Botanical Society Of America

Plant Science Bulletin

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Getting Ready for Botany 2014

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In This Issue.....

Botanical Society Of America
AAAS
Advancing Science, Serving Society

Celebrating BSA Members as New AAAS Fellows.....p. 11

Yearlong Celebration of the AJB *Centennial Begins.....p. 13*

Botanical Education in the United States Part 3 .....p. 28

From the Editor

This issue marks the beginning of the 60th year of *Plant Science Bulletin*, as we also celebrate 100 years of the *American Journal of Botany*—so let's begin the celebration! Sixty years ago *PSB* debuted with a "Challenge to Botanists" to use *PSB* as a platform to address the problems afflicting botanical education. That continues as part of our charge and is the main focus of this issue. Thirteen years ago we presented "The Theory of Plant Blindness" in these pages. In this issue, Peter Pany provides convincing evidence that by careful choice of the plant materials we use as examples in our teaching, we can effectively stimulate plant vision in our students. Although the study focuses on K-12, the 12th-grade results are certainly directly applicable to college freshmen. (I must note that there is a certain irony that we feature a report on countering "plant blindness" in the same issue we remember the co-founder of that theory.)

In the second article, I describe the role of the Botanical Society of America in promoting effective botanical instruction during its first half-century. This is the third installment in my series on the history of botanical instruction in the U.S. It may be surprising to find how many of the difficulties we currently face in presenting our discipline in the classroom that were also of concern to our predecessors. It is instructive to see how they addressed these problems and how their response affects the BSA today.

-Marsh

Table of Contents

Society News
Botany Conference: A Touchstone for Ideas and Inspiration 2
BSA Science Education News and Notes 6
Editor's Choice Review 7
Announcements
In memoriam - James Howard Wandersee - Botanical Science Educator 8
Personalia – Newly Elected AAAS Fellows 11
E.O.Wilson Biodiversity Symposium 12
The *American Journal of Botany* Celebrates Centennial 13
Reports
Students' interest in useful plants – A potential key to counteract plant blindness 18
Botanical Education in the United States: Part 3. The Botanical Society Builds the Discipline, 1895-1960 28
Book Reviews
Bryological 62
Developmental and Structural 63
Economic Botany 64
Phycological 64
Systematics 65
Books Received 68
Volume 59 Reviewers 68

Botany Conference A Touchstone for Ideas & Inspiration while Building Connections

The buzz of scientific collaboration fills the hallways, nooks, and crannies of the hotel. Across the diverse scope of botanical study, there is a sense of excitement about what can be learned in conversations between the "rock stars" of the botanical world and the emerging new scientists.

Diversity in the Botanical Society of America is big and bold, open and loud. It means not only that the Society is open to all colors, shapes, genders and types of botanical scientists, but that it engenders a kind of challenge to bring something bigger to the table. It's more than just talking about your field of study—it's about actively understanding how your field of study fits into the bigger picture and makes a difference to the world.

The Botany Conference, representing over 6,000 plant scientists across the world, is a lot like a family, say some of its attendees. The difference might be that this particular family has learned to discuss issues in a positive way. "We bring issues forward in a way that promotes the science and teaches the individual to be a better scientist," said program chair David Spooner. "We believe in good science."

Janice Coons, a 20-year member, calls BSA an "all-inclusive family. Here, you feel like a first-class citizen. Students feel that sense of excitement too." Anitra Thorhaug calls the BSA "larger thinking, more focused to the future" as an organization. As a senior scientist, she said the society's multi-discipline umbrella allows her to build unique and valuable friendships and resources.

Professor Chris Martine sees BSA and its annual conference as a way to access and network with the professionals in the field. "It's an active community of botanical scientists," he says. "You come to a meeting so you are connected."

And that, he prompts, is the crux of the matter. That connection is imperative to a scientist's ultimate success. "We have to be reminded we're part of a bigger endeavor and part of a larger group of really cool people, not isolated. We're all people trying to figure the same things out," Martine explained.

One good way to see that is the program called PLANTS, where scientists actively mentor students new to the Society and to the conference so they have a great experience and get the most out of the meeting. They connect and get tips and suggestions for the day, but most say the biggest take-away can be friendships that last through a lifetime.

The Botany 2013 crowd applauds Nalini Nadkarni, last year's plenary speaker. Conferences are more than just talking about your field of study—it's about actively understanding how your field of study fits into the bigger picture and makes a difference to the world..

Ann Sakai, who helps to coordinate the program from the volunteer side, says the relationship-building side of the PLANTS program sends fingers of learning in both directions. "Everyone is learning something," both the students and the mentors.

"You never know what might pique your interest in one of these conversations," said botanist Roger Rosentreter. "You have a conversation at the meeting, but that connection extends far beyond that day."

For young plant scientists like Morgan Gostel and Jon Gibbons, the conference offers connections, networking opportunities, and good science. Gibbons said, "I came not knowing anyone and left with real friends I will have a long time. Now I use my TA position and friends to get the word out, and go into classes. The meetings are interesting—if you're lost and trying to find your way, go to a variety of sessions and find out what's interesting. If you know what you want to do, focus on that. You will meet the people you read articles about, the rock stars, the legends in botany!"

Gostel, from George Mason University, came for the first time knowing no one. He described how he was embraced by the members, and went to a cross-section of talks to learn as much as possible about a lot of things. By the next year, he was prepared to take on more networking, interacting, and getting more involved.

"We're breaking the initial misconception that plants aren't cool," Gostel said, laughing.

Spooner says he "hears all the time that the meeting just has a good feeling about it," a feeling born of camaraderie, of family, of good people. "There is a lot of activity in the meeting that brings people of different disciplines together, resulting in long-range friendships," he said.

The world of botanical science is a relatively small group, the scientists will tell you. And there are both bigger and smaller meetings to attend than the Botany Conference. "People who don't attend don't know how much they're missing out on," said Professor Joe Armstrong. "I have some very good friends I wouldn't have if not for the meetings and the field trips over the years."

"I've had the opportunity to sit at tables with some amazing leaders I never would have met if it had not been for leadership positions with the Society," Spooner said in agreement. "Coming to scientific meetings is a key part of my own education."

Fellow BSA member Jack Horner echoed those sentiments, saying he started presenting his work in BSA in 1960 as a graduate student and has been a member ever since. "It's a Society of happy, pleasant people wanting to involve people. BSA allows graduate students to get involved and present their work," he explained, adding that the dimension of dynamic young scientists mentored by the older scientists gives the Society an exciting yet familial feel. "BSA is like a family," says his wife Cecilia Horner, who has been coming to the meetings alongside him all these years. "You always know you'll strike up a relationship that will carry on for years."

Many come to the meeting for the chance to see friends they haven't seen since the last conference, says professor Steve Weller. Then they add to that delight the excitement of learning the new scientific

Many attendees participate in Botany-In-Action, the conference's annual service project —Giving back to the local community and networking! Botany 2013 focused on helping Bayou Rebirth in New Orleans.

"We are not the faceless people behind the doors of academia," - Nalini Nadkarni, Botany 2013 plenary address.

discoveries, filling one another in on their newest research and meeting new students.

Others like BSA member Ed Schneider describe the qualities of the meeting as collaborative, saying the unique way BSA's culture mixes scientific and human interaction is what really makes it stand out. "It's a hallmark trait that is distinct," he said. Early on in his scientific career, Schneider remembers that mentors took him on, and now he believes it is his job to usher other young scientists. "The early mentors who made us feel included are gone. Now, we have to assume those roles and we take great delight in offering the inspiration and encouragement," he added.

Newly minted Post-Doc Mackenzie Taylor says the congeniality of the meeting stood out for her from the first time she attended, and now she finds it's a touchstone for ideas and inspiration for the classroom. "I'm the only botanist at my institution, and that makes me kind of an island, so I can come here to get re-charged," she says. "I can experience the breadth of the discipline and see how people debate the topics, in a friendly and professional way—not tearing people down, but shaping and building science."

