**ccessibility to resources, **A**ligned concept mapping across levels of learning, **A**nalysis, **A**dvances for students; **R**esearch early – an integral component of introductory courses, **R**esources – curriculum, tools, methods – especially ones that have been tested and work, **R**esponsible students and **R**esponsive administrators, **R**elevance and inquiry driven experiential learning, **R**igor in assessments, **R**ecognition and **R**ewards for teaching introductory courses and outreach, **R**eliability of information and data that **r**elates to **r**eality; **O**rganization support, **O**rganism-based, **O**verarching concepts throughout all courses made clear, **O**utcome-oriented assessment, **O**nline resources for curriculum and materials, **O**pportunity for development, **O**ngoing feedback, **O**vercome inertia to change; **M**apping concepts across the whole science curriculum, **M**odeling assessments, **M**aterial that does not impede reform efforts (i.e. textbooks static), and finally a **M**obilized community ready to engage the passion and change the culture. At the large meeting there was a call for an online resource that would search like Google, recommend like Amazon, vet like Consumer Reports, and annotate like Wikipedia. Various groups are beginning to take action to produce such a resource.

It is interesting to compare the comments that came from students at these various meetings. A predictable list of things they did not like about introductory courses emerged: **Professors** who use bad PowerPoints , give lectures in a monotone voice or use jargon/ unknown terms to explain something, give endless lists ("This leads to this leads to this…"), give you lists of facts without connecting them, don't respond, put you off, or are inaccessible, are clearly not into teaching, use small group discussions as an excuse not to teach anything, don't communicate clearly (language, style, writing), teach the same course number as another colleague but with entirely different requirements, use assignments that have already been disseminated on the Internet and **Fellow students** who allow cut-throat competition to take away from learning (emphasis on grades). Of course, exams were an ever-present complaint, and who can blame students for that? None of us have warm fuzzy feelings about exams and most of us get sinking feelings when a medical person suggests a 'new' exam for us to go through. Complaints from students were: don't give exams back, give exams back late, give no explanation of what the right answer was, or re-use tests that don't relate to what was done in class. And we all know how many excuses to miss exams students can find (in my experience exam schedules published at the beginning of the semester seem to be a leading cause of death for grandparents). If we had any concerns about the capability of creativity and innovation among students, exam excuses will certainly argue against that conclusion. Two of my favorites from years of teaching are: 1. the student who would not be present for the final exam because she had to catch a flight back to India the day before the exam as her father made the reservation and he never could figure out the International Date Line; and 2. the student who could not take the exam when scheduled because he was being sent into the witness protection program – no I certainly did NOT ask for more information!

However, there were more interesting suggestions from the students about what they felt was needed in introductory courses and many of these parallel what the faculty would like to be doing: **A**nalytical skills, **A**ppropriate statistics, **A**ccessibility of instructors, **A**nalogies (not jargon), **A**pplication of knowledge, **A**ctive learning, **A**ssistance from instructors, not adversary encounters; **R**elevant issues, **R**eal-life situations, **R**elationships of facts, **R**esearch experiences; **O**pportunities offered for new experiences and critical thinking, **O**wnership, **O**ngoing effective feedback; **M**eaningful material, **M**edia skills for communication to others, **M**emorable, not memorized, **M**entoring critical for learning environment. Students obviously want to share in our excitement about plants, they want to know how plant biology relates to other fields, and they need to see the societal benefits from the science they are doing. And I think that as faculty, we wish to become redundant and unnecessary for the current students we instruct – we want students who become independent researchers and critical thinkers regardless of the career they finally select.

There are two other recent reports that provide positive ways that botany is appreciated and seen as critical for understanding. Both are recent documents from the National Academies – and that seems particularly appropriate considering that a quote from a member of that organization began this musing. Both these reports call for integration of the sciences and note that we cannot understand, much less solve, critical issues surrounding us today without a complete and thorough understanding across all the sciences. Interestingly, this integrative nature of biology caught the attention of the U.S. House of Representatives Subcommittee on Research and Science Education, eliciting comments from the representatives such as "if I were to return to science, these are the areas that would excite me" and "although biology was not my favorite subject…this approach holds a great deal of interest".

The first report from the Life Sciences Board entitled "New Biology for the 21st Century" (National Research Council, 2009) selects economic issues to illustrate the importance of integration of science. The four topics chosen are all dependent upon an understanding of plants: food, energy, environment and health; and the report provides numerous examples derived from plant biology as it addresses the challenges in these areas. One chapter of the report discusses elements that should be created through biology education. Carol Brewer summarized these well at the Vision and Change meeting and I base my list on her presentation. 1. **A**ppreciation of broad integration across science; **A**nchor biology in the principles of chemistry and physics. 2. **R**esearch participation integrated for a working knowledge across several disciplines and technologies to facilitate broad dialogue. 3. **O**rganizing principles and **O**pportunities for new approaches and creative solutions embraced. 4. **M**ath, computation, and quantitative skills highly developed along with a deep expertise in a specific discipline.5. **A**ddress critical social issues through solving complex biological problems and develop skills, knowledge and **A**spirations in students. These are issues which students indicated they were most interested in during the meetings leading up to the Vision and Change meeting also. And we can see that the a.r.o.m.a. is permeating across all of biology.

The second report is less expected because it arises out of the Physical Sciences Board (National Research Council, 2010), but it also calls for more complete integration of the life and physical sciences to solve grand challenges facing us today. Of these challenges, the first four relate directly to plant science: 1) Synthesizing lifelike systems, 2) Predicting organism's characteristics from DNA sequences, 3) Interpreting interactions of the earth, its climate and the biosphere, 4) Understanding biological diversity, and even 5) Understanding the brain is an area where information from plant cells and plant products can be applicable. This report also discusses changes needed to address larger problems and includes a quote that is very applicable to botanical education. "New cultures must be forged and scientists must grow as comfortable in them as they are in their existing subcultures. There must be funding for work in those new cultures that extends beyond existing-culture "stove pipes." Most importantly, they must prepare the rising generation to mine new-culture opportunities without losing touch with scientists in the traditional disciplines or the principles of such disciplines. The future will be driven by progress at this intersection."

What does that mean for us as botanists and for the BSA as your society? We do need to provide better outreach for botany as an area of integrative biology, and we need to stress the importance of understanding botany regardless of what we are discussing. For our students we need to show how plant biology is relevant to all other science, societal issues, and the critical importance of plants for the whole earth environment. I suggest we follow on a method that has been applied in a number of fields, from journalism to economics, to mathematics, to military endeavors and embed ourselves in places we seldom go and do not immediately perceive as relevant. We have to become "embedded botanists." It is only when we are challenged to think on different levels and across different areas that we see relevance and often creative ideas and innovative solutions. As you have possibly noted, in several of these slides, the final A in A.R.O.M.A. has been missing. It is, obviously, a call for **A**ction – to embed botany wherever the opportunity arises and to avoid the 'excessive meekness' that Fuller found in botanists. Let's be sure the aroma of botany diffuses, infuses, and permeates across all education and society for the next fifty years. Then another president of the BSA will be able to speak on the "a**SCENT** of Botany".

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BSA Science Education News and Notes

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: Claire Hemingway, BSA Education Director, at chemingway@botany.org or Marshall Sundberg, PSB Editor, at psb@botany.org.

PlantingScience — BSA-led student research and science mentoring program

Call for 2010-2011 Master Plant Science Team Applications.
We invite graduate students and post-doctoral researchers to apply for the 2010-2011 Master Plant Science Team. This special group of PlantingScience mentors receives a few perks for their year-long service to the online learning community. MPST members commit to mentoring ~4 teams in both the Fall and Spring sessions during 2010-2011. One perk is free membership for the year. For more information and requirements, see http://www.plantingscience.org/MPSTInfo.html

The BSA will sponsor 20 students/post-doc to serve on the 2010-20111 on the Master Plant Science Team. An application is available online: http://www.plantingscience.org/MPSTApplication.html

If you'd like to spark scientific curiosity and understanding in today's youth, but the MPST isn't a good fit for you, consider joining as a regular PlantingScience mentor: http://PlantingScience.org/NewMentor/

Summer PlantingScience Learning Fun. PlantingScience Summer Institute for Teachers.
We had the great honor of working with an outstanding group of committed and accomplished middle school and high school teachers this summer. Fourteen teachers from 11 states and one international participant attended the third PlantingScience Summer Institute for Teachers (June 21-29, 2010), hosted in College Station, Texas by co-PI Carol Stuessy, Texas A&M University Associate Professor of Teaching, Learning and Culture. Botanists Marsh Sundberg of Emporia State University and Renee Lopez-Smith of Southern Illinois University led the initial five days of inquiry immersion. Their masterful content knowledge and open involvement in the inquiry process opened new doors of understanding and fostered a strong community collaboration that has extended well beyond the workshop. (Participant and PlantingScience teacher Dick Willis created a PlantingScience 2010 Facebook group.)

Marsh Sundberg (second from left) and Renee Lopez-Smith (second from right) share a laugh with a few of the 15 PlantingScience Summer Institute participants.

The excitement and engagement teacher teams exhibited as they investigated osmosis, transpiration, and cell types in the Celery Challenge, guided by Marsh, and as they observed alternation of generations and C-Fern reproduction, guided by Renee, were remarkable. Both of these topics are new PlantingScience inquiries in field-testing this academic year. Following the teamwork exploring the new inquiry modules, a botanical illustration session lead by Jeanne Debons (http://www.jeannedebons.com) and Carol Packard of Sisters Middle School offered creative break before the teachers turned to focus on classroom implementation.

Special PlantingScience Brassica Genetics Workshop. "Father" of Wisconsin Fast Plants Paul Williams and plant geneticist Amber R. Smith led a 2-day *Brassica* workshop July 9-10 in Madison, Wisconsin. This was a unique opportunity to bring PlantingScience teachers and scientist mentors together with the

Teacher teams competed in the celery challenge to cause and explain maximum bending.

developers of the PlantingScience *Brassica* genetics module, which introduces students to variation in a population and offers classroom teachers options to observe across a life cycle, examine quantitative and qualitative traits, and test patterns of inheritance. Following last year's classroom field testing and summer workshop, this PlantingScience will be made more broadly available to PlantingScience teachers. Our deep thanks to Paul, Amber, the many teachers and mentors who participated in the field-testing and curriculum development coordinator Teresa Woods for making this possible.

Fostering Student Thinking Through Mentoring Workshop.

Members of the 2009-2010 Master Plant Science Team Eric H. Jones (Florida State University), Laura Lagomarsino (Harvard University Herbaria), Laura Super (University of British Columbia), and Lindsey K. Tuominen (Warnell School of Forestry & Natural

Teacher team The Vial Shakers present their interpretation of the fern life cycle and alternation of generations, complete with The C-Fern Story sung to the tune of the Brady Bunch.

Resources) led an interactive session at Botany 2010 in Providence, Rhode Island.

Drawing on personal mentoring experiences and examples from the PlantingScience community at large, they solicited input about the program. Themes emerging from the conversation included (1) helping students clarify their question of interest and focusing on what they will measure/record to help them translate it into a testable hypothesis, (2)

L. Lagomarsino, L. Super, L. Tuominen, and E. Jones (left to right).

encouraging use of the multimedia capacity of the online platform for photo-documentation of experimental set ups and qualitative observations and drawings, (3) taking advantage of opportunity to communicate with students' instructors, and (4) making the creative aspect of the scientific enterprise explicit to students. Kudos to Eric, Laura, Laura, and Lindsey for their leadership in mentoring.

PlantingScience in the news and on YouTube.

Thank you to our partner societies, the American Society of Plant Biologists and American Phytopathological Society, and dedicated mentors for featuring their reflections in recent newsletters:

ASPB News July/August 2010 Volume 37, No 4.

http://www.plantbio.org/newsletter/julaug10/08mentoring.cfm

Phytopathology News July 2010

http://www.apsnet.org/members/phyto/

Picked as "Best of the Web" by the GEN Online edition of *Genetic Engineering and Biotechnology News* (Vol. 30, No. 14), PlantingScience gets a news boost.

http://www.genengnews.com/issue/best-of-the-web/138/

For a glimpse into the Dutch PlantingScience counterpart coordinated by Edith Jonker, see the YouTube video created by students of Banhoeffer College featuring their classroom research and visit to Wageningen University to present and meet their mentors: http://www.youtube.com/watch?v=DsSWGj0XPSI.

See C-Fern swimming sperm video taken by PlantingScience Summer Institute teacher this June: http://www.youtube.com/user/seageekdivergirl - p/a

Plant IT Careers, Cases, and Collaborations Second Institute for Teachers and Career Camp for High School Students

In July, 11 teachers from across the country and 18 students from Texas converged at Texas A&M University for the final PlantIT summer workshop. Co-PI Ethel Stanley, Director BioQUEST Curriculum Consortium, and co-presenter Toni Lafferty, C.H. Yoe High School, introduced teachers to multidisciplinary investigative case as a means to engage students in real world plant biology content. This summer's exploration theme was bioinformatics and natural fiber textiles with a focus on cotton. Some of the science research and communication/productivity tools introduced were NCBI's BLAST, ImageJ, Yodio, and Google Surveys. Field trips to see real-world applications spanned a cotton field with Dr. Gaylon Morgan, visit to the Forsyth Gallery to see textiles, wildflower garden, horticulture greenhouse, Dr. C. Wayne Smith's organic artifact preservation technologies, Dr. Kevin Ong's plant clinic, and Dr. Keerti Rathore's crop transformation lab.

During the 2-week session, teacher teams created, peer-reviewed, and tried out with student teams investigative cases involving cotton in medical supplies, booms used to clean oil spills, oils in food sources, and international textile markets. A returning PlantIT teacher described the benefits she received from the professional development experience: "*...it enhances my learning in content, technology, and collaboration. These tools will help to enrich my students' knowledge and learning. Knowledge is powerful*."

Teachers stop for a group photo at Norman Borlaug's portrait in the lobby on visit to Dr. Keerti Rathore's Laboratory for Crop Transformation.

For the 18 middle school and high school students coming to Texas A&M University, the one-week summer program was an opportunity to learn about college and careers along with how plants play a role in real-world biology and our lives as humans. The engaging, bright students came from mainly under-represented groups in science and represented 8 Texas schools. The students began the week by meeting a career panel (Dr. Micky Eubanks, a plant-insect interaction expert; Bob Marcotte, turf grass specialist and field manager; and Dr. Carol Stuessy, a botanical illustrator as well as education professor) and explore some of the technology they'll use during the week and campus highlights. In addition to trying out the teacher-teams' newly created cases, the students spent several days immersed in either pecan-integrated pest management investigations with Dr. Marvin Harris, Department of Entomology, or plant epidermal hair and endoplasmic reticulum imaging with Dr. Larry Griffing, Department of Biology.

Student feedback about what they got from the experience touched on the diverse project goals.

"Dealing with the microscope in Dr. Griffing's lab, because I got to see things that I wouldn't imagine seeing."

"...how plants should be well taken care of because they are very important to the world. I can go home and look at plants very different now but in a good way."

" I honestly found most useful how to work together as a team, how to communicate and

Student teams work with teachers on oil spill and cotton boom investigative case.

how to meet new people. There are many different careers out there that I didn't know of." "How many things you're able to do that has to do with plants."

"The most useful thing would be about the science experiment … it gave me a good understanding about the oil spill and made me realize that cotton is an important product in our daily lives."

You'll find student reflections on the project blog http://myPlantIT.org/blog/
You'll find the new cases and resources under the teacher tab/workshop 2010 on the project website http://myPlantIT.org

Our thanks to Co-PI Carol Stuessy, Associate Professor Department of Teaching, Learning, and Culture at Texas A&M University, and the stellar graduate student team of Laura Ruebush, Cheryl Ann Peterson, Denise Knibbe, Jules Johnston, Tori Hollas, Chris Call, Marissa Munoz, Chad Scott, and Chyllis Scott for their incredible work for the Plant IT Summer Institute!

Dr. Larry Griffing introduces students to confocal microscope at TAMU Microscopy and Imaging Center.

(And more thanks to Carol and her graduate students for hosting the summer institute and conducting the education research in PlantingScience.)

Editor's Choice

Adopt-a-Bud Project: An Exercise in Observation of a Tree Bud from Winter until Sprout Completion. Digiovanni, Nick, Jane P. Digiovanni, and Colette Henley. *The American Biology Teacher* 72: 357-360.

Observation is a difficult skill to re-master once students reach middle-school and beyond - - usually into their second or third year of graduate work. This simple activity, similar to PlantingScience's seed sprouting activities, reinforces observation and note-taking and, with modification, could be applied at any level from k-16. Its only limitation is seasonal.

A Guide to the Gynoecium. Burrows, G.E. *Journal of Biological Education* 44:93-95.

If you looked at the Virtual Floral Formula website we featured last year in PSB 55(4), you'll recognize some of the images in this paper. This paper includes a section on assessment of the efficacy of using this on-line supplement to laboratory instruction.

A simple Computer Application for the Identification of Conifer Genera. Strain, Steven R. and Jerry G. Chmielewski. 2010. *The American Biology Teacher* 72: 301-304.

The article describes the CD (available from the authors) that students can use to identify conifers – virtually anywhere in the country. The key provides 2 or more options for a particular character and includes excellent images to illustrate genera or species illustrating that trait. This is a good tutorial for high school and college students.

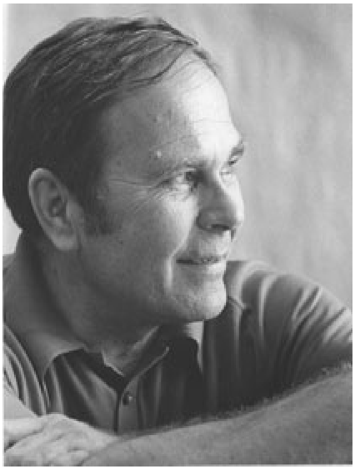
In Memoriam

Francis Theodore Haxo, 1921-2010

Dr. Francis T. Haxo died in La Jolla, CA. on June 10, 2010. Haxo had a long and significant career with pigments, algae and physiological processes of algae.

Haxo was perhaps best known for the following: 1.) The Haxo-Blinks oxygen electrode, widely utilized in measuring responses; and 2.) The discovery of chromatic transients, from which the critical concepts arose of Photosystem I and II, two differing methods for plants to photosynthesize. He and L.R. Blinks discovered this light enhancement from measuring a number of red algae for their chromatic transients finding that their phycoerytherin was more effective than chlorophyll *a* for photosynthesis.

During Haxo's voluminous correspondences



with me (AT) to get things on the record over the past four years between bouts with illnesses he wrote of the time when the action course of the two photosynthesis systems were being discovered. "Reviewing the past, research on the effectiveness of phycoerythrin as a photosynthetic pigment in red algae must have been on Blinks' mind for some time after his return to Stanford in 1933 (from the Rockefeller Institute). Several years later, in 1944, Haxo, then a graduate student in photobiology with A. C. Giese and fresh from G.M. Smith's fascinating summer course on local marine algae, was readily drawn to Blinks' problem. These first studies suggested that not only was phycoerythrin a highly effective light-harvesting component for photosynthesis but that, surprisingly, half of the light absorbed by chlorophyll seemed to be inactive. The detailed action and absorption measurements needed to document this anomalous situation had to be postponed until Haxo had completed the research for his doctoral dissertation on the identity and light activated biogenesis of the carotenoid pigments of the red bread mold Neurospora and its color mutants (a problem proposed by G. W. Beadle). A decision then had to be made about the direction of future research. Remaining at Caltech with its lively cutting-edge biology research atmosphere was a tempting possibility but Haxo opted to pursue a career emphasizing photo-physiology and so accepted Blinks' offer of a research appointment.) Haxo wrote, "Thus in September 1946 I returned to Pacific Grove and began a year of intense research mostly buried in a dark room, rarely emerging to hear the friendly barking of the seals and to smell the output from the dwindling sardine factories along Monterey's Cannery Row.

"In a subsequent summer at the MBL in Woods Hole I introduced myself to W. J. V. Osterhout, Blinks' much admired mentor. I was barely in the door when asked 'and what is Larry doing with all that equipment we sent him to California with?' I asked him how it was that he never returned to the field of photosynthesis after getting such a prominent start as article #1 in volume 1 of the Journal of General Physiology, a journal he had founded. Peering over his very thick glasses he replied, 'Well when I came to realize how Otto Warburg was taking over the field I decided that photosynthesis and Willie Osterhout were simply not going to get along.'"

Haxo also wrote, "Shortly after I set up a lab in La Jolla in the early 1950s the interest of Blinks and my labs converged in establishing the uniqueness of the phycoerythrin found in some species of the *Bangiales*, a subgroup of the Rhodophyta, which by mutual agreement came to be called â-phycoerythrin (Airth and Blinks 1957)."

Some of the simply displayed action spectra from Blinks and my publication were widely duplicated in textbooks to illustrate spectral assimilation and pigment involvement in representative phototrophic systems of eucaryotes. They were also key to estimating spectral assimilation curves for photosynthesis with depth in the ocean by the principle algal groups, part of the photosynthesis exhibits that Melvin Calvin organized as the US contribution to the science pavilion at the 1958 World Fair in Brussels. But in calculating these curves I failed to consider that in broad natural light fields, light absorbed by accessory pigments would have a marked enhancing effect on spectral performance at the ends of the spectrum, notably in phycoerythrin rich red and blue-green algae (Haxo, 1961).

During the maiden voyage of the RV Alpha Helix to the Great Barrier Reef in 1966, Blinks and I joined the group of photo-biologists and biochemists we had assembled to study photosynthesis and pigments of symbiotic associations in corals and giant clams.

Professor Lianne-Jensen recalls, "Francis was a true scientist, polite, gentle and friendly, much respected and appreciated. We originally met during during my sabbatical leaves where I visited Scripps in La Jolla. At a later occasion Francis sent Nancy Withers as post doctoral to work in our Trondheim laboratory. A thick file of mostly handwritten letters from Francis Haxo during this period 1971-2001 reminds me of a long, rewarding and pleasant collaboration in the carotenoid field. Some joint 11 original papers and symposium abstracts were published in this S L-J and Haxo collaboration. Francis`s contributions were on the algal systematics, cultivation and isolation part, whereas I (SL-J) continued with the structural elucidation or chemical identification work."

Dr. Haxo is survived by his wife, Judith Haxo; his children, John, Philip, Theodore and Aileen Haxo, and Barbara H. Phillips

- Anitra Thorhaug, Yale School of Forestry and Environmental Studies and Synnøve Liaanen-Jensen, Trondheim University, Trondheim, Norway

Charles B. Heiser, 1920-2010

The world lost two important Hoosiers this spring – Charles B. Heiser and John Wooden, both known for their basketball, one perhaps better known in the sports world. They shared more than their Indiana roots, and a love for sport. Both were also honorable, ethical, committed people and both were exceedingly successful in their professions.

The 'Hoosier' we wish to honor here is Charles Bixler Heiser. He was born on 5 October 1920 in a small southern Indiana town, Cynthiana. He liked to say that you could still tell that he came from rural southern Indiana by his accent; he was right. His father's job moved the family among several towns in Indiana, but they eventually settled in Belleville, IL, just outside St. Louis, MO, where he attended high school - and played basketball. He enrolled at Washington University in St. Louis in 1939, where he was proud to 'letter' in basketball for three years – and also served as the (graduate assistant) coach in one of those years (during WW II). Those who had the pleasure of knowing Dr. Heiser know about his great sense of humor, a sense of humor that was often self deprecating. In that context, he pointed out that his greatest talent in basketball might have been being tall ("...only 2 or 3 were taller" when he was at WU). Those who knew him also know that he was an incredibly determined and focused person; undoubtedly, that played a role in basketball, just as it did in his scientific career.

At Washington University, he majored in English and was elected to Phi Beta Kappa. Perhaps most importantly for him personally, he met Dorothy Gaebler in one of his small botany classes at WU/Missouri Botanical Garden. He and Dorothy were married in 1944. They had three children, Lynn, Cynthia and Charles Bixler III. Most important professionally were the classes he had with Edgar Anderson and Robert E. Woodson. The former introduced him to the weedy sunflowers growing along the railroad tracks in St. Louis. There is a very nice paper describing this introduction in the *Annals of the Missouri Botanical Garden* (1972: vol. 59: 362-372). The other major professional influence came at the University of California, Berkeley, where he interacted with G. Ledyard Stebbins while pursuing a Ph.D. While a student at Berkeley, he taught botany at UC Davis, and also managed the herbarium. He finished his Ph.D. in 1947; for those counting that is only three years after his bachelors degree. His first, and only job, was back in Indiana, where he was recruited by Ralph Cleland and began as an Assistant Professor in 1947. Even in the 70s he used to point to some very dusty boxes under one of the lab benches, and say: "...I have not completely unpacked, because I am not sure I will stay at IU...". He indicated that he had to choose between a job at Davis and at IU. He chose IU partly because botany (under the direction of Dr. Cleland) "...appeared to have a great future," and partly because at IU he "...would have a free choice of ...research topics." He remained in his professorship until retirement in 1986.

He did spend time on sabbaticals elsewhere, mostly on research travel to Central (Costa Rica) and South (Ecuador, mostly) America. He really loved the field research, the plants, the diversity, and the people. In particular, he had many wonderful field studies with former graduate student Jorge Soria, first in Costa Rica when Soria was at the Instituto Interamericano de Cooperación para la Agricultura, and then in Ecuador (Jorge's home country). Illustrative of his commitment to tropical American botany, and his love for the Andean countries, was the high value he placed on a plaque that he received from INIAP (Instituto Nacional Autónomo de Investigaciones Agropecuarias of Ecuador) in 1997. He was very proud to have been a mentor to 29 doctoral students and uncounted (he couldn't remember how many) masters students, and to have influenced many more. He taught a number of courses at IU, including vascular plants, systematics, economic botany, and evolution. He was mightily influenced by Edgar Anderson, not only in terms of science, and the way Anderson approached problems, but also by his commitment and ability to write for more general audiences. This was manifest in Charley's case by six books on sunflowers, nightshades, gourds, domesticated plants in general and weeds. In the latter part of his career, he took particular pleasure in introducing two ornamental plants: the ball loofah (*Luffa operculata*), and a Peperomia (*Peperomia serpens* 'Tena' – collected near Tena, in Ecuador). He spent considerable time working with Soria to develop, successfully, a nematode resistant form of a semi-popular topical crop, 'lulo' (or 'naranjilla'; *Solanum quitoense*) that put helped bring this crop back from near extinction in cultivation.

His professional contributions are diverse and deep – and long (at least 64 years); he continued research until the day in 2008 that he was disabled by a stroke (he died of complications from the stroke about 18 months later, in June 2010). Perhaps under Anderson's influence, he always seemed interested in plants that intersected with people. Thus, the early work (that continued through much of his career) on sunflowers that involved both their weedy aspects – and thus hybridization, as well as their importance in nascent North American (north of Mexico) agriculture, was supplemented very soon by studies of chili peppers, and from there to many more taxa in the Solanaceae, through squashes and gourds and other cultivated plants of Latin America, and eventually back to weeds in general (his last book). His studies of sunflowers were part of the early and exciting days of the development and 'blooming' of biosystematics, especially focusing on chromosomal evolution and hybridization. His work, in fact, became synonymous with studies of hybridization and introgression. He authored the two seminal papers on the latter topic, with a first review of its importance in 1949 (*Botanical Review* vol. 15, 645-687), followed 24 years later by an update (*Botanical Review* vol. 39, 347- 366). The work on sunflowers and chili peppers proved to be a goldmine of paradigms for evolution within and between lineages, for principles of evolution, for understanding the evolution/ selection of domesticates from wild species, and for many graduate student projects, theses and … careers. During the course of that work, he and two students of the time, Don Burton and Jorge Soria, helped to refine the applications of the relatively new field of numerical taxonomy, with a trend-setting study of quantifiable variation in *Solanum* and its limitations in groups with hybrids and polyploids (1964; *American Naturalist* vol. 94: 471-488). As his career matured, he devoted more time to books, on plants associated with people. In his first book (1969) *Nightshades, the Paradoxical Plants*, he joined science and popular writing – much like Edgar Anderson did before him (e.g., Anderson's 1952 book, *Plants, Man and Life*). In 1973 he published the first edition of *Seed to Civilization*, a book that became a popular text book in economic botany/ ethnobotany courses that went through several editions and printings, and was translated into at least Japanese and Chinese. He followed a paradigm similar to 'Nightshades' with very successful books on sunflowers (first edition 1976) and gourds (first edition 1979), and with his last book, *Weeds in My Garden, Observations on Some Misunderstood Plants.* The first subtitle was to be, "*Reflections of a Mid-western Botanist*" – his Indiana roots were strong!