Many attendees talk about the advantages of rubbing elbows across the disciplines. BSA member Bill Crepet says, "There are many more societies now than there used to be, most narrower in focus and competing for members. I like the broad approach. It's excellent. You gain knowledge across the spectrum of all that is transpiring."

Why? The scientists are all saying that while it used to be enough to be alone in your lab busily accomplishing your research, today's culture calls for successful scientists to be more collaborative and to understand the scope of the world around his/her research.

"We are not the faceless people behind the doors of academia," pressed Dr. Nalini Nadkarni of the University of Utah in her Botany 2013 plenary address, taking farther the point that scientists must pick up the role of ambassadors for science by understanding the broader issues. She called on the attendees to use their deep passion for plants and diversity to communicate what they know about plants to others. "We are not powerless," she said.

If that is the case, what better place to get prepared than the Botany Conference?

"It's an active community of botanical scientists. You come to a meeting so you are connected."

Registration is open for
Botany 2014 - In Boise
Sign up now and don't miss the fun!
www.botanyconference.org

Science, Technology & Conversation Converge In Trade Show

If you like a little bit of science—a glimpse at the best of technology, the best in the world of scientific books, or a job opportunity in botany—where do you go?

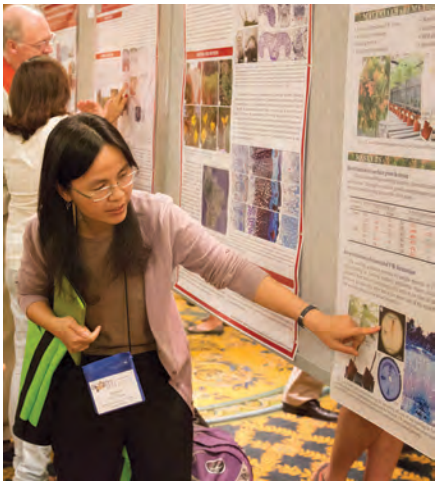
Go to the Exhibit Hall at the Botany Conference!

If you hit it right, you can avail yourself of the fabulous poster sessions, chat it up around the yummy food stations, and still get around to the 20-some vendors who make the annual trek from around the country to make sure the BSA members know how much they support the botanical scientists.

Name visibility, brand awareness, product notoriety, and the ability to launch new products and even sell products right on site are all the reasons the vendors book into the conference show.

"These are the people we want to sell to," said Andrea Ciecierski of CABI, a research organization from the UK who brought books to Botany 2013.

Bruce Davis of Academia in Books, a long-time vendor at the show, said the publisher picks out the show and books every year and believes BSA is the place to be.



And the American Society of Botanical Artists, represented by Marilyn Garber, not only came to the show for the first time—they also put on a workshop on botanical art. "It was time to step forward and connect with the scientists, so we brought an artist from the Smithsonian to do a workshop on illustration," she said.

Art took another form in Jensen Botanical Art's booth, where scientist William Jensen turns electro-microscope images into art that goes like hotcakes every year. Shaped like trees, hearts, animals, and more, it is one of the popular spots for conversation on the floor.

Monsanto organized its booth into a conversation pit, hoping to engage conference-goers into dialog about potential jobs in plant research. "We need scientists with a broad range of skills," said Carlos Gomez, the Technology and Recruiting Lead for the company.

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: Catrina Adams, Acting Director of Education, at CAdams@botany.org or Marshall Sundberg, *PSB* Editor, at psb@botany.org.

New and Ongoing Society Efforts

BSA to Host Booth at USA Science and Engineering Festival in April

The Third Annual USA Science and Engineering Festival will be held at the Walter E. Washington Convention Center in Washington D.C. on April 25, 26, and 27. This event is the largest STEM education event of its kind in the United States, and approximately 350,000 visitors are expected. The BSA will host a booth at the Expo and have several interactive stations set up to encourage visitors to experience plants and learn about botany and botany careers.

We are still recruiting volunteers to help staff the booth. If you are in the D.C. area, we would love to have your help at the booth, sharing your love of plants with the public. We are especially looking for volunteers available to volunteer on Sunday, April 27th. If you would like to volunteer, please contact Phil Gibson at jpgibson@ou.edu.

PlantingScience Going Strong, Seeks Continued Funding

The spring 2014 session of PlantingScience opened on February 18, and teams are now connecting with their scientist mentors. This session we have over 200 teams, 180 mentors, and approximately 850 students participating. Please stop by our project gallery at http://www.plantingscience.org/ to see the student teams' progress this spring, or perhaps to browse last fall's Star Project winners, representing some of the best projects of the previous session.

We are also happy to report that an additional partner has joined the PlantingScience team. We'd like to welcome the Arabidopsis Biological Resource Center out of The Ohio State University. Their outreach group will be promoting PlantingScience's Arabidopsis Genetics module and is putting together a kit of seeds specifically for our teachers participating in that module.

Since PlantingScience's NSF DRK-12 grant ended last year, a primary goal of 2014 is to secure continued funding for PlantingScience. Several grant applications are in the works, as well as plans for a crowdsourcing campaign and a new area of the site for accepting donations. The newly published book and forthcoming e-book "Inquiring About Plants: A Practical Guide to Engaging Science Practices" by Gordon Uno, Marshall Sundberg, and Claire Hemingway will also be used to support the PlantingScience program.

Vision and Change Societies Coalition Highlights Scientific Society Contributions to Vision and Change Goals

BSA is participating in the Vision and Change Societies Coalition, a group of scientific societies headed by the American Institute of Biological Sciences. The goal of the coalition is to share and publicize what scientific societies are doing toward the goals of Vision and Change. The current project is to create a matrix of activities that can be shared both internally within the coalition, and openly with the public. This should allow cross-fertilization of ideas, serve as the basis for evaluating society impacts, and increase the visibility of societies' Vision and Change initiatives.

One item we'll be sharing with other societies through the coalition is this summer's "Vision and Change in Undergraduate Botany Education" Symposium at Botany 2014. If you will be joining us this year in Boise, please consider attending this symposium to learn more about and discuss the objectives of the Vision & Change Call to Action from the perspective of plant science.

Editor's Choice Review

For those of you who missed last year's annual meeting in New Orleans, three papers from the "Yes, Bobby, Evolution is True!" symposium were recently published in the *Reports of the National Center for Science Education*.

Yes, Bobby, Evolution is True!

Armstrong, Joseph E, Marshall D. Sundberg. 2014. *Reports of the National Center for Science Education* 34(1): 1.1-1.4.

Louisiana's Love Affair with Creationism.

Forrest, Barbara. 2014. *Reports of the National Center for Science Education* 34(1): 2.1-2.7.

Confessions of an Oklahoma Evolutionist: The Good, the Bad, and the Ugly.

Rice, Stanley A. 2014. *Reports of the National Center for Science Education* 34(1): 4.1-4.7.

In the first paper, Joe Armstrong and I discuss the rationale for organizing this symposium for the Botanical Society meeting in New Orleans. Our objectives were educational: first, to introduce plant scientists to the ongoing confrontation between science and creationists that is prevalent in most states, with Louisiana as a timely example; second, to provide examples of how botanists can use plants to effectively teach about science in general and evolution in particular.

The Forrest paper provides a historical perspective to this controversy which includes one of the landmark Supreme Court decisions in the Creationism/Evolution controversy, as well as an ongoing controversy over a recently passed state law permitting creationism to be taught as a scientific alternative to evolution in public school biology classes.

Stan Rice provided one of four examples of how to effectively approach teaching science, and specifically evolution, in the undergraduate classroom, particularly in an environment friendly to fundamentalist religious values.

In Memorium

James Howard Wandersee, Botanical Educator (1946-2014)

Early Career

James Howard (Jim) Wandersee was born on December 21, 1946 in New Ulm, Minnesota. Early on, he chose a path in biology education, attending nearby Mankato State University (now Minnesota State University) where he earned a BS in biology in 1968. It was there that he met his wife, Carol, and they married soon after graduation. Jim took a middle school/high school teaching job in Milwaukee and began graduate work in science education, completing his MS in 1974 at the University of Wisconsin-Milwaukee. He shifted his focus to Curriculum and Instruction and completed his PhD at Marquette University four years later.