His honors are manifold. He served as president of more or less all the societies relevant to his research: the Botanical Society of America (BSA), the Society for Economic Botany (SEB), the American Society of Plant Taxonomy (ASPT) and the Society for the Study of Evolution. In addition to the Raven Award for scientific outreach (ASPT in 2002), he was awarded a BSA Merit Award, a BSA Centennial Award, and the ASPT's highest honor, the Asa Gray Award. He was a founder of the Society for Economic Botany, and in 1984 received the SEB's Distinguished Economic Botanist Award. IU recognized him with a Distinguished Professor award in 1979, the Indiana Academy of Sciences with a Distinguished Scholar Award in 1997, the New York Botanical Garden with the Gleason Award in 1969, and the Pustovoit Award from the International Sunflower Association in 1985. He enjoyed the support of a Guggenheim Fellowship in 1953. That fellowship supported his first sabbatical — work in Costa Rica that allowed him to study tropical plants. He loved the work on sunflowers, but they only grew as far south as Mexico, and Woodson, at MBG, had ignited an interest in tropical plants. It was on this first sabbatical that his interest in native markets blossomed, and he began studies of *Capsicum.* And, in recognition of all his diverse, far- reaching and visionary studies, he was elected to the US National Academy of Sciences in 1987.

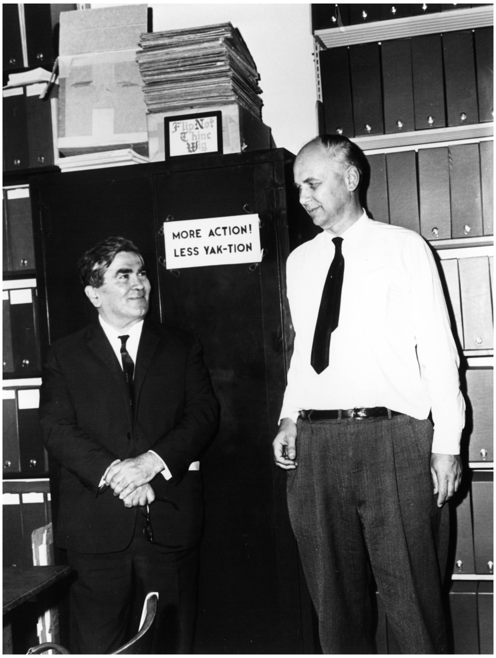
He enjoyed his career. He loved to work with plants, and especially with plants modified by people; he loved field work, and stayed involved with growing plants his whole professional life, in the greenhouses and fields at Indiana University. He enlisted his grandchildren to help him move around heavy pots of 'lulo' when they became too much for him. Visits to his lab (the lab and greenhouse space were wisely and generously provided by the IU Botany/ Biology Dept. through his whole career) were always associated with talk of his most recent projects, and with a trip to the greenhouses to see the latest projects underway. He enjoyed his life. He enjoyed his family and friends, and he is one of those from Indiana, a true 'Hoosier,' who will be remembered for his huge contributions — probably not so much in basketball as in science.

For those interested in making a contribution in honor of Professor Heiser, the Department of Biology at Indiana University has set up a fellowship — The Charles B. Heiser Graduate Fellowship in Plant Evolution, described at: http://www.bio.indiana.edu/alumni/support/heiser.shtml

-Gregory J. Anderson, University of Conneticut

Armen Takhtajan, 1910-2009

Last November 13, at the age of 99, we lost one of the greats of twentieth century botany, Academician Armen Takhtajan. We generally think of his work in plant systematics, phytogeography, and Plant Morphology. However, Armen also edited many multivolume series on plant embryology, seedlings, and a plant encyclopedia as well as many floras and editing Botanisky Zhurnal. It is common to give a review of such a person's work. However, this case is, in my opinion, quite different given Armen Takhtajan's life. We all know his impact on Botany in general, and if not, there is the library. In this brief article, I will concentrate on the unique role played by Armen Takhtajan during the years of the Soviet Union. The information given below was told to me while Armen was preparing the text of his 1997 book, Diversity and Classification of Flowering Plants. From 1992 to 1997, Armen spent three to four months each year at the New York Botanical Garden in my office working on the text. It is during that time that he shared with me the incidents given below. This is, also, how I came to understand what a close friendship he had with Arthur Cronquist (1919-1992).



Takhtajan with Arthur Cronquist

Armen Leonovich Takhtajan was born on June 10, 1910 in Shusha, Nagorno-Karabakn, a largely Armenian community in a disputed area of Azerbaijan. One of the things that Armen was most proud of was receiving an Armenian passport after the dissolution of the Soviet Union. Armen Takhtajan was born before the "Russian Revolution." During his lifetime, he witnessed the formation and dissolution of the Soviet Union. In fact his community in Armenia did not know of the revolution immediately as it took some time for it reach their community. As a boy, he saw and heard speeches by Lenin and Trotsky, the latter being mesmerizing according to Armen. He lived through the vicissitudes of the Lysenko era. Nikola- Vavilov was a friend whose untimely death had a profound effect on Armen's subsequent activities. For his resistance to Lysenkoism and keeping genetics alive, albeit underground in Russia, he was made a Hero of Labor and presented with a gold medal in 1990 by Mikhail Gorbachev. How did he do this? A couple of examples will suffice here. One way was that Arthur Cronquist would smuggle books into Russia to give to Armen when Arthur made his almost annual trips (Art also smuggled in heart medications for Armen). Another example occurred during the 11th International Botanical Congress in Seattle in 1969. In those days, a KBG agent would either accompany the scientist when they went to western countries or would simply go on their own to observe. Arthur Cronquist, G. Ledyard Stebbins, and many others organized a large dinner party at a local restaurant. The number of participants equaled to capacity of the restaurant so that it was quite crowded. Armen was then able to sneak out the back door to meet with Theodosius Dobzhansky (1900-1975).

Armen had subtle ways of avoiding confrontation with the authorities. One way was fieldwork. So when problematic meetings were called to censure dissidents in the Soviet Academy of Sciences, Armen would be in the field in the Caucasus Mountains or elsewhere. Sometimes, though, things did not always work as when he was removed from the airplane on the tarmac for presumed dissident activities as he was about to depart for the 13th International Botanical Congress in Sydney in 1975.

Armen Takhtajan was among the greatest authorities in the world on the evolution of plants. His knowledge was truly eclectic and that is reflected in the posts he held throughout his career. Armen did his undergraduate degree in the Institute of Subtropical Cultivation in Tbilisi, Georgia, a Ph.D. in Leningrad, and a D. Sci. at the Yerevan State University in Armenia where his father was a Professor of Languages. He had several positions in Armenia. First as a researcher at the Natural History Museum in Yerevan, then as Senior Botanist in the Biological Institute of Armenia and finally as lecturer and Professor of Botany at Yerevan State University. Problems with the powers that be (were) led to his having to move, first to Leningrad State University and then to the Komarov Botanical Institute in Leningrad (St. Petersburg) via arrangements made by friends at the former. It is our good fortune that the Lysenkoists in Armenia had little influence with the Dean at Leningrad State University. At the Komarov Botanical Institute, he was first Head of the Laboratory of Palaeobotany and later Director of the Komarov Botanical Institute. He always felt his broad interests and knowledge stemmed in part from having held a variety of positions and in part from his edited varied series and journals.

Clearly, Armen Takhtajan was a person of integrity, a problem solver, and dedicated scientist who made sure that the advances made were not ignored in the long run. This is reflected in his ability to produce at age 99 in 2009 a second edition of the 1997 book, Flowering Plants, which incorporates literature as recent as 2008. Truly, a monumental achievement in a monumental career. Testimony to that career is found in the honors he received in addition the Hero of Labor Medal. He was a member of the Armenian Academy of Sciences and the Russian Academy of Sciences. He was a foreign member of the Finnish Academy of Sciences and Letters, German Academy of Naturalists (Leopoldina), Norwegian Academy of Sciences, and the Polish Academy of Sciences as well as a foreign associate of the United States National Academy of Sciences. He was a corresponding member of the Botanical Society of America and a foreign member (FMLS) of the Linnean Society of London.

One of the last books by Armen Takhtajan was "Principia Tektologica: Principles of Oragnization andTransformation of Complex Systems: An Evolutionary Approach" 1998. (ISBN 5-8085-0008-7). Aside from the English title, the book is in Russian. It represents Armen's interest in philosophy and the suppression by Leninists of the books by Aleksandr Bogdanov "Allgemeine Organisationlehre (Tektologie)" Band 1, 1926 and Band 2, 1928. Berlin (translated by G. Gorelik in 1980 as "Essays in Tektology", Seaside, California) and the several books by Bertalanffy on General System Theory. Armen more or less used his energy to deal with Lysenkoism and returned to General System Theory when that battle was finally over. He had planned an English version of that book but first wanted to finish his last book on flowering plants.

The passing of Armen Takhtajan is a great loss not just to botany but also to science in general. His career certainly made a difference in how we perceive the world around us and has made it a better place to live for many. He was a great mentor to many and a good friend to many more. His life should serve as an example for those that follow.

-Dennis W. Stevenson, New York Botanical Garden

Lawrence J. Crockett

Emeritus Professor Lawrence [Larry] J. Crockett passed away on June 8, 2010. Larry moved to Texas after retiring from The City College of New York , CUNY. A memorial service for Larry is planned for September in New York City. Information can be obtained from Dr. Jane Gallagher: janegall@sci.ccny.cuny.edu or Edith Crockett edith@waterfordconnection.com.

(a full memorial will run in the December issue)

Personalia

Arboretum Hires New Director, Edward L. Schneider

Chanhassen, Minn. (March 29, 2010) - The Minnesota Landscape Arboretum will welcome a new director later this summer, Edward L. Schneider, currently president and CEO of the Santa Barbara Botanic Garden in California. Schneider will join the Arboretum as its fourth director, since its was founded nearly 52 years ago. Schneider will also serve as a professor in the Department of Horticulture Science at the university.

"The Arboretum will benefit greatly from Schneider's leadership and experience as it continues to grow as a community resource and popular environmental attraction in this challenging economy," stated Dean Allen S. Levine of the College of Food, Agricultural and Natural Resource Sciences (CFANS) at the University of Minnesota, of which the Arboretum is a part. The Arboretum, located in Chanhassen, is a premier public garden, with more than 1,100 acres of gardens, woodlands and natural areas; and 115 year-round employees.

Since 1992, Schneider has headed the Santa Barbara Botanic Garden, located on 65 acres in historic Mission Canyon, and featuring over 1000 species of rare and indigenous plants.

He has also served as adjunct professor at the University of California at Santa Barbara. Prior to that, Schneider held faculty appointments at Texas State University, most recently as dean of the College of Science for more than eight years.

"The University of Minnesota allows me to combine my two passions, teaching and directing a world-respected garden. My career began as a professor and, for the past 18 years, I've led the Santa Barbara Garden," stated Schneider.

Professor Loren Henry Rieseberg FRS

Professor of Botany, Department of Botany, University of British Columbia

Professor Loren Rieseberg was elected Fellow of the Royal Society (FRS). Rieseberg has made fundamental contributions to our understanding of speciation mechanisms and the evolution of local adaptation. He has pioneered the application of experimental genomic approaches to studies of microevolutionary processes. He demonstrated that new diploid plant species arise through hybridization, that this mode of speciation results from significant ecological and karyotypic divergence, and that the process occurs with remarkable speed. Rieseberg has also shown that new hybrid gene combinations facilitate the colonization of extreme environments indicating that hybridization provides a mechanism for major ecological and evolutionary transitions requiring simultaneous changes at multiple traits and genes.

Award Opportunities

American Philosophical Society, Research Programs

All information and forms for all of the Society's programs can be downloaded from our website, http://www.amphilsoc.org Click on the "Grants" tab at the top of the homepage.

INFORMATION about ALL PROGRAMS
Purpose, scope
Awards are made for non-commercial research only. The Society makes no grants for academic study or classroom presentation, for travel to conferences, for non-scholarly projects, for assistance with translation, or for the preparation of materials for use by students. The Society does not pay overhead or indirect costs to any institution or costs of publication.

Eligibility
Applicants may be residents of the United States or American citizens resident abroad. Foreign nationals whose research can only be carried out in the United States are eligible. Grants are made to individuals; institutions are not eligible to apply. Requirements for each program vary.

Contact information
Questions concerning the FRANKLIN and LEWIS AND CLARK programs should be directed to Linda Musumeci, Director of Grants and Fellowships, at LMusumeci@amphilsoc.org or 215-440-3429.

BRIEF INFORMATION about INDIVIDUAL PROGRAMS

Franklin Research Grants
Scope
This program of small grants to scholars is intended to support the cost of research leading to publication in all areas of knowledge. The Franklin program is particularly designed to help meet the cost of travel to libraries and archives for research purposes; the purchase of microfilm, photocopies or equivalent research materials; the costs associated with fieldwork; or laboratory research expenses.

Eligibility
Applicants are expected to have a doctorate or to have published work of doctoral character and quality. Ph.D. candidates are not eligible to apply, but the Society is especially interested in supporting the work of young scholars who have recently received the doctorate.

Award
From $1,000 to $6,000.

Deadlines
October 1, December 1; notification in February and April.

Lewis and Clark Fund for Exploration and Field Research
Scope
The Lewis and Clark Fund encourages exploratory field studies for the collection of specimens and data and to provide the imaginative stimulus that accompanies direct observation. Applications are invited from disciplines with a large dependence on field studies, such as archeology, anthropology, biology, ecology, geography, geology, linguistics, and paleontology, but grants will not be restricted to these fields.

Eligibility
Grants will be available to doctoral students who wish to participate in field studies for their dissertations or for other purposes. Master's candidates, undergraduates, and postdoctoral fellows are not eligible.

Award
Grants will depend on travel costs but will ordinarily be in the range of
several hundred dollars to about $5,000.

Deadline
January 15; notification in May.

The Rupert Barneby Award

The Rupert Barneby Award, named in honor of the late NYBG scientist and renowned legume expert, consists of US$1000.00 granted annually to assist researchers to visit The New York Botanical Garden to study the rich herbarium collection of Leguminosae. Graduate students and early career professionals with research in systematics and/or legume diversity are given special consideration. Anyone interested in applying for the award should submit their curriculum vitae, a two-page proposal describing the project for which the award is sought, and the names of 2-3 references. The application should be addressed to Dr. Benjamin M. Torke, Institute of Systematic Botany, The New York Botanical Garden, 200th Street and Kazimiroff Blvd., Bronx, NY 10458-5126, USA, and received no later than December 1, 2010. Submission by e-mail is preferred (send to: btorke@nybg.org). Announcement of the recipient will be made by December 20, 2010. Travel to NYBG should be planned for some period during 2011. Recipients are asked to give a presentation about their research at NYBG.