Jim took his young family, now including a son, Dan, and a daughter, Chris, back to New Ulm where he accepted a position at Martin Luther College. Beginning in 1980, and for the next eight summers, he did postdoctoral training with botanist/educator Joe Novak at Cornell University. This collaboration, along with another Novak protégé, Joel Mintzes, resulted in a number of important studies, including the classic *Teaching Science for Understanding* (Mintzes, Wandersee, and Novak, 1994). During the evenings of 1988-89, he commuted from New Ulm to St. Paul to work in the Biology & Society Program at Hamline University.

In 1989 he accepted a position in the Department of Curriculum and Instruction at Louisiana State University (LSU). (His timing was perfect as I [MDS] had just assumed responsibility for redesigning the biology program.) Jim eagerly encouraged one of his new Master's students to choose a project focusing on assessing the effectiveness of the program, and this established a solid bridge between science and science education on campus. Jim was an active participant in the LSU chapter of Sigma Xi, religiously attending monthly luncheon meetings and occasionally presenting his research.

Before the internet arrived, Jim produced a monthly newsletter with a listing of all seminars and lectures in every science and technology department on campus, which was distributed widely to promote interdisciplinary communication. In 1992 he joined Professor Mark Hafner (Director of LSU's Museum of Natural Science) as co-PI on a grant supporting the National Evolution Education Research Conference on campus, which brought together 46 scientists, science teacher educators, and science teachers to discuss critical issues and areas of needed research on evolution education.

Jim was always interested in the visualization of information and so, in 1996, he established the 15^0 Laboratory at LSU which ultimately became the largest biology education group in the country (http://www.15degreelab.com/thelaboratorysmission.html). The focus of the lab was visual cognition research to improve biological and botanical learning. One of the early projects culminated in "Toward a Theory of Plant Blindness" (Wandersee and Schussler, 2001).

Personal Memories

By Elisabeth E. Schussler

As he was for many others, Jim was an important mentor to me and had a far-reaching impact on my views about science education. I was a botany graduate student at LSU when we first met;

uncertain about my future in botanical research, I was looking for opportunities to explore my interest in biology education. I registered for his graduate education courses on "Teaching About Plants" and "Visualizing Science" and realized through Jim's example that you could have a passion for science without needing to do bench science. Jim's love of science practically oozed out of his pores when he was teaching, and I still remember the joy he conveyed about every scientific concept he taught.

When Jim and I began our discussions about the ideas that would lead to "Plant Blindness," it was mainly out of a sense of injured disbelief that others couldn't see the plant world as clearly as we did. We would cry (figuratively) into our coffee and try to explain to each other how people could walk around the world and *not* see all the plants. Others attributed this phenomenon to an explicit bias against plants, but Jim and I—optimists always—thought it was more of a collective lack of awareness. It was Jim's understanding of cognitive processing of visual features that ultimately provided the explanation we published—that, in essence, the visual system and the brain, along with a strong dose of culture, make people "blind" to plants. Jim dove into spreading the word about Plant Blindness with the same enthusiasm he demonstrated in teaching, and I will never forget his joy when the term caught on and started to be used by others.

Not only did Jim instill a sense of research ethics and professionalism among his students, but he also built a community of scholars. He facilitated multiple networking opportunities each year for doctoral students and past graduates, including the annual 15º Lab Banquet. One highlight of the banquet was the announcement of the prestigious Giverny Award winner for the year, given to the outstanding children's science picture book. The 2013 awardee, Green, marked the 16th year the award was presented (http://www.15degreelab.com/2013givernyaward.html). However, attendees also acknowledged that discussions of scholarly publications, and the sharing of accomplishments and challenges, were incredibly rich and valuable experiences. The careful mentoring and guidance served former students well: Jim's students make major research contributions in both national and international forums.

Jim Wandersee and Renee Clary, co-founders of the EarthScholars team.

Personal Memories

By Renee Clary

Jim Wandersee chaired my PhD committee, and we subsequently founded EarthScholars Research Group, the primary focus of which is to enhance the integration of geological and biological knowledge in science instruction (http://earthscholars.com/). To date, EarthScholars Research Group has produced 52 peer-reviewed journal articles, 16 book chapters, 49 electronic publications, and 156 research presentations. One research article, "Krakatoa Erupts!" was honored with the 2012 Gold (first prize) Association Media and Publishing EXCEL Award for outstanding feature article. Throughout the 12 years of our research program, EarthScholars presented research by invitation at many international forums, including the International Botanical Congress (Austria), the International Geological Congress (Norway, Italy, Australia), and the Delta Research and Global Observation Network (Cambodia). EarthScholars also served as official interpretative science signage consultants for Missouri Botanical Garden's Doris I. Schnuck Children's Garden, and designers for the Palmetto Trail at Barton Arboretum.

Until his retirement, Jim held the W.H. "Bill" LeBlanc Endowed Chair of Educational Theory, Policy, and Practice and was proud that "…the LSU

Chancellor and Board of Supervisors voted to grant me Alumni Professor Emeritus status—the first time any LSU science education professor has ever been named an emeritus. I am very happy to retain an official LSU faculty connection; we published 10 articles and book chapters since I retired a year ago" (MDS, personal communication). During his LSU career, Jim also held a number of visiting appointments, including the Center for Academic Practice, University of Strathclyde, Glasgow, Scotland; Faculty of Education, Monash University, Melbourne, Victoria, Australia; Department of Education, Cornell University, Ithaca, NY; Center for Research in Mathematics and Science Education, San Diego State University; and the Science Media Group, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.

His further accomplishments include election as Fellow of the American Association for the Advancement of Science and Fellow of the Linnaean Society of London. He served as Editor of the *Journal of Research in Science Teaching* and the *International Journal of Science Education*. He was a 2007 recipient of the BSA's Charles E. Bessey Teaching Award and in 2013 he received the Postlethwait Award from the Teaching Section of the Botanical Society.

Fifty science education researchers are proud to call Jim Wandersee their major professor. Many more of us are proud to have been his friend and colleague.

Literature Cited:

Mintzes, Joel, James Wandersee, and Joseph Novak. 1994. *Teaching Science for Understanding: A Constructivist View*. New York: Academic Press.

Wandersee, James H. and Elisabeth E. Schussler. 2001. Toward a Theory of Plant Blindness. *Plant Science Bulletin* 47(1):2-8.

--Marshall D. Sundberg, Professor of Botany, Emporia State University; Renee M. Clary, Associate Professor of Geosciences, Mississippi State University; Elisabeth E. Schussler, Assistant Professor of Ecology and Evolutionary Biology, University of Tennessee, Knoxville.

Congratulations New AAAS Fellows

Gordon Fox

Gordon Fox studies plant population ecology, especially demography and the evolution of life histories. Some of his research is empirical, ranging from the effects of fire on pine populations to the ecology and evolution of variation in flowering time. Other research is theoretical, lately focusing on consequences of how demographic heterogeneity within populations affects growth and extinction risk of populations. Still other research concerns the development of practical quantitative tools for population biology. He is co-author of the textbook *The Ecology of Plants*. Gordon can be reached at gfox@usf.edu.

John Freudenstein

John Freudenstein's research focuses on angiosperm systematics, and in particular on the following broad topical areas: patterns of morphological and molecular evolution and their relationship to biodiversity, species definition and the interpretation of molecular and morphological patterns at the base of the systematic hierarchy, historical associations among taxa and their integration in life histories, and methodological issues in phylogenetic analysis. His research group focuses especially on studies in Orchidaceae and Ericaceae. One genus in particular that he has focused on is the leafless Corallorhiza, in which he and his students have investigated phylogenetic relationships, species circumscription, molecular evolution, and fungal associations. John can be reached at freudenstein.1@osu.edu.