Other News

How prepared is the U.S. to meet future botanical challenges?

The Chicago Botanic Garden and Botanic Gardens Conservation International 's U.S. office have been working with partners across the country, including the Botanical Society of America, to assess current and future botanical capacity in the United States. The aim of this grant-funded project is to understand the resources we currently have to conserve and manage native plant species and habitat, identify gaps in capacity and highlight opportunities to fill them in the future. *Thanks to the over 1,500 survey respondents and 30 workshop participants who contributed to this project in 2009. All surveys were anonymous, and covered topics like academic background, research & management interests and expertise, access to resources, & opinion on conservation issues.* Following is a summary of gaps and recommendations. Full s*urvey results are summarized in a report outlining strengths & areas for improvement in plant science education, research, & habitat management in the United States which can be viewed and downloaded at* www.bgci.org/usa/bcap.

Assessing botanical capacity to address grand challenges
Summary of gaps identified and recommendations made

EDUCATION AND TRAINING

GAPS IDENTIFIED

Loss of botanical degree programs: In 1988, 72% of the nation's top 50 most funded universities offered advanced degree programs in botany. Today, more than half of these universities have eliminated their botany programs and many, if not all, related courses. Statistics from the U.S. Department of Education reveal that undergraduate degrees earned in botany are down 50% and advanced degrees earned in botany are down 41%. During the same time, undergraduate degrees awarded in general biology have increased 17% and advanced degrees earned in general biology have grown by 11%.

Decline in botanical course offerings: Nearly forty percent of the over 400 university faculty who completed the survey said botany courses in their department had been cut in the past 5-10 years. The courses eliminated tend to be from among those required for the 0430 (botanist) federal job code. A majority of faculty and graduate student respondents were dissatisfied with botany courses offered by their college or university.

Preparation for employment at federal agencies: Neither students or faculty were aware of the coursework requirements for employment as a federal botanist (24 credit hours in botany). Given course offerings at many academic institutions, it is likely that many students considering careers as federal botanists will graduate without meeting coursework requirements for federal hiring.

RECOMMENDATIONS MADE

Recommendation 1: Faculty and administration involved in college and university biology education should ensure plant science is appropriately incorporated in annual course offerings for undergraduate and graduate students to ensure they are employable both within and outside the academic sector. This includes offering courses that meet requirements for employment as a federal botanist (such as botany, plant anatomy, morphology, taxonomy and systematics, mycology, ethnobotany, and other plant-specific courses), and encouraging interdisciplinary research programs to train students in both basic research and applied science.

Recommendation 2: Faculty and administration at the nation's academic institutions should ensure plant science, including basic organismal expertise, is strongly represented within interdisciplinary departments, particularly as staff with botanical expertise retires in the coming decade. Accreditation bodies should develop recommendations and criteria for monitoring and evaluation to support adequate representation of botanical disciplines in biologydepartments and interdisciplinary study programs nationally.

Recommendation 3: Non-profit organizations play an increasingly critical role in filling gaps in botanical education and training. They contribute to course development and classroom
education while providing amplification and practical experience, particularly for subjects that are most in demand for the nation's botanical workforce outside of academia. Because demand will likely only increase in this area, non-profit organizations should take strategic steps to increase their ability to fill this gap in capacity in this area. Leadership to recognize, support and sustain the ability of non-profit organizations to fill this role is needed from private foundations as well as academic and government sectors.

Recommendation 4: A full-time liaison position should be established between the Botanical Society of America and federal land management and research agencies to ensure botanical education and practical training needs for expert resource management are met. Similar to the current liaison position between the Bureau of Land Management and the Society for Range Management, this position would strengthen collaboration and workforce building through avenues such as quick-hire programs as well as the Office of Personnel Management's Student Educational Employment Program and Presidential Management Fellows Program.

Recommendation 5: Academic, government and private sectors should work collaboratively to strategically strengthen botanical education and training at all age levels. This includes curriculum development that recognizes the central role plants play in biological systems and human life, and better integration of plant science into biology standards and textbooks. Work through the STEM Education Coalition as well as organizations like the Botanical Society of America, the American Institute of Biological Sciences and the National Association of Biology Teachers is needed to build support for and better integration of plant science education and training in biology coursework.

COMMUNICATION AND OUTREACH

GAPS IDENTIFIED

Private sector: Respondents in this sector provide the greatest outreach to government agencies and private citizens, but more is needed. While 50% of respondents from this sector consulted with government agencies on botanical matters from 2007 - 2009, over 70% consulted with private citizens, and non-profit respondents gave on average 2.3 media interviews during the same timeframe.

Academic sector: While outreach within the academic sector is strong, there is a need for greater outreach to government agencies and private citizens: fewer than 37% of respondents reported consulting with government agencies on botanical matters, only 2.2% consulted with private citizens, and each respondent gave an average of 1.3 interviews to the media from 2007 - 2009.

RECOMMENDATIONS MADE

Recommendation 6: All sectors should work both individually and collaboratively to strategically increase outreach efforts to different audiences, and to monitor the effectiveness of this work. Action is needed to create appropriate materials and deliver information that increases the level of botanical literacy and appreciation among policy makers, other scientific disciplines, and the general public. The private sector should build on current outreach efforts to the government and general public, the government sector should ensure outreach efforts to the public effectively include plants as well as the wildlife that depends upon them, and the academic sector should make a commitment to increase outreach efforts beyond the academic sector.

RESEARCH AND MANAGEMENT

GAPS IDENTIFIED

Demand for research not being met: Survey respondents were unanimous in selecting invasive species control as the top management issue requiring additional research, yet very few faculty or graduate students reported undertaking research that was applicable to invasive species control. **Plants are being left out of climate change planning and action:** Planning and policy actions within federal and state government agencies focused on climate change adaptation and mitigation are not incorporating botanical expertise. This is likely due at least in part to a false perception that plants are not being impacted by climate change, when in reality they will often be more impacted than the wildlife and people who depend upon them.

Private sector's valuable but under-supported role: businesses and non-profit organizations are beginning to fill key gaps in government and academic botanical capacity through cross- sector partnerships. Botanical services most commonly contributed to these partnerships match up with top needs for research and management, including invasive species identification and monitoring, botanical training, and rare species monitoring and conservation. Additional support is needed to ensure botanical capacity in the private sector is in place and able to help the nation address these current and future grand challenges.

Bureau of Land Management (BLM) — charged with managing biological resources on 40% of all public land, but employ just over one botanist per 4 million acres (equivalent to having one person responsible for all of Connecticut). Of the 95 BLM survey respondents, 97% said their agency did not have enough botanically trained staff to meet current needs.

US Geological Survey (USGS) — provides the science to guide management of nearly 400 million acres of public lands. All USGS survey respondents said their agency did not have enough botanically trained staff to meet current needs. A preliminary assessment of USGS scientists at science centers in the western U.S., where most public lands are located, shows that wildlife scientists outnumber botanical scientists by over 20 to 1.

RECOMMENDATIONS MADE

Recommendation 7: The significant impacts of climate change on plants, as well as the people, wildlife, and ecosystem services that are dependent upon plants for survival and well-being, should be recognized. Appropriate botanical expertise should be incorporated into climate change planning and policy efforts in all sectors to ensure appropriate proactive research efforts are initiated, and collaborative partnerships are encouraged to support effective, efficient, and economically defensible solutions. This includes ongoing work by the Department of Interior in developing and managing Climate Science Centers and Landscape Conservation Cooperatives, where botanical capacity is currently greatly underrepresented.

Recommendation 8: Public and private funding should be directed to help all sectors close key gaps identified in plant science research that are directly linked to top needs and applications identified by this survey. This includes identified research needs in invasive species control, climate change mitigation and adaptation, habitat restoration, and the preservation of ecosystem services.

Recommendation 9: The nation's five federal land management agencies* should increase the number of trained, full-time botanists on staff. *At minimum, each agency should have at least* (a) one full-time botanist working collaboratively at the national level to address critical climate change issues facing plants on public lands, and (b) one full-time botanist with appropriate training on staff at all regional, state, and field offices.

*Bureau of Land Management (BLM), Department of Defense (DOD), National Park

Service (NPS) US Forest Service (USFS), and US Fish and Wildlife Service (USFWS), which are collectively responsible for managing nearly 1/3 of the nation's landmass.

Recommendation 10: The US Geological Survey, responsible for carrying out research to guide management of Department of Interior lands** should have *at least* five full-time botanists with a range of appropriate training on staff at each of its regional science centers.

**US Geological Survey (USGS) is the research arm of the BLM, NPS, and USFWS National Wildlife Refuge system, therefore charged with research on the native plant communities comprising almost 400 million acres of public lands.

Recommendation 11: Administrators and decision-makers at federal and state land management and research agencies should engage full-time staff botanists and work collaboratively with academic and private sector expert advisors in developing land-use plans, and in planning and implementing responses to key challenges (including climate change mitigation planning, habitat restoration and invasive species control strategies). This will lead to more successful, efficient, and economical outcomes.

Recommendation 12: Federal and state land management and research agencies should provide support for full-time staff botanists to identify and prioritize plant-related issues, and ensure these priorities are clearly and consistently communicated to the academic and private sector to allow for effective and efficient action. Once identified and communicated, management and funding decisions in the private and public sectors should ensure that capacity and resources are focused on the highest priority issues (such as invasive species) and/or taxa (such as those most critically threatened).

Recommendation 13: All federal land management and research agencies should ensure new hires have appropriate botanical training, and that monitoring and reporting mechanisms are in place to avoid a similar decay in botanical capacity in the future. Specifically, all new federal hires recommended here should be employed under the US Office of Personnel Management employment code 0430 (Botany), rather than the more general code of 0400 (Natural resource management / general biology), as it does not effectively capture required botanical expertise.

Recommendation 14: Cross-sector communication and partnership should be enhanced to pool existing resources, maximize efficiency, and more rapidly address and fill critical gaps in botanical capacity. Additional resources are needed to facilitate partnerships among government, academic, and private sectors, ensuring long-term sustainability of programs necessary for science-driven management of the nation's biological resources. The Plant Conservation Alliance provides an effective vehicle for multi-sector partnerships, and examples of programs built around public-private partnerships include the national Seeds of Success program and regional programs such as the New England Plant Conservation Program and the Georgia Plant Conservation Alliance.

Visit www.bgci.org/usa/bcap to download the full report

***Project staff*:** Kayri Havens, Chicago Botanic Garden; Andrea Kramer, Botanic Gardens Conservation International U.S.;
Barbara Zorn-Arnold, Chicago Botanic Garden

***Advisory Board*:** Patricia DeAngelis, U.S. Fish and Wildlife Service; Kent Holsinger, University of Connecticut; Kathryn
Kennedy, Center for Plant Conservation; Rachel Muir, US Geological Survey; Peggy Olwell, Bureau of Land Management; Kristina Schierenbeck, California State University, Chico; Larry Stritch, US Forest Service; Marsh Sundberg, Emporia State
University

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Reports and Reviews

Planting memories: What students learned about plants from a conservatory field trip[1]

Mary L. Keppler[2, 4], Elisabeth E. Schussler[3]

Done correctly, school field trips extend and enhance the classroom learning experience. In the context of botanical education, local conservatories provide a unique opportunity for students to experience plants. The field trip experience is one that makes a lasting impression on students, and may improve their attitude toward plants. This study used surveys to assess student retention of plant knowledge and attitude toward plants several months after a conservatory visit. The results show that the majority of students not only recalled specifics about plants, but also regarded the event favorably. Students described plants they recalled using several categories such as shape, color, movement, and texture. Results from student feedback were used to make revisions to the program to further increase learning. Teachers and non-formal institutional staff can use the results of this study to build effective botanical education programs, taking into account student perspectives about plants.

Key Words: assessment; botanical education; field trip; non-formal; retention; survey

Students need to learn about plants as early as possible so they can discover the origins of their food and understand the basis for all animal life on our planet. Developing and assessing effective student experiences with plants deserves special attention since most students know little about plants as compared to animals (Uno, 1994; Hallé, 1999; Wandersee and Schussler, 2001; Schussler and Olzak, 2008). The characteristics of plants being static, not having a face, and rarely being viewed as individuals contribute to a general disregard for the producers of our environment despite their importance to everyday life (Hallé, 1999; Wandersee and Schussler, 2001).

Non-formal learning, which can take place at a museum, nature park, zoo, botanical garden, or conservatory, appeals to students on a different level than traditional classroom instruction and can enhance learning by those of varied intelligence levels and abilities (Eshach, 2007; Fraser and Maguvhe, 2008; Melber, 2008). These settings give students a chance to relate practical experiences with what they have learned at school, potentially creating lasting memories and long-term learning. It is imperative that learning outside the formal setting is implemented and studied (Tunnicliffe, 2001) because young students identify their out-of-school experiences as the source of most of their botanical knowledge (Tunnicliffe and Reiss, 2000; Bebbington, 2005; Falk, 2005).

School field trips bridge non-formal and formal classroom learning, and the most effective field trips provide experiences that reinforce classroom learning. In particular, teacher investment in field trip planning helps to prepare students to be effective learners during the field trip (Lindemann-Matthies, 2002; Tilling, 2004; Bebbington, 2005; Eshach, 2007; Stern, 2008). In a study done in Switzerland, there was a positive correlation between the time teachers spent on preparation activities in class to how much knowledge was obtained out of the classroom (Lindemann-Matthies, 2002). Class time spent talking about the potential of the trip allows students to prepare for their visit and reviewing their experience afterwards promotes retention and synthesizes the experiences with class studies.

Although the total impact of museum and science center visits on student learning is unknown, there is evidence that these visits

[1]Manuscript received January 15, 2010; revision accepted June 12, 2010.
[2]Department of Botany, Miami University, 700 East High Street, Oxford, Ohio 45056
[3]Department of Ecology and Evolutionary Biology, University of Tennessee - Knoxville, 569 Dabney Hall, Knoxville, TN 37996
[4]send correspondence to: keppler.marylee@gmail.com

can promote positive attitudes and motivate an interest toward science which can be recalled months later (Stevenson, 1991). Learning from a single visit does not occur only during the event, but is an extended process of compiling observations and information over time (Falk, 2005). Too often, students and visitors are asked what they learned immediately after a science center visit, rather than asking what they understand about the topic months later (Eshach, 2007).