Muriel Poston

It is a wonderful honor to have been elected as an AAAS Fellow. Over the past several years, I have been involved in various educational initiatives focusing on undergraduate science education, most notably in the planning and development of the AAAS "Vision & Change in Undergraduate Biology Education." In addition, as chair of the AIBS Education Committee, we have focused on the leadership challenges for biology departments as they undertake the transformation in undergraduate biology programs. During my appointment as the Division Director in the Human Resource and Development Division (HRD) at the National Science Foundation, I worked with the NSF programs supporting underrepresented groups, especially those programs serving minority institutions, e.g. the HBCU and Tribal College programs, and those that supported women and girls, e.g.,

(Poston con't) ADVANCE and GSE. As a member of the Botanical Society of America and the American Society of Plant Taxonomists, my focus in undergraduate science education has always been through the lens of plant biology. The importance of broadening participation in undergraduate biology education, and in plant biology in particular, continues to inform my academic and professional work here at Pitzer College.

E.O. Wilson Biodiversity Symposium Scheduled for April

Join Dr. Edward O. Wilson and a panel of biodiversity experts for three days of briefings and stimulating dialog on the state and future of biodiversity on our planet. The event will be held at the University of Alabama on April 22-24, 2014.

Speakers will include:

- Dr. E.O. Wilson, Harvard University
- Dr. P. Dee Boersma, University of Washington
- Dr. R. Scot Duncan, Birmingham-Southern College
- Dr. Ryan Earley, University of Alabama
- Dr. Scott V. Edwards, Harvard University
- Dr. Harry W. Greene, Cornell University
- Dr. Juan Lopez-Bautista, University of Alabama
- Dr. Jonathan B. Losos, Harvard University
- Dr. Meg Lowman, North Carolina State University
- Dr. D. Bruce Means, Coastal Plains Institute and Land Conservancy & Florida State University
- Dr. Michael B. A. Oldstone, The Scripps Research Institute
- Dr. Richard Richards, University of Alabama
- Dr. Leslie J. Rissler, University of Alabama
- Dr. Sahotra Sarkar, University of Texas at Austin
- Dr. Diana H. Wall, Natural Resource Ecology Laboratory & Colorado State University

Registration is required; seating is limited.

For more information, visit biodiversity.ua.edu/

The *American Journal of Botany* Celebrates Centennial Throughout 2014

This year, the BSA is celebrating 100 years of continuous publication of the *American Journal of Botany*. Through special "*AJB* Centennial Review" papers, author profiles in *PSB*, a party at the annual meeting this summer, and other surprises, the Society and the journal will reflect on its accomplishments so far and look forward to what lies ahead. Thus far in 2014, the *AJB* has taken a look back at not only the formation of the journal and some of the key research published within its pages, but also where the journal, and plant science, is headed in the future.

The following *AJB* Centennial Review articles are already available and can be accessed for free:

"The *American Journal of Botany*: Into the Second Century of Publication" by Judy Jernstedt [101(1):1, 2014]

"The evolutionary-developmental origins of multicellularity" by Karl J. Niklas [101(1):6, 2014]

"The nature of serpentine endemism" by Brian L. Anacker [101(2):219, 2014]

"The voice of American botanists: The founding and establishment of the *American Journal of Botany*, 'American botany,' and the Great War (1906-1935)" by Vassiliki Betty Smocovitis [101(3):389, 2014]

These articles are also hosted at www.botany.org/ajb100, and the site also hosts other free content---nearly 1000 articles from the history of the *AJB,* as written by the journal's top 25 contributors!

The *AJB* is one of the few surviving plant science publications published by a non-profit scientific society. The journal, and its authors, reviewers, editors, readers, and subscribers, are at the heart of the Botanical Society of America, and the strength of this connection makes the *AJB* stand out from many other journals. As Judy Jernstedt wrote in the article listed above,

> **"Science and scientific communication will change in unimaginable ways over the decades of the *AJB*'s second century. What won't change is that the *AJB* will always be moving forward and constantly striving to fulfill its role in botanical publication, with the charge of the first Editor-in-Chief, F. C. Newcombe, as the guide: to '…be as wide as the whole science, … to serve the interests of organizations whose members come from all quarters.' We as supporters, authors, and readers of the *AJB* should reflect with satisfaction on its past successes and enthusiastically commit ourselves to working for a bright future for our journal, the *American Journal of Botany*" [Jernstedt, 2014: 4].**

In the pages of the *Plant Science Bulletin* throughout 2014, we want to acknowledge some remarkable and prolific authors—many of whom also provided service to the Society in numerous other capacities. In this issue, we highlight Karl Niklas, Pam and Doug Soltis, and Mark Chase.

Karl Niklas, Cornell University

Karl Niklas, New York Botanical Garden, 1974

Karl Niklas has had a long history of serving both the Botanical Society of America (a 37-year member who served as BSA President from 2008 to 2009) and the American Journal of Botany *(Editor-in-Chief from 1995 to 2004, with 79 papers published in the journal since 1976). We asked Karl about the unexpected turns his research has taken, and continues to take, throughout his illustrious career.*

What were you doing and what most interested you around the time you published your first *AJB* paper in 1976: "Morphology of *Protosalvinia* from the Upper Devonian of Ohio and Kentucky" [63(1):9, 1976]?

I was 25 years old when I received my Ph.D. in 1974. That year, I was offered my first job at the New York Botanical Garden, as an assistant curator. Shortly thereafter, my interests shifted from traditional paleobotanical researches to the study of the chemical composition of fossil plants. So, the first of my papers published in the *AJB* (dealing with the morphology of the fossil alga *Protosalvinia*) was already part of my past and did not reflect what I was doing in 1976, which was paleochemotaxonomy.

How has the thread of your research changed over time?

My undergraduate degree was in mathematics. My Ph.D. was in paleobotany. In the 1980s, I started retooling as a scientist to study biomechanics and returned to my mathematical roots. In the 1990s, I gained an interest in size-dependent phenomena (allometry and scaling). In the early part of the 21st century, my interests in biomechanics and allometry continued, but I've explored new areas of interest (such as computer simulations of developmental phenomena).

What areas have you consistently explored? What areas did you not expect to explore?

I have always explored the quantitative relationships between organic structure and function (in the context of environmental factors). I never expected to study the organic chemistry of fossils.

Which of your *AJB* papers stands out most to you and why?

I have to say that the one article that stands out the most to me was the one I wrote after receiving the Jeanette Siron Pelton Award in 2002 ("The *bio*-Logic and machinery of plant morphogenesis" [90(4):515, 2003]). Writing this paper forced me to confront a new field (evo-devo) that continues to interest me.

Why have you chosen *AJB* as one of the journals in which you've published throughout your career?

The BSA has always been my professional society of choice, and the *AJB* is its official "voice." The journal speaks to all plant biologists, because it is a "generalist" journal. I will always be an *AJB* subscriber, and I will continue to submit my work to the *AJB*.

Karl's latest AJB *article is an* AJB *Centennial Review titled, "The evolutionary-developmental origins of multicellularity," which appears in the January 2014 issue [101(1):6, 2014]. Karl's complete list of* AJB *publications, which are free for viewing throughout 2014, can be found at http://botany.org/ajb100/kniklas.php.*

Karl Nikilas at the 2012 ceremony where he received the Stephen H. Weiss Presidential Fellow Award, Cornell University.

Pamela Soltis and Douglas Soltis, University of Florida

Pam and Doug Soltis are each accomplished scientists in their own right---and yet their names are often mentioned together for the combined research they have pursued over the years. They recently offered insights regarding their service in the BSA (including Pam's 2007-2008 term as president and Doug's 1999-2000 term) and their numerous contributions to the AJB *dating back to the 1980s.*

Take us back to the early 1980s: Where were you, what were you doing, and what were you studying/most interested in at the time?

Doug: I was in my second year as a faculty member at UNC Greensboro. At that time we were doing a lot of isozyme work (enzyme electrophoresis)—that was the hot molecular/genetic tool at the time. Things have come a long way. I was very interested in population genetics and breeding systems in flowering plants and also ferns. We also did a lot of chromosome banding, a cutting-edge cytogenetic technique of that time, which allowed us to look at chromosomal evolution, species relationships, etc.

Pam: I was finishing graduate school, getting married to Doug, and moving to Washington from Kansas. I was interested in applying molecular (DNA) methods to questions of hybridization and polyploidy and had been exploring these approaches while a student. My first *AJB* paper ("An Intergeneric Hybrid in the Saxifragaceae: Evidence from Ribosomal RNA Genes" [72(9):1388, 1985]) was a test case for using rDNA for these sorts of questions.

How has the thread of your research changed over time?

Doug: The DNA revolution and now the informatics revolution have dramatically changed what we are able to do. When I started, we were not yet using DNA as a tool for examining relationships or population genetics. Now we are building massive phylogenetic trees using huge DNA data sets and conducting mega-analyses using large computer resources. Amazing.

Pam: I still continue to collaborate with Doug on Saxifragales work occasionally, as one of our recent papers attests ("Phylogenetic relationships and character evolution analysis of Saxifragales using a supermatrix approach" [100(5):916, 2013]). Interestingly, much of my other research remains focused on hybridization and polyploidy, and the application of new molecular approaches to obtain more detailed views of reticulate evolution.

Pam and Doug Soltis, 1988, during an AIBS conference in Davis, CA.

In looking back over the course of your research, what areas have you consistently explored? What areas did you not expect to explore?

Doug: We have consistently been interested in angiosperm relationships and polyploidy… the tools have changed. Some things have come full circle. Interesting to see that my first *AJB* paper ("Heterochromatin banding in *Boykinia, Heuchera, Mitella, Sullivantia, Tiarella*, and *Tolmiea* (Saxifragaceae)" [69(1): 108, 1982] was on chromosomes using what we then considered a sophisticated method (Giemsa banding) and my most recently accepted paper ("Natural hybrids between *Tragopogon mirus* and *T. miscellus* (Asteraceae): A new perspective on karyotypic changes following hybridization at the polyploid level" [100(10): 2016, 2013]) was on chromosomes using FISH and GISH, which are now the most powerful tools we have for examining chromosomes. Certainly, I never thought we would be doing floral evolutionary developmental genetics, transcriptomics or proteomics.

Pam: I have long been interested in hybridization, introgression, and polyploidy, since my dissertation research, and these areas continue to be a major focus, with 25 years of work on Tragopogon polyploids. Although also having conducted phylogenetic analyses since my dissertation, I did not expect to become as deeply involved in angiosperm phylogenetics as I have. However, phylogeny is the framework for so much of what we do, and it therefore has been a very important part of my research over the years. I could not have

predicted 29 years ago that I would be sequencing a genome or doing population genomics on *Amborella trichopoda!*

In looking back at all of the articles you've published in the *AJB*, which ones stand out above the others?

Doug: "Allopolyploid Speciation in Tragopogon: Insights from Chloroplast DNA" [76(8):1119, 1989]. This is one of our first papers on the recently and repeatedly formed polyploids in *Tragopogon*—this kind of got the ball rolling for us on this topic, which is something we have thoroughly enjoyed and one we have now invested considerable time and energy. It has been exciting to see more and more people interested in the *Tragopogon* system as the years have flown past. Interestingly, one of our most recent *AJB* papers is on these *Tragopogon* polyploids!

"Angiosperm phylogeny: 17 genes, 640 taxa" [98(4):704, 2011]. This more recent paper culminates many years of interest in clarifying the backbone of angiosperm phylogeny. This paper represents the results of another large collaborative aimed at clarifying angiosperm relationships. Earlier papers in this series include *rbcL* by Chase et al. (1993) ("Phylogenetics of Seed Plants: An Analysis of Nucleotide Sequences from the Plastid Gene *rbcL*" *Annals of the Missouri Botanical Garden* 80[3]: 528, 1993), and the three gene analysis of Soltis et al. (2000) ("Angiosperm phylogeny inferred from 18S rDNA, *rbcL*, and *atpB* sequences" *Botanical Journal of the Linnean Society* 133[4]:381, 2000). I like these papers because they illustrated well one of the real strengths of the botanical community—our ability to collaborate and work towards a common goal on a large- scale process. I feel that we (the botanists) really transformed systematics/evolutionary biology with these huge collaboratives—I think we can all be very proud of that.

Pam: "Electrophoretic Evidence for Genetic Diploidy in *Psilotum nudum*" [75(11):1667, 1988]. I really enjoyed working on ferns and other tracheophytes with independent sporophyte and gametophyte generations. Their genetic systems were nearly unknown at the time. *Psilotum* was an enigma, with high chromosome numbers suggesting ancient polyploidy, but diploid enzyme expression patterns. It set up a question still unanswered today: Are lycophytes and monilophytes with high chromosome numbers ancient polyploids with silenced genes, or did they get their high chromosome numbers and large DNA contents through some other mechanism?

Pam and Doug Soltis, 2010.

Another favorite is "Genetic Variation in Tragopogon Species: Additional Origins of the Allotetraploids *T. mirus* and *T. miscellus* (Compositae)" [82(10):1329, 1995]. At the opposite end of the polyploidy continuum from the possible ancient polyploids in the monilophytes and lycophytes are two allotetraploid species of *Tragopogon*, which originated in the early 1900s. In this paper, we compiled all available evidence, from our own allozyme and DNA data to earlier data in the literature, to estimate the number of independent origins of these two species. It was a fantastic experience to pull all the data, from Marion Ownbey and his collaborators and beyond, together to develop a (then) comprehensive picture of polyploid origins.

Why have you chosen *AJB* as one of the journals in which you've published throughout your career?

Doug: I've always loved the BSA—a great organization. It is important to support in any way I can. Plus, *AJB* is a quality journal run by quality people. It remains my top choice for getting papers out to a largely botanical audience.

Pam: *AJB* continues to be the key journal worldwide for all of plant biology, from molecules to ecology. Its standards are consistently high, and editors and reviewers alike take their roles very seriously. The BSA provides strong support for the journal, and the journal has been and continues to be one of the most prominent facets of the BSA.

Pam and Doug's latest AJB *article (Doug's 77th and Pam's 63rd for the* AJB*) is the aforementioned 2013 article, "Natural hybrids between* Tragopogon mirus *and* T. miscellus *(Asteraceae): A new perspective on karyotypic changes following hybridization at the polyploid level," which appears in the October 2013 issue [100(10):2016, 2013]. Pam and Doug's complete list of* AJB *publications, which are free for viewing throughout 2014, can be found at http://botany.org/ajb100/psoltis.php and http://botany.org/ajb100/dsoltis.php, respectively.*

Mark Chase, Royal Botanic Gardens, Kew

Mark Chase, a BSA member since 1987, has contributed 58 articles to the AJB since 1988. As a member of the BSA's Systematics section, his interests include angiosperm phylogenetics, hybridization, and polyploidy—as was made evident during the following interview.

Your *AJB* articles have spanned from "Isozyme Number in Subtribe Oncidiinae (Orchidaceae): An Evaluation of Polyploidy" in 1988 [75(7):1080, 1988] to "Phylogeny of the Asparagales based on three plastid and two mitochondrial genes" in 2012 [99(5):875, 2012]. How has the thread of your research changed over time?

My original paper was focused on genome evolution in orchids, but the tools that became available for phylogenetics led me to move in that direction, particularly on monocots as a whole (the original intent was to figure out how the orchids fitted in the monocots). That area of investigation resulted in the 2012 paper on Asparagales with many other collaborators. My current research focuses back on those original subjects, polyploidy, hybridization and genome evolution, particularly changes in chromosome number.

Over the course of your research, what areas have you consistently explored? What areas did you not expect to explore?

When I started, I was strictly interested in orchids, particularly chromosome number, but the advent of DNA technologies led me in the direction of angiosperm phylogenetics, which had never been part of my original game plan. I also would never have expected to work so much on *Nicotiana,* but I inherited a project on GISH on *Nicotiana* to investigate the parents of the allotetraploid species. Once I had started working on them, it was clear that they were doing some very interesting things, and that led to my current project on N. sect. *Saveolentes* and genome evolution.