Few published studies contain information about student feedback from field trip experiences; however, it is known that most students enjoy breaks from the typical classroom setting, yet know they are expected to learn during their trip (Eshach, 2007). Some students may find leaving the comfort of school and changing routine to be emotionally taxing. Particular attention needs to be taken to sensitively prepare students for the outing so they can look forward to the experience (Ballantyne and Packer, 2002; Dillon et al., 2006; Eshach, 2007).

Since 2006, students from a primarily suburban town in southwest Ohio have experienced non-formal learning through a field trip program conducted on a local campus. Every fourth grader in the district has had the opportunity to spend two hours in a college laboratory using microscopes to dissect flowers and learn about the basics of sexual reproduction. Additionally, they spent two hours in a conservatory playing a game of plant identification; the goal of the field trip was to expose them to plant diversity and build botanical vocabulary. This fourth grade curriculum focuses on plant biology and is part of the Ohio Department of Education Academic Content Standards for Science (Ohio Department of Education, 2004, p. 11). The content of the field trip correlates to a classroom study that involves experimentation on *Brassica rapa* cv. ‘Wisconsin Fast Plant®’ (Gladish, 2006).

There are few reports of longer-term post assessments of non-formal programs and how they were used to improve science education programs. The purpose of this study was to assess the field trip portion of the program, with a specific focus on what students learned about plants and their attitudes towards the trip. Student surveys were used to gather data on long-term content retention and student perceptions. Results support that students recalled specific information about the trip several months after it occurred, but that their learning did not always match the intended outcomes of the experience. The data collected were used to revise the program to facilitate more directed student learning for future field trips.

MATERIALS AND METHODS

In 2005, a botanical conservatory with approximately 5,200 square feet of greenhouse space was opened on a regional campus of a public mid-sized university in southwestern Ohio. A native plants garden and prairie grassland occur on the surrounding property (Gladish, 2006). This impressive structure has the potential to enhance the learning of students throughout the area and is currently being used to educate fourth graders in the nearby school district, as well as university students.

The fourth grade students who attend the field trip to the conservatory are enrolled in a large school district located in southwestern Ohio, which serves both urban and rural students. The majority of students are of European descent (78%), 9.4% are African-American, and 6.6% Hispanic, with less than a percent of Asian students, and 5.3% of students from multiracial backgrounds. The majority of the students are from economically disadvantaged homes (57.1%) and 16.4% hold either cognitive and/or physical disabilities. Five percent of students struggle with basic English proficiency skills (Ohio Department of Education, 2008).

From October through December 2008, approximately 700 fourth grade students and their teachers visited the conservatory in groups of about 50 students each day. Students were divided into two groups, one group heading into the conservatory and the other into a science laboratory. Students in the science laboratory were taught about plant reproduction and then dissected Peruvian lilies using dissecting microscopes and a structured worksheet. Students in the conservatory engaged in a question/answer session on plant processes and were instructed on how to play an inquiry-based game, the goal of which was to accurately describe the features of a specific plant so another classmate could identify the plant (Gladish, 2006). The primary author of this paper assisted with the conservatory portion. After two hours, the students had lunch and then switched locations. By the end of the field trip, each student had dissected a lily in the lab and played the game in the conservatory.

In February and March 2009, a survey (Table 1) was created by the primary author and administered to students by the science teachers of each class. Depending on when the student visited the conservatory, the time from visit to assessment ranged from three to five months. Every student who visited the conservatory had the opportunity to fill out a survey. The science teachers were provided with instructions on how to administer the survey and the students took the survey during normal class time; the primary author was not present in the classrooms when the students took the surveys. An open response questionnaire for the science teachers of these students was posted online during the same time period. All data collection procedures were approved by the university's human subjects review board.

The surveys asked students to recall how they felt about the field trip experience, to describe a plant they saw at the conservatory, and what they learned on the field trip. The survey also included questions to identify students' favorite aspects of the trip and what students would like to do on a future visit. The structure of the survey included both forced choice and open response questions. The responses to the forced choice questions were chosen based on the activities performed during the trip and those that elicited the most excitement from the students during their visit (e.g., the desert room was the topic of many student conversations when waiting for the bus, and the clicker game was mentioned in thank-you letters). Students could select multiple responses on the forced choice questions.

Every science teacher in the district returned student surveys to the author, resulting in 100% participation of the elementary schools. Student surveys and teacher questionnaires were analyzed by compiling frequencies of each forced choice response and sorting the open responses of students into categories. Student descriptions of plants they remembered often listed several characters, and these were sorted separately from each other. The primary and secondary author independently identified categories from the data to increase validity of the results. Disagreements in categories were resolved through discussion.

RESULTS

A total of 560 student surveys were completed and returned. Twenty-seven surveys were disqualified because the students had not attended the field trip, so 533 surveys were used for the results. Six of fourteen science teachers returned the teacher questionnaire.

Student attitudes towards the field trip were assessed through questions 3, 4, 5, and 8. The results of the student survey revealed that 92% of students liked visiting the college; 47% of students had never been to a college before. The most common student response about leaving the school was being happy and excited with 79% of students marking these emotions, however, a significant number of students (35%) were scared, nervous, or sad about leaving school. The majority of students, N=419, responded that they like learning about plants.

When asked to describe a plant they saw at the conservatory (question 7; open response), students overwhelmingly focused on shape and color, or tried to name a specific plant. Many students used several different types of descriptors for the plants they recalled, but overall, 93% of students (N=497) could describe a plant from the field trip using characteristics such as shape, color, type of movement (if observed), and texture. As shown in Figure 1, students chose different ways to describe what they remembered, most using shape, or morphology, (N=224 of the students) to describe plants such as "big," "tree," "spiky," and "tall." The following plants were named specifically; Venus fly trap (18%), the sensitive plant (15%), cacti (11%), and cotton (4%). 37% of students (N= 307) used color (such as the words "green," "purple," "pink," "white," "red," "yellow," or "brown"). Responses (N=111) that fell into the action category included words such as "move,"

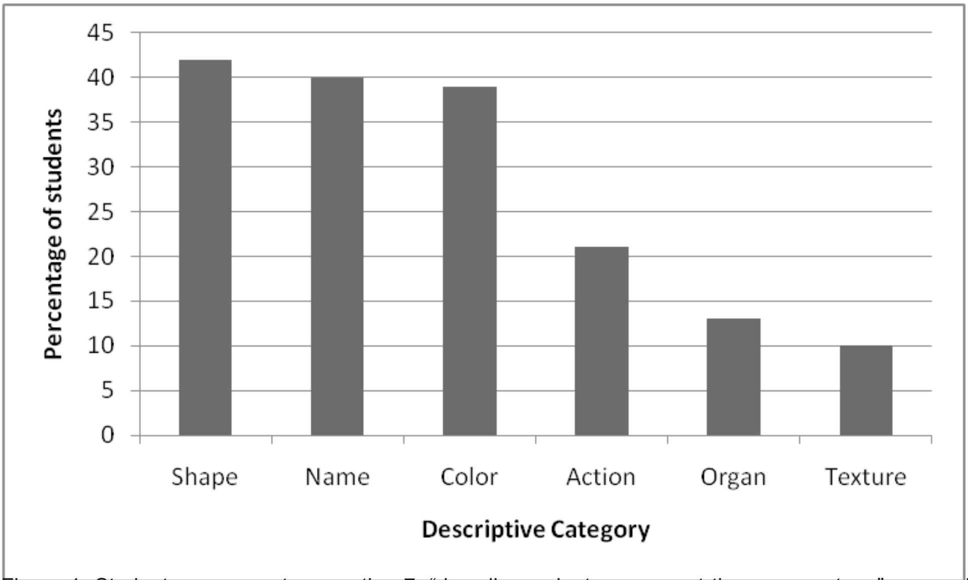

Figure 1. Student responses to question 7; "describe a plant you saw at the conservatory," grouped into the most frequent descriptive categories.

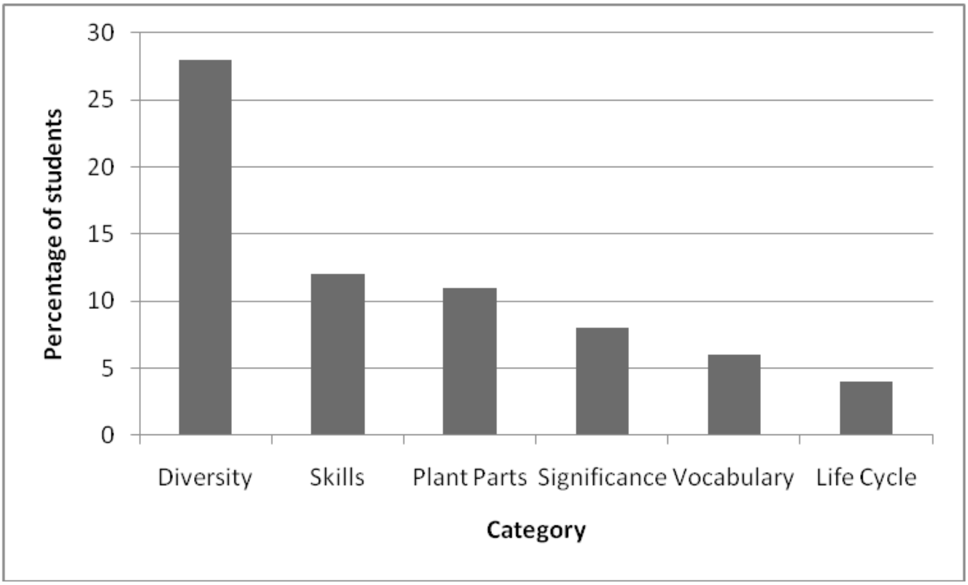

Figure 2. Student responses to question 9; "what did you learn on your field trip," grouped into the most frequently used categories.

"close," "eat," "fold," and "curl." The organ category (N=70 responses) included "leaves," "flower," "fruit," "stem," and "trunk." While texture (N=51) was inclusive for "fuzzy," "sharp," "sticky," and "fluffy."

When asked what they learned on their field trip (question 9; open response), both the lab dissection and the conservatory exploration were catalysts to learning (Figure 2). Overall, 481 students (90%) gave a plant-related response. Many students (N=149) wrote that they learned that plants are diverse, writing phrases such as "there are many different plants in the world," "there are many kinds of plants that can do cool stuff," and "there are cool exotic plants then [sic] the ones in Ohio." Students also responded that they learned how to dissect plants and how to use microscopes (N=65), showing a gain in skills. Students frequently noted that they learned that plants have parts, writing "there is a female and male part of a plant," "about different parts of a plant like a pistil," and "about the four parts of a flower." After the experience, some students understood the significance of plants in the world saying, "plants aren't just pretty they help the environment," "how they give us oxygen," and "that the most important thing in the world is plants." Several students mentioned vocabulary terms that they had learned including "stamen," "pistil," and "pollen." Students also referred to learning the plant life cycle on the trip writing, "how they grow and live," and "when pollen spreads the female part of the plant reproduces."

The activities chosen by students (question 6; forced choice) as their favorites during the trip included; leaving school (54%), using the microscopes (52%), and using the clickers (47%). Touching the plant that moved (46%), learning about plants (45%), and dissecting the flower (42%) followed close behind. When asked what they would like to do if they returned to the campus, (question 10; forced choice) students overwhelmingly chose to "take pictures" (70%). "Bringing family" came second (65%), "touch the moving plant" followed (58%), and "bringing friends" ranked fourth (57%).

Teachers who responded to the questionnaire enjoyed the opportunity to visit the campus, the hands-on experiences for the students, and the correlation to the classroom curriculum (namely the Fast Plants project). The use of microscopes and models, the background information and handouts that were provided and the exotic plants in the conservatory were also mentioned as positive aspects of the trip. All six teachers who responded to the questionnaire enjoyed the trip and were looking forward to it in 2009.

DISCUSSION

From the 533 student surveys used in the analysis of the results, students indicated that although most enjoyed the field trip and the act of leaving school, many were nervous about the experience. Three to five months after the field trip, students had strong recollections of the experience and what they learned. They used familiar words and identifiers to describe plants they recalled, mentioning shapes, common names, colors, and textures. In spite of the fact that leaf arrangement, leaf type (simple v. compound), and leaf margins were presented during the conservatory lesson, students did not use these attributes to describe plants. Students never mentioned petioles, nodes, internodes, or apical meristems during the game or afterwards in the survey. These findings were an inspiration to alter the program materials to reflect what students were focusing on about plants. The students learned how to dissect plants and use microscopes, that plants are an important part of our ecosystem and come in many different forms. The students understood that plants have parts and these parts are responsible for growth and reproduction. They recalled specific terms presented to them during the trip in regards to plant parts such as stamens, pistils, petals, and sepals. The retention of these terms could be the result of classroom reinforcement prior to and after the field trip. They rated the use of tools and touching plants as the activities they most enjoyed, and these aspects of the program were maintained.

***Implications of Study*—** Teachers who have completed pre-visit activities, are fully engaged during the field trip, and reinforce learning in the classroom can significantly increase the level of student enjoyment, understanding, and retention in regards to non-formal field trips. Strgar (2007) found that the enthusiasm and competency of the teacher was positively correlated to student interest in the non-formal experience. The conservatory staff encourages teachers to look over the plant descriptions the students are writing during the game and help their students to use botanical vocabulary and make accurate observations. The overheads used during the conservatory portion of the trip were also made available to the teacher of each class prior to the visit so they could review the material before and after the visit. This helps to reinforce the content and also gives students familiarity with the institution they are visiting. The surveys indicated that although a majority of students were happy or excited about the visit, many others were scared or nervous about visiting the college; this attitude has also been found in other studies (Ballantyne and Packer, 2002; Dillon et al., 2006; Eshach, 2007). Eshach (2007) noted that anxiety can result in undesirable behavior such as acting out and an inability to focus on learning tasks. Ballantyne and Packer (2002) established that although students valued the experience of leaving the classroom, and remembered the visit as enjoyable, those students who had engaged in pre-visit activities tended to mark the visit as more enjoyable than those who had not. Their study included data collected from both primary and secondary schools, supporting the fact that these results can be applied to a wide range of students.