You've had many productive collaborations with Pam and Doug Soltis. How did this come about? How have you sustained that over the years?

We've had a set of shared interests in the phylogenetics and classification of plants. For the first few years, we found that our separately funded and planned projects were actually intertwined, so it made sense to combine forces. We also became friends, and this also helped sustain our joint efforts.

In looking back at all of the articles you've published in *AJB*, which ones stand out?

"Relationships of Droseraceae: A Cladistic Analysis of rbcL Sequence and Morphological Data" [81(8):1027, 1994]. I enjoyed this one because of my interest in carnivorous plants.

"A Phylogenetic Analysis of the Orchidaceae: Evidence from rbcL Nucleotide Sequences" [86(2):208, 1999]. This was the first broad-scale study of orchid phylogenetics.

"Coding and noncoding plastid DNA in palm systematics" [88(6):1103, 2001]. This article showed that old phylogenetic approaches could still provide major insights on plants.

"A Genetic Appraisal of a New Synthetic *Nicotina tabacum* (Solanaceae) and the Kostoff Synthetic tobacco" [93(6):875, 2006]. This showed how genomic studies could provide insights into the origin of polyploid taxa.

Why have you chosen *AJB* as one of the journals in which you've published throughout your career?

I like *AJB* because it covers most area of botany and provides a means to reach researchers in other fields.

Mark's most recent AJB *article is "Phylogeny of the Asparagales based on three plastid and two mitochondrial genes" from 2012, which can be found at http://www.amjbot.org/content/99/5/875.full.pdf+html [99(5):875, 2012]. Mark's complete list of AJB publications, which are free for viewing throughout 2014, can be found at http://botany.org/ajb100/mchase.php.*

Students' interest in useful plants: A potential key to counteract plant blindness

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Abstract

"Plant blindness" is a term for the observation that people tend to overlook plants in everyday life, resulting in a constrained view on nature. The present study addresses how botany educators could counteract this phenomenon by looking at students' interest in useful plants. Therefore, a questionnaire was developed that tests students' interest in five subscales (medicinal plants, stimulant herbal drugs, spice plants, edible plants, and ornamental plants). Students (n = 1299) between 10 and 19 years of age were investigated in order to detect patterns of interest in useful plants. Results show that stimulant herbal drugs are of above-average interest for all grades, and medicinal plants are interesting for grade 12 as well as for grade 5, although less interesting for grade 8, whereas edible plants and ornamental plants trigger only low interest. Hence, medicinal plants and stimulant herbal drugs seem to be especially suitable for counteracting plant blindness in education.

Key words: plant blindness; questionnaire; students' interest; useful plants

"Teaching botany is a hard thing to do" is a sigh heard from many biology teachers and botany lecturers. Since the 1950s, teaching botany in school and at the university level has been considered difficult (Greenfield, 1955). One of the most apparent reasons for these problems is a phenomenon called "plant blindness" (Wandersee & Schussler, 2001), which means that students tend to overlook plants and herbal products in everyday life (Hershey, 1996). Therefore, students not only ignore the important role of plants in nearly every ecosystem, but also in their personal lives. Hence, processes essential for life on our planet (e.g., photosynthesis) do not find a way into students' consciousness.

A major part of biomass on earth seems to remain unperceived by most people of all age classes.

Many reasons are given for this problem, with some attributing it to the way biology is taught in school. Even at university level, botanists sometimes do not emphasize sufficiently the important role of plants as producers, food, habitats, etc. (Hoekstra, 2000). Instead, the phenomenon of so-called "zoochauvinism" (Bozniak, 1994) is predominant in teaching biology; teachers use animals as examples to explain general biological principles (e.g., natural selection and evolution) much more frequently than they do with plants (Hershey, 1996; Link-Pérez et al., 2010). In addition to these teaching-based reasons, the perception of plants by people is different compared to that of animals. Plants are rarely perceived as individuals but rather as a kind of "green mass" with leaves and stems blurring into an indistinguishable pattern of green shades (Wandersee & Schussler, 2001; Schussler & Olzak, 2008).

The phenomenon of plant blindness has serious consequences for the attitude of students (and, by extension, of people in our societies) toward the environment and their way of perceiving nature. Recent research has pointed out the following manifestations of plant blindness:

- Plants are completely overlooked in students' everyday lives (Balick & Cox, 1997).
- Students do not perceive plants as creatures but consider them only as a kind of "scenery" for animals (Wandersee & Schussler, 1999).
- Students do not know the needs of plants; that means they are not aware of what substances

plants need to survive (e.g., water, nitrogen, phosphorous, etc.) (Wandersee & Schussler, 1999; Schussler et al., 2010).

- There is a lack of personal contact with plants and plant growth. Even frequent plant species cannot be differentiated or named (Wandersee & Schussler, 1999; Bebbington, 2005).
- Students do not have a basic knowledge of plant life cycles, their reproduction, or their roles in different ecosystems (Wandersee & Schussler, 1999; Schussler & Winslow, 2007).
- The role of plants in one of the most important cycles in ecosystems—the carbon cycle—is completely ignored (Wandersee & Schussler, 1999).
- The diversity of the plant kingdom, the co-evolution of plants with many animals, the manifold evolutionary adaptations, and the versatile colors, smells, and flavors are not perceived (Wandersee & Schussler, 1999).
- Even if plants are seen as creatures, they are seen as inferior compared to animals (Flannery, 2002).
- When working with plants, students usually become aware only of visually perceptible structures (e.g., colorful blossoms or patterned stems) but do not go into further understanding of the role plants play in an ecosystem or the contribution of plants to their personal lives (Tunnicliffe, 2001).
- In educational settings (e.g., in botanical gardens) students tend to move their attention immediately from the plants to any animal appearing on the scene (Tunnicliffe, 2001).

Nonetheless, plant blindness can be counteracted. Hershey (1992, 2002, 2005) proposes specific "plant-mentoring-programmes" in schools: for example, planting seedlings and watching them grow to procure practical experience with plants and make their life processes more apparent to students. Moreover, special programs in museums and botanical gardens should be implemented, communicating the important role of plants in everyday life. Strgar (2007) indicates that the knowledge of teaching experts and their enthusiasm may also make it easier for students to realize the importance of plant life. Lindemann-Matthies (2005) also examined the preferences of students for animals compared to plants and investigated programs to enhance students' interest in plants (e.g., creating a "plant gallery" with pictures of plants students encounter growing on their way to school).

In spite of all these efforts, there are few evidence-based considerations about which specific plant groups should be used to efficiently counteract plant blindness. According to the self-determination theory of motivation, considering an object "interesting" is an important condition to make cognitive learning efforts possible and to develop intrinsic motivation (Deci & Ryan, 1993). Moreover, present research has pointed out that pre-existing interests are an important key for connecting new information to existing knowledge (Hidi & Baird, 1986; Hidi, 1990; Krapp, 1999). Nevertheless, scientific studies investigating which plants students perceive as interesting have hardly been performed.

Only few data are available concerning the interest in plants (Schreiner & Sjøberg, 2004), and they only provide information on a quite general level (e.g., interest in "plants in my environment"). However, results of Krüger & Burmester (2005) and Lindemann-Matthies (2005) show that useful plants may be considered interesting by students because usability is one of the most important criterion students apply when arranging plants into groups. In addition, Hammann (2011) pointed out that medicinal plants are interesting for students. What remains unknown is whether students find useful plants interesting on the whole or only selected subgroups of useful plants. Furthermore, there are no findings regarding how far students' interest in useful plants depends on gender and/or age, which may have special relevance in light of the studies by Kattmann (2000) and Löwe (1987), which describe students' decreasing interest in biological topics with increasing age.

Therefore, the aim of the present study is to explore the structure of interest with regard to useful plants. This objective seems all the more important since a look into currently used biology text books (e.g., Campbell & Reece, 2011; Cholewa et al., 2010) shows that botanical content already is often introduced by means of a subgroup of useful plants, namely ornamental plants. Is this plant group then an appropriate gateway entering botany? In order to answer this question, the study presented here seeks to find out whether there are any differences in interest within the target group (high school students) regarding different subgroups of useful plants. Which subgroups of

useful plants are actually interesting for students? Since students' interests cannot be assumed as stable and are known to change in high degrees during adolescence, for example, to fulfil gender roles (Krapp, 2000), the present study also explores how students' interest in useful plants differs with regard to various grades and genders in order to assist teachers (or any other botany educator) to impart botanical contents on the basis of plants that are seen as interesting by their particular students. For this purpose, a questionnaire (Fragebogen zur Erhebung des Interesses an Nutzpflanzen, or FEIN) was designed that measures the interest in useful plants, based on a pre-study (Sales-Reichartzeder et al., 2011) and induced by findings from recent research that has shown that questionnaires are appropriate tools for examining students' interests (e.g., Urhahne et al. 2004).

MATERIALS AND METHODS

The FEIN questionnaire

The definition of the term "useful plants" underlying the questionnaire is based on the fundamental work "Nutzpflanzenkunde" (meaning "botany of useful plants") by Lieberei et al. (2007). Hence, "useful plants" are defined as all plant species used by humans. They are divided into various groups according to their specific purpose (e.g., spice plants, edible plants, etc.). In our pre-studies (Sales-Reichartzeder et al., 2011), the questionnaire contained six subscales. In addition to the subscales "edible plants," "spice plants," "medicinal plants," "stimulant herbal drugs," and "ornamental plants," a subscale based on biological theory named "technically used plants" was introduced that represented plants used for gaining energy, producing textiles or dyes, or building materials. This subscale could not be maintained with reliability analysis (Cronbach's Alpha = 0.53). These findings do not astonish with regard to the high variability of application fields of technically used plants, their most important common feature being that they do not belong to any of the other subscales. Because of these reasons, the subscale "technically used plants" was excluded from the questionnaire.

The final version of the FEIN questionnaire tests five subscales that measure the interest in edible plants (mean of items 1, 6, & 11), spice plants (mean of items 4, 9, & 14), stimulant herbal drugs (mean of items 2, 7, & 12), medicinal plants (mean of items 3, 8, & 13), and ornamental plants (mean of items 5, 10, & 15). Each plant group is represented by three items, with the whole questionnaire containing 15 items (see Appendix A). The design of the items follows the ROSE Questionnaire (Relevance of Science Education), an instrument used in one of the largest international comparative studies investigating students' view on science and science education in 41 countries (Schreiner & Sjøberg, 2004). The items are formulated as headlines describing the object of interest, such as "plants to improve my room" or "plants curing a sore throat." Similar to ROSE, the questionnaire uses a four-stage Likert-scale (1-Not interested, 2-Rather not interested, 3-Rather interested, and 4-Very interested). Additionally, the following demographic data were collected in the questionnaire: sex, age, grade, school. Without any time pressure, filling in the questionnaires took approximately 10 to 15 minutes.

Survey Participants

In a preparation phase (December 2009) before performing the study on a large scale, the questionnaire was handed out to 95 students from one secondary school in Vienna. Afterwards, ten students from different grades were asked for detailed feedback about the questionnaire to ensure that each statement was well understood by the students. According to the first test-run and the preliminary statistical analysis (n = 95), minor changes were made in wording and layout to improve the questionnaire for the large-scale survey.

Subsequently (from March to May 2010), 15 secondary schools voluntarily participated in the main phase of the present study. Each of these was located in a different Viennese district and two were outside Vienna, providing a representative cross-section of secondary schools in and around Vienna. The questionnaires were filled in voluntarily during the students' biology lessons. A total of 1,417 students answered the questionnaire; 118 of them were excluded due to missing, double, or obvious hoax answers (e.g., zigzag patterns), which resulted in a final number of 1,299 participating students. These 1,299 usable questionnaires were filled in by 51% male and 49% female secondary school students; 21% of the students attended the 5th grade, 14% the 6th grade, 13% the 7th grade, 17% the 8th grade, 10% the 9th grade, 16% the 10th grade, 4% each the 11th grade and the 12th grade (exact numbers are given in Table 1).

Table 1. Descriptive statistics of the sample (n = 1,299).

	5th Grade	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade	Total
Male students	133	97	87	122	63	117	30	14	663
Female students	144	85	80	103	69	95	26	34	636
Mean of age (a)	10.75	11.87	12.89	13.76	14.95	16.00	16.93	18.06	14.40

Statistics

In order to investigate the structure of students' interest in useful plants, original data were subjected to principal components analysis (PCA) using the correlation matrix. Only principal components that accounted for variances greater than 1 (Kaiser-Guttman criterion) were used to represent the data. A "varimax" rotation was applied to the retained components to redistribute the variance among factors to obtain PC scores (James & McCulloch, 1990; Jolliffe, 2005; Norusis, 1990). Multivariate analysis of variance (MANOVA) with subsequent post-hoc tests (Scheffé tests) was used to find out whether the students exhibited any differences concerning interest in useful plants. Univariate analysis of variance (ANOVA) with subsequent post-hoc tests (Scheffé tests) then was used to find out whether there were differences in students' interest in different groups of useful plants as such and to analyze differences with regard to the degree of interest students have in different grades for the five groups of useful plants, respectively. *T*-tests were used to test differences in interest between the five subscales and to test gender differences between the five subscales. Cronbach's Alpha was used to measure the reliability of the subscales. All statistical analyses were performed using SPSS™ for Windows, Version 16.0.

Results

Components of interest in useful plants

The PCA of our data led to five principal components complying with the Kaiser-Guttman criterion (see Appendix B). They together explained 51.9% of the total variance. This structure of interest in useful plants found in the investigated population corresponded with the five subscales derived from biological theory. Cronbach's Alpha gave values between 0.66 and 0.76 for the five subscales (see Table 2).

Differences between the five subscales relating to the whole sample

In order to investigate whether there are differences in interest between the five subscales, a univariate ANOVA was calculated. The results of this analysis show that there are significant differences in interest between the five subscales ($F_{4,\ 6490} = 202.5$, $P < 0.001$). Furthermore, it seemed to be important to gather information whether a plant group is interesting for students or not. Hence, the mean of interest of a certain subscale was tested on whether it exceeds or falls below the value of 2.5, which represents medium interest on the Likert scale from 1 to 4. The results of the analysis for the whole sample show that medicinal plants are the most interesting plant group (mean of interest = 3.09, $t = 28.25$, df = 1298, $P < 0.001$), followed by stimulant herbal drugs (mean of interest = 2.90, $t = 16.31$, df = 1298, $P < 0.001$) and spice plants (mean of interest = 2.56, $t = 2.91$, df = 1298, $P = 0.004$). These three plant groups attract above average interest and can therefore be termed as interesting. Edible plants(mean of interest = 2.43, $t = -3.33$, df = 1298, $P = 0.001$) and ornamental plants (mean of interest = 2.32, $t = -7.20$, df = 1298, $P < 0.001$) turn out to be the plant groups arousing below average interest. An overview of the means of interest with standard deviations in the five subscales calculated for the whole sample is given in Table 3.

Differences between grades

The results of the MANOVA show that there are noticeable differences in how far students

Table 2. Reliability of the five subscales of the FEIN questionnaire.

	Medicinal plants	Stimulant herbal drugs	Spice plants	Edible plants	Ornamental plants
Cronbach's Alpha	0.718	0.739	0.660	0.661	0.760

Table 3. Means (M) and standard-deviation (SD) of interest in different plant groups measured with the FEIN questionnaire. Means above 2.5 indicate above-average interest.

Plant group	M	SD
Medicinal plants	3.09	0.75
Stimulant herbal drugs	2.90	0.88
Spice plants	2.56	0.78
Edible plants	2.43	0.78
Ornamental plants	2.32	0.89

from different grades are interested in the five plant groups (*Wilks's* $\Lambda = 0.907$, $F_{35, 5416} = 3.628$, $P < 0.001$), although the order of the subscales is similar in most grades (see Table 4). The results of the calculated ANOVAs enabled us to detect three types of patterns; interest means of the five subscales for all grades with *F*-statistics are given in Table 4.