Students and botanists differ widely in the terms they use to describe plants, and it is important to understand students' perspectives when designing botanical programs. Greenberg (2006) found that students often rely on a mixture of newly-acquired scientific terms and previously learned vocabulary to describe novel objects. Tunnicliffe (2001) analyzed student conversations in a botanical garden and found that the majority of students used dimensions, colors, and sizes to describe plants. The students in her study noted leaves, visible flowers and fruits, and other unique characteristics to refer to specific plants. The fourth grade students who visited the conservatory in 2008 also used layman terms to describe plants including colors, textures, movement, and common names instead of the more technical terms introduced by instructional staff during the program. Encouraging students to learn and use new botanical vocabulary meant making revisions to the materials currently used during the program.

The revisions were aimed at increasing student use of botanical vocabulary about common plant characteristics such as growth habit, number of petals, and shapes in addition to the frequent use of colors and texture. To accomplish this goal, the results from the survey were used to construct new overheads, which provided visual examples of growth forms, leaf shapes and margins, flower shapes, and fruits. Instead of seeing black and white drawings of oak, maple, and locust tree leaves, the students were presented with color representations of actual plants in the conservatory such as papaya leaves, palm trees, and pitcher plants. The overheads also emphasized the use of words like “tree,” “vine,” “needles,” and “lobes” by marking them in bold letters beneath examples depicting each character state. The directions for the game were rewritten to emphasize the characters that the students should focus on in their descriptions, such as number of petals, the plant growth form (tree, vine, hanging plant), and leaf or flower shape. Based on recent observations, the photos of plants on the revised overheads clearly excited the students and increased their level of anticipation for exploration of the conservatory.

Providing students with experiences with familiar plants and allowing them to touch plants is critical to conservatory programs. Instructors should take advantage of student fascination with carnivorous plants and familiar crops to demonstrate leaf attributes, flower function, and fruit production. For example, a picture of a Venus fly trap is now used during the program to demonstrate leaf margins, and to explain that the teeth are not actually used for chewing. When discussing fruits, the students are shown a picture of a cocoa pod and many go searching for this fruit in the conservatory after the lesson. Students take great pride in identifying an object that they are familiar with (Tunnicliffe, 2001), and the majority of students are aware of Venus fly traps and chocolate. Letting students touch the plants clearly made a positive impression on the students in our study because variations in texture were mentioned by several students in their plant descriptions. Being able to touch and smell the plants gives students additional ways to observe differences between species. They were also fascinated by the sensitive plant, which has inspired the staff at the conservatory to grow one sensitive plant (*Mimosa pudica*) for each elementary school science room so the students can extend their exploration into the formal classroom setting.

The students were impressed with the technology used during the field trip, especially the dissection microscopes and clickers used during the laboratory portion. These results have prompted the lab instructor to include the use of document cameras and compound microscopes mounted with prepared slides of pollen and ovules. Younger generations of students are very tech savvy and respond well to the appropriate use of modern tools during instruction. The conservatory staff is currently looking into how cameras can be used in response to the 70% of students who wanted to perform this activity on a repeat trip.

Results of improvements— During the 2009 field trips, clue sheets were collected from the students after they completed the conservatory game, and analysis of these sheets showed that students were describing plants using terms discussed in the lesson such as "oval leaves," "needle-like leaves," "small teeth," "long spikes on edge of leaves," "starfish flowers," "bell-shaped flowers," "3 petals," "5 petals," "tree-like," "water plant," and "vines." Students mentioning leaf margin attributes, specific numbers, and growth forms was a goal of the program and supports the notion that the revisions are having an impact.

This study shows that student surveys can be used to assess non-formal programs for long-term student retention, and that students recall specifics about a botanical field trip months after it has occurred. These types of assessments can be used to revise programs to facilitate additional student learning about plants, by bridging the gap between what students and botanists know about plants.

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Table 1. Student Survey

1 Did you go on a field trip to [university] to learn about plants? YES/NO/Don't remember

2 If yes, when did you play the "find the mystery plant" game in the conservatory? BEFORE Lunch/AFTER Lunch/Can't remember

3 Was this your first time at a college? YES/NO/Maybe/Don't know

4 Did you like visiting the college? YES/NO/Maybe/ Don't know

5 How did you feel about leaving school for the field trip? Scared/Nervous/Happy/Excited/None of these/Other_________________

6 What was your favorite thing about visiting the lab and the conservatory? Leaving school/Using the microscopes/Touching the plant that moved/ Dissecting the flower/Using the clickers/Looking at the Venus fly traps/The Desert room/Eating lunch/Learning about plants/ Seeing all the different plants in the conservatory/Other_____________________

7 Describe a plant you saw at the conservatory. (open response)

8 Do you like learning about plants? YES/NO/Maybe/Don't know

9 What did you learn on your field trip? (open response)

10 If you went to the lab or the conservatory again, what would you like to do? Look for neat plants/Touch the moving plant/Use the microscopes/Bring my friends/Ask questions about plants/Use the clickers/Bring my family/Dissect another flower /Take pictures/Look at the Venus fly traps/Other______________

Books Reviewed

Ecological

Economic Botany

Genetic

Systematics

From Plant Traits to Vegetation Structure: Chance and Selection in the Assembly of Ecological Communities. Shipley, Bill. 2010. ISBN 9780521117470 (cloth US $120.00); ISBN 9780521133555 (paper US$60.00), xi + 277 pp. Cambridge University Press, The Edinburgh Building, Cambridge CB2 8RU, UK.

What is a "plant community"? Is it a set of interacting species growing at their environmental optima (Clements 1916)? Is it a random selection from a broader species pool, each behaving idiosyncratically (Gleason 1927)? Is it a group of species each of which represents a particular functional type as defined by particular, morphological or physiological traits (Warming and Vahl 1909): Do species in a community represent strategic "solutions" and "trade-offs" constrained by natural selection (Grime 1974)? Or, as Bill Shipley writes in *From Plant Traits to Vegetation Structure*, (pp. 17-18), "What do you see when you stand in a forest?...[P]lants belonging to different species...or [a set of] plants possessing different traits? And once one has settled on a definition of a plant community, the next important question is how such a community comes to be, or, in the ecological jargon *du jour*, how it is assembled. Shipley dispenses with definitions quickly and then uses statistical models to illustrate why trait-based models of community assembly can have more explanatory power than species-based models of community assembly.

In this clearly written book, Shipley first argues that different species are associated with different environments because of different demographic processes (births, deaths, dispersal). These demographic processes in turn are not *caused by* species identity but rather are a function of morphological and physiological *traits* that are subject to natural selection. Therefore, plant communities are best seen as groups of species that have traits (or "strategies") that are successful in their local environments. Thus, community assembly can be viewed as a process of filtering: the end result of a set of (species with) traits that pass through an environmental filter. The key challenge, and the focus of the bulk of *From Plant Traits to Vegetation Structure*, is to turn this clear, but qualitative, link between traits and environment into a quantitative framework that can be used to link species that have particular traits to the environment. Shipley has been working on this problem for the better part of 30 years, and his keen insights and engaging style of writing lead the reader easily through a very dense body of theory, models, and data.

Shipley begins this journey with an analogy: the process of community assembly is "nature-as-a-biased-die" (p. 2). The world we see is the result of constantly throwing dice. The face of each die is a species, but the dice are loaded – the traits of each species bias the dice. These biases are expressed differently in different environments, or to continue the analogy, on different gambling tables. Because the environment is constantly changing, the biases are also constantly changing, and the dice need to be re-rolled just to stay in the game (*cf.* Van Valen 1973). So, consider the dynamics of community assembly as equivalent to playing craps with biased dice. Developing a quantitative model of this endless crooked game requires extensive use of probability theory and statistical mechanics.

The central two chapters of the book (and nearly 120 pages) take the reader through probablity theory, Bayesian statistics, information theory, and the "Maximum Entropy Formalism". Although the mathematics are formidable, the verbal explanations carry the reader along to the central idea: to "*find the distribution of relative abundances of species* [in a given community] *from a* [broader, regional] *species pool that maximizes the relative entropy* [or degree of uncertainty] *subject to community-aggregated trait values*" (p. 133). Chapter 4 focuses on the details of quantifying relative entropy – the throwing of the dice. Chapter 5 continues by incorporating traits as constraints on assembly – the biases of the dice. Both chapters include helpful computer code snippets in the R language that illustrate how to maximize entropy and simulate crooked craps. (It is somewhat annoying that the code was typeset without any attention to line-breaks. Thus, the important comments (prefaced by the # sign) are broken across lines, and if a reader simply scanned or typed the code *as written*, it would fail to run because the R interpreter would try to execute fragments of comments.)

A brief 12-page detour lets the reader view an empirical example of community assembly based on data collected during secondary succession after some French vineyards were abandoned (Shipley *et al.* 2006). The results of the confrontation of Shipley's model with Shipley's data are encouraging but limited in scope. The scope would be expanded if more data were available or brought to bear on the problem. Shipley asserts that this dataset is the only one available to actually test whether or not his models actually work. I suspect that combining ecological studies with trait data in floras and emerging databases would yield more chronosequences of vegetation composition, traits associated with the species, and reasonable species pools – at least as reasonable Shipley *et al.*'s dataset, which itself was not collected to address this model..

The strength of the empirical example is that Shipley *et al.* (2006) had detailed information on the species pool, the actual species in the sample, and their functional traits. In most cases, however, the composition of the species is not known. One needs precisely that information to determine the relative abundance of species in a given environment that results from filtering of traits! However, we can use the data we do have on traits and environmental filtering to forecast a species abundance distribution (SAD). A SAD illustrates the expected number of species with *n* individuals (on the *y*-axis) as a function of the number of individuals (*n*) per species (on the *x*-axis). Constructing a SAD requires no information on the *identity* of each species. In contrast, a relative abundance distribution illustrates the number of species having a proportion *p* of all individuals (on the *y*-axis) against *p* (on the *x*-axis), and *does* require information on the identity of each species. Chapter 7 explores the application of the Maximum Entropy Formalism to SADs. Although this chapter, as Shipley himself notes (p. 213-214), is not cleanly linked with the rest of the book, it does illustrate well the generality of the maximum entropy approach.

Ecologists have spent decades looking at SADs and constructing and endlessly debating complex models and ecological explanations for the predictions of these models (the current “niche-versus-neutral” debate is only the most recent salvo; see Leibold and McPeek 2006). But SADs are a special case of a general set of “abundance distributions” – including not only relative abundance distributions but also distributions of income, classes of star types, molecules of gasses, and bits of information – that can be analyzed with a common set of equations (Rostovtsev 2005). To me, bringing this paper to the attention of ecologists and expanding on this insight is one of the most important messages of this book. The observation that ecological phenomena are part of a larger, mathematically unifiable framework should encourage ecologists to look beyond the idiosyncracies of individual species or particular ecosystems and towards more general rules that can be used to understand natural phenomena.

Overall, *From Plant Traits to Vegetation Structure* provides a quantitatively strong and pleasantly readable treatment of contemporary ecological theories of community assembly. Nonetheless, despite an awareness that natural selection works on traits, a longer view of evolutionary dynamics is rarely evident. The emerging field of community phylogenetics (Cavender-Bares *et al.* 2009) seeks to link evolutionary history with community assembly. Closely-related species often have similar traits, and recent work illustrates that traits with strong phylogenetic (and hence species-linked) signals are filtered similarly along environmental gradients (Pillar and Duarte 2010). Although Shiplely does not apply the Maximum Entropy Formalism in this evolutionary framework, the generality of the model provides some cause for optimism. The time spent reading *From Plant Traits to Vegetation Structure* will be time very well spent in preparing for the next generation of models of community assembly.

– Aaron M. Ellison, Harvard University, Harvard Forest, Petersham, Massachusetts 01366 USA (aellison@fas.harvard.edu)

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Plant Microevolution and Conservation in Human-influenced Ecosystems. Briggs, David. 2009. ISBN-13: 978-0521818353 ISBN-10: 0521818354 (Hardcover US$157.99) ISBN-13: 978-0521521543 ISBN-10: 0521521548 (Paperback US$75.00) xix + 598 pp. Cambridge University Press. Cambridge, UK.

There is a tendency amongst ecologists and evolutionary biologists to examine populations in a "natural" setting; that is to say in the absence of obvious human influence. In order to try to untangle the complex interplay between ecological and evolutionary processes and the patterns they generate, it is necessary to remove the confounding effects of human influence given that one subscribes to the assumption that most of these natural processes have been taking place long before *Homo sapiens* ever made their appearance. There is a certain validity to this assumption because the explosive growth of human populations has resulted in the strongest anthropogenic ecological impacts being generated in the last few thousand years, hardly even a tick on the evolutionary clock. However, as we try to gaze forward and comprehend the possibilities for the future, this bias does not serve us well because it is simply not possible to understand the process of evolution today outside the context of human influence. This is one of the central themes of David Briggs' new book, *Plant Microevolution and Conservation in Human-influenced Ecosystems*, a comprehensive yet accessible treatment of evolutionary biology and conservation issues, unique, as far as I am aware, on its focus on plants. The stated audience of the text is students, undergraduate and post-graduate, as well as interested general readers. With 500+ pages of text in 21 chapters and 79 pages of reference, there is more than enough to appeal to and challenge such a wide-ranging audience.

David Briggs is Emeritus Fellow of Wolfson College and former Curator of the Herbarium at Cambridge University. With the botanist Max Walters, he wrote one of the classics of plant evolutionary biology, *Plant Variation and Evolution.*1 Briggs and Walters has mentored students for over four decades and is as balanced and relevant today as it was in 1969 when the first edition was released. In many ways Briggs' new work is a companion to the classic text with the latter being a standard reference for a backward-looking view on how evolution shaped plant populations before human influence (although, not exclusively) and the former being a forward-looking view examining plant microevolution since the arrival of humans.

Plant Microevolution and Conservation in Human-influenced Ecosystems is essentially organized into three-parts with a past, present and future structure. In the first seven chapters, Briggs provides a historical context and solid overview of the Darwinian ideas and modern methods used to look at plant microevolution —evolution below the species level. He also reviews the history of human-influence on ecosystems as well as examines their impacts. For areas that are close to the reader's interests, components of these chapters may come across as being too basic. For instance, there is a reproduction of the genetic code and how the triplet codon sequence determines amino acid sequence which seemed unnecessary. However, it quickly becomes apparent that what is repetitive for one reader will serve as a good refresher for another as the substantial breadth of introductory information is revealed. Few readers would have familiarity with the entire range of evolutionary, conservation and anthropological observations and concepts that the author summarizes. For example, many parts of Chapter 4, the review of the human history of ecological impact from the perspective of human population growth, were fascinating and new to me. I was reminded how dramatic the human population expansion has been and that many ecosystems that were largely free of such influences just a few thousand years ago now face anthropogenic pressures akin to a plate of bacteria exposed to an anti-biotic. This pressure creates what Briggs identifies as a dichotomy between species that are "winners" (i.e., the anti-biotic–resistant bacteria) and "losers" (i.e. all the other bacteria) in the context of human influence.

The subsequent six chapters, Chapters 8-13, will have a familiar feel to readers of Briggs and Walters. With a logical and thorough approach, the author looks at present plant microevolution vis-à-vis some of the best-studied human impacts on ecosystems such as farming, ranching, forestry, pollution, introduction of invasives, habitat fragmentation and habitat destruction. Each topic is presented with an identification of important questions and a review of the studies that have tried to answer these questions. For example, what is the consequence of wide-spread herbicide use? The author looks at why herbicides are used in agriculture then proceeds to look at herbicide resistance, the speed with which resistance develops and then the population consequences of this resistance. Extensive references are provided, permitting particularly motivated readers to follow up on each topic. The benefit of an authoritative review of a topic is that the answers that have yet to be satisfactorily resolved, as well as new questions become readily visible. For this reason, readers will be stimulated to pursue new lines of research in these areas.

A common question upon the identification of our ecological impact is: "What can we do about it?" The question of how we can mitigate and manage the human impact on ecosystems is the subject of the final eight chapters. Briggs critically examines the role of *ex-* and *in-situ* conservation, restoration, reintroduction and reserves. Each subject is broken down into key components. For example, on the topic of reserves, the reader is introduced to the concepts of fragmentation, edge effects, the impact and role of corridors and reserve design. What is refreshing about this treatment is that these ideas are generally illustrated from plant examples, not just charismatic mega-fauna, although animal examples are certainly used when necessary. The last three chapters of the book look at climate change and its over-arching influence on the microevolution and conservation issues that are discussed in the previous chapters. There are times when these chapters feel heavy with quotes from IPCC reports and that they are tacked onto an already complete book, but there is no debate that much uncertainty in our understanding of conservation issues hinges on the fact that we can-not refer to any past experience when it comes to the influences of climate change.

Plant Microevolution and Conservation in Human-influenced Ecosystems is a book that successfully offers broad and balanced coverage of Darwinian ideas as they operate today in plant populations. It could only be written by a professional botanist. However, a lasting impression of the text is that it is also a personal oeuvre, a coalescence of contrasting impressions formed from a young age in South Yorkshire where industrial landscapes were juxtaposed against natural beauty. The questions and concerns introduced in this book are complex and multi-disciplinary, and to tackle them requires a historical and scientific knowledge, as well as social and political awareness. Most of us are not educated or experienced with such breadth and depth, and there is a distinct sense that the author is trying to contribute to the training of such individuals by sharing the personal knowledge and wisdom acquired in a productive and ongoing career. The fact that ecologists, evolutionists and conservation biologists have huge and separate international annual meetings attests to enormity of each field. As a result, the shear amount of information required to grasp the collective and overlapping issues is daunting at times and this is why, in an environment where journal articles are the norm, a comprehensive book is required to centralize major ideas. If a hallmark of science is the generation of some predictive ability, Briggs reminds us it is necessary to further integrate these fields to try to understand what the future offers. The book is thought-provoking as advertised; it is also quite humbling.

-Tan Bao, University of Alberta.

[1] Briggs, D. and Walters, S.M. (1997). Plant variation and evolution (3rd ed.) Cambridge University Press, Cambridge, UK. 256 pp.

The Art of Plant Evolution. W. John Kress and Shirley Sherwood. 2009. ISBN 978-1-84246-421-2. Pp 320. Kew Publishing.

This is a curious volume that merges botanical illustration with modern science. The idea is fantastic, trying to teach botanists a little about art and artists a little about science. Such a cross cultivation of ideas can go a long way, although probably requires a more idiosyncratic approach than was taken here.

This book is organized around a modern phylogenetic tree, largely generated by the Angiosperm Phylogeny Group (APG), with a few gymnosperms, pteridophytes, bryophytes, and two out groups (a fungus and a brown algae) thrown in. The authors, Shirley Sherwood, an art collector, and John Kress, an evolutionary botanist, cover over a hundred botanical illustrations from Sherwood's collection, representing a wide swath of taxa, especially angiosperms. They devote two pages per plant, with both author's contributing text in their areas of expertise. Each pair of facing pages contains one botanical work of art, plus occasionally a zoom-in detail. Although a *scala natura* is no longer fashionable, the authors present plants in such a traditional order, albeit with an unexpected interleaving of rosids between several groups of non-rosid/non-asterid core eudicots.

For each plant illustrated, Sherwood provides a brief biography of the artist, while Kress provides a summary of how molecular biology, especially DNA sequencing, implies phylogenetic placement. Occasionally, the author's provide other snippets, such as about the artist's style or about the plant's biogeography or pollination mode. Kress's brief insights into pollination were always nice. Often there is a lot of white space on each page, allowing us to really appreciate the illustrations.

Emphasis of the text is on sytematic placement, so this book may have been better called "The Art of Plant Systematics". Both the main text and the inside back cover provide a visually elegant simplified phylogenetic tree. As a casual reader or as an artist, this is much better than looking at boring computer-generated output from a phylogenetic computer program. But there is much more to plant evolution than simply phylogenetics and systematics. And these other evolutionary aspects are unfortunately largely missing from this book.

In rare instances, interesting evolutionary gems are mentioned. For instance, with temperate violets, "It is a curious fact that the same plants also produce much reduced flowers hidden under the soil that never open and are consistently self-pollinated and inbred." I would have loved such pearls on most pages. That would have really drawn non-biologists into science, much more so than discussing who is related to who. The botanical painting of the violet is also lovely insofar as it is a rare illustration of the entire root system. While not as technical, another pearl is that *Heliconia* was named after the Greek mountain Helicon, home to the muses, thereby signifying that *Heliconia* was and still is thought to be related to *Musa*. Many non-botanists would love reading that sort of material from cover-to-cover…and Kress probably has that knowledge at his fingertips.

The editing of this book was substandard, with lots of redundancy, self-contradiction, and other gaffes. For example, at the top of one page Kress says, "This order [Arecales] consists of a single family, the palms, with 2,000 species. Yet, near the bottom of that same page Kress says, "Over 2,775 species and 200 genera make up the palm family." A few assertions are blatantly wrong, yet could have been very illuminating about plant evolution. Kress says that *Gingko biloba* gametes are wind dispersed, by which I assume he means male gametes. However, since the late 1800s, we have known that gingko and cycad male gametes – i.e. sperm – swim to the egg using numerous flagella. While gingko pollen is dispersed by wind, pollen is a gametophyte, not a gamete, thereby missing an important evolutionary lesson that could have been taught to non-scientists. As a final example, we do not need to know that "Vicki Thomas is an attractive and energetic botanical artist." Of course she is a botanical artist and, more importantly, her attractiveness is irrelevant.

Overall, I really like this book, but was nonetheless hoping for better. The book needs more quixotic observations, remembering that, "Darwin admonished us not to ignore the 'oddities and peculiarities' of life as we see it today. It is by the analysis of such oddities that evolutionary history can be reconstructed." (Margulis & Sagan 1988: 26)

— **Root Gorelick**, Department of Biology, Carleton University, Ottawa, ON Canada K1S 5B6

Essential Oil-Bearing Grasses. The genus *Cymbopogon*. Anand Akhila, Editor. 2010. ISBN 978-0-84937-857-7. (Cloth US$139.95) 245 pp. CRC Press, Boca Raton, FL.

The audience for this book appears to be the industrial users of extracts of lemon grass, the overall common name applied to this genus of tropical grasses. *Cymbopogon flexuosus* is a major source of citral used for flavoring as a substitute for lemon. In addition, citronella oil, derived from *Cymbopogon winterianus* and *C. nardus*, is important for the perfume industry, repellants, soap, and other uses. References cited are extensive.

A great deal of technical information on the chemistry of the compounds is presented and the chapters are rife with structural formulae. In addition to chemistry, there are chapters on toxicology, trade, and harvest. Inexplicably, little information on the culture of these grasses is presented. Also lacking is significant information on their role in natural plant communities and how indigenous people used them.

The book could benefit from more careful editing. For example, names for all *Cymbopogon* species on the International Plant Name Index site are listed with little indication as to which are synonyms. How is the reader to use this information? Likewise, the table recording the export of lemongrass oil from India takes four pages. There are similar extensive tables with little informative value, i.e., French South and Antarctic Territories imported 1 kg of lemongrass oil from India in 2007. One gets the impression that data is presented without any—no pun intended—distillation.

The few black and white images are poorly produced resembling those from an office photocopier. While this small expensive volume (about $0.60/page) might be a helpful resource for anyone working with plant essential oils, I would not recommend it for any but the most specialized user.

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

Maize Cobs and Cultures: History of Zea mays L. Staller, John E. 2010. ISBN 978-3-642-04505-9 e-ISBN 978-3-642-04506-6 DOI 10.1007/978-3-642-04506-6 (Cloth US$ 179.00) ix + 262 pp. Springer. P.O. Box 2485, Secaucus, NJ 07094-2485.

This volume is a digest and a progression from papers in the massive 48-author volume edited by Staller, Tykot, and Benz, 2006. The author here follows other books in the same sphere he has written or co-edited recently. The main emphasis is on the prejudgments and influences that have affected studies and interpretations on (a) the origin and phylogeny of maize, (b) the antiquity of maize, and (c) the value systems of maize held by pre-Columbian peoples in the Western Hemisphere. In some respects this is an apologia for past assumptions by ethnohistorians, ethnographers, archaeologists, and ethnobotanists, and an effort to set a current perspective. The author's works are covered comprehensively. Substantial parts of the same analysis, less repetitive and more easily digested, are in the 2006 book, which has the added value of glossaries of terms in the various articles. Nonetheless, the 2010 book is thoroughly referenced and is a compilation resource. Accordingly, the writer, while presenting his own synthesis and a composite view, provides a service to the research-user. Thankfully, searches can be done in the entire text through Springer's access via Amazon, and the reader can locate citations and terms at will.

The influences of past assumptions are visited repeatedly throughout. Highlighted are uncritical absorption of ill-supported claims for the origin and phylogeny of maize; time determinations based on limited methodologies such as associations rather than on direct dating with multi-dimensional evaluations; and biases in perspective that have been imprinted onto indigenous peoples. Much emphasis is given to Old World bias, among students of New World agriculture, with respect to productivity of grain per se. In contrast, substantial information is provided for the use of stalks for sweet juice, of maize for fermented beverages, and of the plant and grain for social and intercultural and religious form. According to the author's studies, in

Ecuador maize was a secondary food source in its earliest identified introduction, approximately 4000 BP. If maize was domesticated to be a storable grain, initiating static agriculture, the argument of the author is that ethnobotanical evidence provides little support. The origins of agricultural practices are encircled but not defined in the book. I expected, but did not see, mention of one major difference between domestication of cereals in the Fertile Crescent and in the Western Hemisphere: In contrast to the small grains, which are largely cleistogamous and self-fertilizing, maize is freely cross-pollinating and promiscuous. This has supported great diversity and high plasticity of the species.

The treatment of the origin of maize may mislead a casual reader, specifically if one does not read the whole. The historical survey has P. C. Mangelsdorf quoted or cited early and over 50 times in the text. As the author ultimately points out, Mangelsdorf held the dubious honor of maintaining a theory (more appropriately an hypothesis) of the origin of maize that was experimentally discounted on cytological grounds and was untenable. That hypothesis was a baseline for many, though not all, ethnohistorical studies for well over 50 years. A more tenable proposal by Beadle in 1939 (and others) was based on sound and rational grounds, has since been steadily supported by morphological and phylogenetic studies, and has been proven by molecular means, —but full proof is not documented until p. 94. Even some claims by some of Mangelsdorf's protégés are afforded attention early on. Staller cites one protégé multiple times, implying at first credibility to questionable evidence, which is only discounted on p. 94 and pp. 123-124. The issue is fully faced on pp. 119, 123-124; – The paper by Bennetzen et al., 2001, which is the definitive presentation of genetic evidence and multidisciplinary evidence regarding the origin of maize, is cited then as a "final rebuttal" but at in only two places in the volume. That paper, in full, lays out both the validating evidence for the teosinte origin and the invalidating evidence for a Tripsacum hypothesis. Uneven weight, besides that for Bennetzen et al. 2001, is given to key sources: The chapter by Galinat (1988) is a comprehensive and primary resource, but is only cited once, and only incidentally, in the text. The book by Mangelsdorf (1974), however, is cited repeatedly. One source of information is overlooked: Crosses of Tripsacum with maize, backcrossed repeatedly to maize (e.g., Grimanelli et al., 1980 a, b), were conducted to transfer diplosporous apomixis from Tripsacum to maize. Despite exhaustive efforts, their results in no way supported ready transfer of traits into fertile maize, much less transitions from one to the other, and are contradictory to any conspecific relationship.

Very nearly contradicting the previous, p. 222 states the following: "Despite the enduring controversy [reviewer's italics] over the phylogeny, origins, chronology, macrobotanical identification, and routes of dispersal of maize…. …" – itIt should be more appropriate, instead of "enduring controversy," to use words like "unfolding story." The phylogeny and origins, at least, are no longer controversial.

Criticisms: The writing is dense with terms that are not always defined in place, especially native or Spanish words. The flow is also interrupted throughout by references cited in clusters, some of which are less relevant than others and some even inconsistent. In addition, the production of the book is seriously flawed. The writer and the publisher have previously produced highly readable and editorially clean papers, but the text is so sprinkled with errors in syntax, typography, and redaction that it is as if it has been dictated, transcribed without review, and published hastily without emendation by the publisher. On the other hand, there is no acknowledgment of help from a transcriber, reviewer, or editor. Comma faults, subject-verb agreement, misspellings, extraneous words, incomplete words or sentences, repeated phrasing, repeated concepts, citation errors, and grammatical non-sequiturs are so common that they often leave the meaning unclear or distract the reader. Some errors of a bit higher order: (1) Mismatches between text citations and the Reference list (a few examples, cited but not in references: p. 141, Hard et al. 1976; p. 94, deWet and Harlan 1976; p. 192, Hart and Matson 2009). (2) Fig. 2.26(a) shows ears from Cuzco that are described as popcorn but are instead the well-known, large-kernel flour corn from this area. (3) Fig. 3.1, "Map showing the spread of maize …" is important yet is all but unreadable; its source or credit is unstated. (4) Fig, 3.3 states that "Maize is highly mutagenic" – the correct term is "mutable". ." (5) Puzzling meaning, p. 106: "Some members of the related genus Tripsacum are locally referred to as "teosintes," plants that have compound leaves, a Cycad." (6) Terminology: the term "cob" should be used only for the structure upon which the kernels are borne, and "ear" for the filled cob. The text often uses "cob" for ears. "Spout" is often used where "sprout" is meant. (7) Fig. 3.11, a photograph of teosinte, is cited on p. 120 in respect to Tripsacum origin but is not relevant. (8) P. 143, footnote 23 is cited but is not shown. (9) P. 156 cites Fig. 2.13a but refers to Fig. 3.13a, and cites Fig. 2.2b but refers to Fig. 3.2b. (10) Fig. 4.3, "Teosinte male inflorescence or tassel."— – this morphology does not represent all teosintes. (11) P. 177 cites Fig. 2.7 but refers to Fig. 3.7. (12) P. 197, 13C decay data are described as "resulting in what are referred to as C3 and C4 plants."— – the data do not result in, but discriminate, them.

If one has deep curiosity about maize and cultures (that is, cultures of indigenous peoples and of scientists who study maize history); if one is prepared to expand study by referring to sources; and if one has tolerance with text flaws and redaction, this volume is a thorough access point.

-Edward Coe, University of Missouri, Columbia, Missouri 65211-7020.

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"To know the name of a plant, and to be able to ascertain its place in the Linnaean system, is, in the opinion of many, to be a botanist: although such a person may be entirely unacquainted with its anatomy, or organic structure, and ignorant of its peculiar, or medicinal qualities: as well as of the nature of its food, and the means of its nourishment; yet these are the things which principally govern its nature."

-Benjamin Waterhouse, 1811, *The Botanist* (2nd botany textbook written in the United States)

Gene Flow between Crops and Their Wild Relatives. Andersson, Meike S. and M. Carmen de Vicente. 2010. ISBN 978-0-8018-9314-8. (Cloth US$60.00) 564 pp. Johns Hopkins University Press. .

This is a timely, well-edited compendium of information on major crops and gene flow between them and their wild relatives. It "focuses on one particular concern that is of utmost importance for the release of GM [genetically modified] crops in or around areas with concentrated crop diversity—the likelihood of gene flow and introgression to crop wild relatives and other domesticated species." With the increased use of GM crops around the world, this book will be of value.

Twenty crops (Banana and plantain, barley, canola, cassava, chickpea, common bean, cotton, cowpea, finger millet, maize, oat, peanut, peal millet, pigeonpea, potato, rice, sorghum, soybean, sweet potato, and wheat) based on world acreage, availability of GM technology, and role of the crop in food security. Each of the twenty crops are discussed relative to center of origin and diversity, general biology (ploidy level, hybrids), flowering including phenology, pollinators and general life history; pollen dispersal and viability, sexual reproduction (heterozygosity, genomic information), vegetative reproduction,

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

Flora of North America. Volume7. Magnoliophyta: Salicaceae to Brassicaceae. Flora of North America Editorial Committee. 2010. ISBN 978-0-19-531822-7 (Hardback. US $95.00; £60.00) 797 pp. Oxford University Press, 198 Madison Avenue, New York, New York 10016, U.S.A.

With Volume 7, the FNA Editorial Committee has produced 16 volumes, thereby passing the halfway point in publication of this landmark series. General commentary concerning the layout is unnecessary given that it is unchanged from previously volumes and most readers of this review probably are well familiar with other volumes.

This book treats eleven families, including (in order) Salicaceae (which now includes *Flacourtia* and *Xylosma*, formerly of the now non-existent Flacourtiaceae), Tropaeolaceae, Moringaceae, Caricaceae, Limnanthaceae, Koeberliniaceae, Bataceae, Resedaceae, Capparaceae, Cleomaceae, and Brassicaceae. These families include 125 genera, 17 of which are endemic, and 923 species, of which 593 are endemic. Of these, 196 taxa of conservation concern, many of them in Brassicaceae. Introduced species (138) account for ca. 14.9% of the Flora. Approximately 31% of the taxa are illustrated.

The majority of Volume 7 covers the willows (Salicaceae) and mustards (Brassicaceae). Considerable attention is given to hybridization in Salicaceae (*Populus* and *Salix*). *Populus* (written by James Eckenwalder) includes separate keys to flowering, fruiting and leafy (sterile) specimens. The genus *Salix* (by George Argus) includes 113 species in the FNA region. Over 5-1/2 pages are devoted to a discussion of the biology of the willows, including an historical overview of the generic classification, information on its ecology (including seedling establishment), propagation, morphology, intraspecific variation, hybridization, polyploidy, economic uses, and conservation. I was happy to see Argus plug his own interactive key for *Salix* (http://aknhp.uaa.alaska.edu/willow), which he suggests may be more reliable than the printed dichotomous keys, given the widespread variation within some taxa. Where needed, a separate paragraph summarizes the biology and recognition of confirmed hybrids after description of the parental taxon. In some cases (e.g., *S. alba*, *S. arctica*) the space devoted to the biology of the hybrid taxa exceeds considerably that of the focal species. In some cases (e.g., *S. ovalifolia*), a key is given to the named hybrid taxa (in this case, at the varietal level). Of notable value is discussion of similar species, which will help workers identify difficult specimens.

Capparaceae is now treated apart from Cleomaceae, the latter of which is much more prevalent in the FNA region. The well-known Rocky Mountain bee-plant is now *Peritoma* (not *Cleome*) *serrulata*. The common moniker of this species is appropriate. For several years in Colorado we allowed one plant in a small native plant garden to grow to full size (over a meter tall and nearly as wide, when watered heavily). Bees visited the plant in great numbers, which we can only presume led them to other flowers nearby.

Slightly over 70% of the volume (excluding introductory material, literature cited, and the index) covers Brassicaceae, which was written largely by Ihsan Al-Shehbaz, a lifelong student of the family. Prepare to re-learn some generic boundaries among the mustards, for plenty of changes have occurred in recent years. A short key to genera (p. 229) directs users to 4 groups of genera keys, based on type of trichomes, presence or absence of cauline leaves (and whether auriculate), and whether fruits are linear of some other shape. A 4-winged, circular icon (see p. 228) is included at the end of generic couplets if mature fruits and seeds are needed for identification of subordinate couplets; this feature surely will help many users. The entirety of *Lesquerella* is now in synonymy under *Physaria*, which at 88 species in the FNA region is third in size within the family (in the FNA region) behind *Draba* (121 species) and *Boechera* (109 spp). Considerations of ploidy level and apomixis were given particular attention in re-consideration of recognized species in *Boechera*.

In my view, Volume 7 is a desirable, if not required, addition to the library of any active North American plant ecologist or taxonomist, given that virtually all broad taxonomic or ecological field study inevitably leads workers to species of Salicaceae and Brassicaceae, and both families have many challenging taxonomic groups.

My complimentary copy arrived with considerable water damage along the lower part of the spine and front cover. I can use this situation as a point of praise, since the binding and signatures withstood the damage, despite the inevitable wrinkling and a small amount of reddish fungal growth. After 72 hours on a plant drier, however, the volume was perfectly usable.

Like all volumes of the series, this contribution represents the only taxonomic summary across the FNA region for most of the taxa covered. If past and potential granting agencies wonder whether the volumes are worth their long gestation periods, this reviewer answers unhesitatingly in the affirmative. Delays do arise in production and publication, but that typically is a price we pay for good science.

May the FNA series come to its full fruition in the years ahead.

— Neil Snow, Bishop Museum, 1525 Bernice Street, Honolulu, HI 96817.

Plants of Central Texas Wetlands. Scott B. Fleenor and Stephen Welton Taber. 2009. ISBN 978-0-89672-639-0. (Paper$27.95.) 275 pp.Texas Tech University Press, Lubbock, TX.

This is the kind of book I would like to write, a flora of a local area of great botanical interest imbued with the passion of the authors. The title is somewhat misleading, the plants occur in the Ottine wetlands of south-central Texas rather than in the more expansive central Texas region. These wetlands include elements from the southeastern United States at their western extent as well as western species near their eastern limit making the flora of phytogeographical interest.

The plan of the book is simple, straight forward, and effective. In the first chapter, the geology, soils, vegetation history, plant communities, and detailed descriptions of some areas are described. The majority of the book is devoted to entries dealing with individual species.

These entries are thorough with descriptions perhaps more extensive than necessary with loads of fascinating references to the biology of the plants and the authors' observations. For example, I was interested to learn that *Lobelia cardinalis*, a plant I have studied, has a fenestrated corolla admitting nectar thieves (page 148). In some large and complex groups, as *Carex*, superficially similar species are discussed (page 110).

For the user, an identification guide like this requires quality images. Overall, the pictures are clear, informative, and well printed with very good color separation. One could point out minor problems like the vertiginous attitude of *Lamium amplexicaule* (page 120) or the close up of *Boehmeria cylindrica* (page 185) giving the initiate no idea of what the plant looked like but these and a few other problems do not detract from the immense value of the 260 full color pictures.

A nice feature of the book, usually absent from such guides, is the inclusion of some bryophytes (though no *Sphagnum*) along with the algae *Chara* and *Nitella*.

The back material is extensive and useful—including a complete checklist, what appears to be an excellent index, and references cited.

This volume is well produced and carefully edited. A real value at less than $30.00! It is an exemplar for future studies and will be an invaluable reference for anyone interested in the flora of the southeastern United States, especially wetlands.

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

Lone Star Wildflowers: A Guide to Texas Flowering Plants. Lashara J. Nieland and Willa F. Finley. 2010. ISBN: 978-0-89672-644-4. 321 pages

Lone Star Wildflowers: A Guide to Texas Flowering Plants contains a wide range of information covering the myths and legends, medicinal or landscape uses, history, and other fun facts for various Texas wildflowers. The book is not meant to be a field guide on plant identification but more as a supplement to these guides. The text is well-written and flowing. It starts out with a brief biography for each family, followed by a presentation of various wildflower species separated on the basis of flower color. The family biographies are insightful and provide distinct traits for each family. Within each color chapter, the flowers are further separated into families, then species. Each species is listed with its scientific name, several common names, information on current and historical uses, and a striking photograph focusing on the floral details. Each color chapter ends with an 'Exploring Further' section containing more in depth photographs of some plants, including flower color variations, leaves, buds, fruits, and entire plants.

There are no morphological keys in this book since the book was intended to provide a broader range of information, but the book would have benefited from a map of Texas showing the general localities for these flowers so readers knew where to look for them and could gain further insight into the historical information included. Although the photographs are very detailed, most lacked a name immediately next to the picture, and it was not always obvious which picture went with which description. Furthermore, the photographs are deceptive with respect to flower size, and since there is no mention of size in the species descriptions, this may create some confusion for general users. Also, two of the color chapters, green flowers and white flowers, are so similar for some species that it may be more useful to combine the two chapters or place them next to each other to avoid confusion. Poaceae is not included in the guide, but Ephedraceae is listed even though it is a gymnosperm. However, this fact is clearly indicated in the text.

Overall, this is an enjoyable book and perfect for Texas flower enthusiasts who wish to learn insightful facts about the history and uses of wildflowers. However, while the book is a useful supplement to other plant identification guides, it is not useful alone, since there is little information on plant morphology, habitat, or distribution. This book is more suited for general botanists who wish to learn more fun facts about wildflowers. Still, it is a truly outstanding work and a pleasure to read.

-Traesha R. Robertson, Texas Tech University.

The Kew Plant Glossary: An Illustrated Dictionary of Plant Identification Terms. Beentje, Henk J. 2010. ISBN 978-1-84246-422-9 (Paper US$30.00) 170 pp. Royal Botanic Gardens, Kew, Press through University of Chicago Press, 11030 S. Langley Avenue, Chicago, IL 60628.

The Kew Plant Glossary, compiled by Henk Beentje, a botanist at the Royal Botanic Gardens, Kew, is a thorough collection of terminology relevant to botany. The glossary contains 4144 defined terms with 735 accompanying illustrations. It also has 28 illustrated plates of grouped terms, a bibliography, and lists of common symbols, prefixes, and suffixes.

This glossary is a welcome companion to my collection of plant keys and field guides. It is an approachable work with readable font and concise definitions. The author provides only one or two definitions to prevent confusion and provide much needed continuity in the field. Though the glossary focuses on descriptive terms and plant morphology, it also provides definitions to many terms common throughout all plant literature ranging from ecology, genetics, evolution, to forestry. There are, however, some poorly defined terms in this glossary. For example, "d.b.h." is defined as "diameter at breast height" and has an illustration of a person standing next to a tree trunk with an arrow on the tree at the person's chest height. It would be more accurate to define "d.b.h." as the diameter of a tree bole at 4.5 feet or 1.37 meters from the ground, the standard in forestry. These cases are few and in no way take away from the value of this work.

The illustrations, by Juliet Williamson, are simple sketches or line drawings that accompany many of the terms to provide visual clarification. The structures and forms illustrated in this book are clear, but arrows that point to specific features are left out in some of the more detailed illustrations. This may be because these structures are obvious to the author, illustrator, and botanists, but these structures may not be obvious to those outside the field. Again, this only occurs in a few cases. The number of illustrations is nicely balanced; the glossary is not overrun with illustrations, nor does it contain too few.

One of the more valuable features of this glossary is the 28 illustrated plates of grouped terms. This section provides a series of illustrations of various morphologies, e.g. leaf shapes, surfaces, and inflorescences, for comparison. There will always be confusion due to plant variation, but these plates certainly help the reader determine what form or shape particular terms describe.

Overall this glossary is beyond my expectations. I've yet to come across a confusing or unknown term in an identification key that was not in *The Kew Plant Glossary*. The addition of the illustrated plates of grouped terms, list of common symbols, prefixes, and suffixes, and a bibliography greatly add to the value of this book. I am sure this glossary will be the first resource many botanists, ecologists, and naturalists reach for when an unfamiliar term springs up in identification keys, journal articles, or plant descriptions. My copy of *The Kew Plant Glossary* has found a permanent home next to my dissecting microscope.

-Kevyn J. Juneau, The School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI 49931.

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- Editor

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