1. The interest in edible plants, spice plants, and ornamental plants in low grades (5 and 6) is significantly higher than in higher grades (7 to 12) (see Figure 1A–C).

2. The interest in medicinal plants in grades 5, 6, and 12 is significantly higher than in the other grades, so the very young and older students are very interested (see Figure 2).

3. The interest in the plant group of stimulant herbal drugs does not change at all; there are no significant differences between the eight grades (see Figure 3).

As the results show, the interest in different groups of useful plants is definitely not the same at all grades and also strongly depends on the useful plant subscale.

GENDER DIFFERENCES

In general, there are few significant gender differences with regard to the interest in useful plants. Ornamental plants are the only subscale in which significant gender differences could

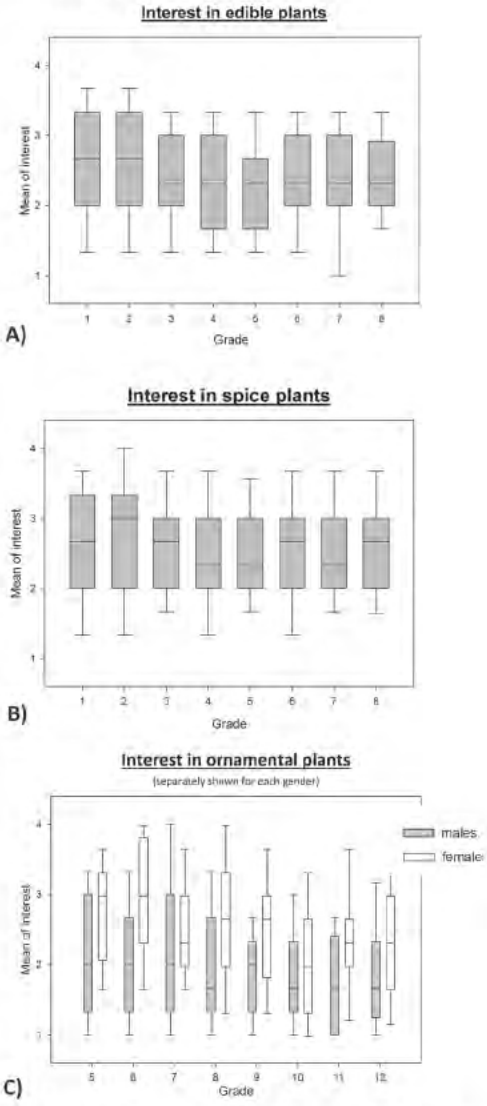

Figure 1. Means of interest of the subscales "edible plants," "spice plants," and "ornamental plants" for all grades; for ornamental plants, male and female students are indicated separately.

Table 4. Means (M), Standard deviations (SD), and univariate F-Statistics of interest in the subscales of the FEIN-questionnaire for different grades.

Subscale	5th Grade		6th Grade		7th Grade		8th Grade		9th Grade		10th Grade		11th Grade		12th Grade		$F_{7, 5416}$	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD		
Medicinal plants	3.18	0.74	3.22	0.75	3.05	0.71	2.91	0.77	2.87	0.86	3.11	0.69	3.11	0.67	3.19	0.55	7.524	**
Stimulant herbal drugs	2.85	0.88	2.87	0.90	2.97	0.81	2.94	0.91	2.96	0.96	2.92	0.87	2.84	0.81	3.00	0.84	0.748	
Spice plants	2.81	0.80	2.75	0.80	2.57	0.75	2.48	0.81	2.51	0.70	2.49	0.75	2.48	0.67	2.60	0.79	2.484	*
Edible plants	2.81	0.77	2.58	0.81	2.42	0.71	2.20	0.81	2.27	0.76	2.39	0.73	2.33	0.71	2.45	0.63	5.719	**
Ornamental plants	2.56	0.80	2.54	0.95	2.42	0.80	2.29	0.92	2.19	0.84	2.04	0.79	2.04	0.77	2.23	0.85	8.012	**

Note: *P < 0.05, ** P < 0.001.

be detected in all grades. This plant group is significantly more interesting for female students of all ages than for males (t = –11.72, df = 1298, P < 0.001) (see Figure 1C), although in itself it is a less interesting subscale for both genders.

DISCUSSION

In order to efficiently counteract plant blindness (Hershey, 2002), educators should introduce botanical content using exemplary plants considered interesting by students (Hidi & Baird, 1986). Such interesting teaching objects may be found in the group of useful plants (Krüger & Burmester, 2005). Regarding the structure of students' interest in useful plants, the following important findings are to be pointed out: Students do differentiate the group of useful plants in subgroups (Appendix B), and some groups of useful plants (medicinal plants, stimulant herbal drugs, and spice plants) are significantly more interesting for students than others (edible plants and ornamental plants) (see Table 3). Furthermore, there are significant differences between students of different grades with regard to the interest in all groups of useful plants with the exception of stimulant herbal drugs (see Table 4 and Figures 1–3). Significant gender differences could only be detected concerning interest in ornamental plants (see Figure 1).

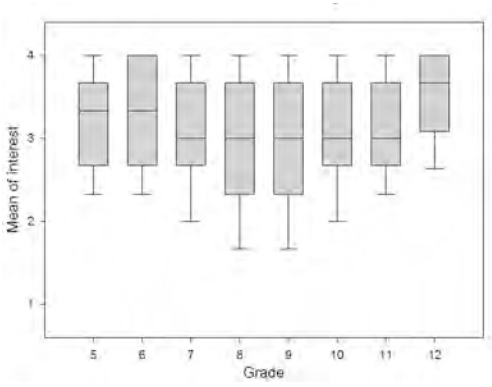

Figure 2. Means of interest of the subscale "medicinal plants" for all grades.

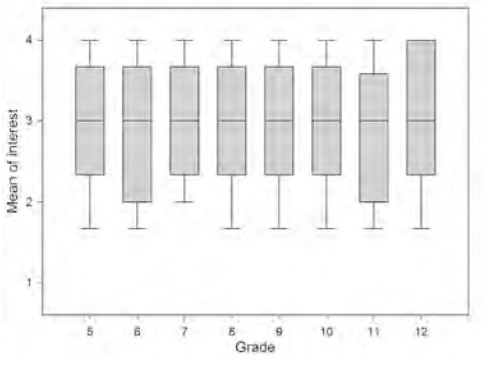

Figure 3. Means of interest of the subscale "stimulant herbal drugs" for all grades.

These findings can be very helpful to structure botany units focusing on plants that are perceived as interesting by students. This is important for learning settings such as botanical gardens as well as museums, where working with students is limited to a short time. During the few hours available in such settings, no time should be wasted on plants considered as uninteresting by the recipients. The results might also be useful for programs enhancing the role of plant science in school, such as "PlantingScience" (www.plantingscience.org) or "Biological Sciences Curriculum Study – BSCS" (www.bcsc.org). Furthermore, it is especially important for developing botany teaching units in school—the institution that is usually the basis of general education.

At present, botanical content tends to be imparted mainly by means of ornamental plants. Even in university textbooks (e.g., Campbell & Reece, 2011), ornamental plants (e.g., lilies) can often be found as examples. Plants such as *Amaryllis*, devil's backbone, or cut flowers sometimes are recommended as advantageous examples for school (e.g., Hershey, 1992, 2005) because they can be purchased easily and be grown inside a classroom without problems. Even if individual teachers decide to do otherwise, a view into currently used Austrian biology textbooks confirms this trend. In all these books, information about the general structure of plants or the structure of flowers is implemented using daffodils or tulips as examples (Rogl & Bergmann, 2003; Cholewa et al., 2010; Schirl & Möslinger, 2011).

Quite on the contrary, the investigated interest ranking of different plant groups suggests using medicinal plants and/or stimulant herbal drugs as key plants to proceed into botanical matters. Medicinal plants should be used as flagships because they are very interesting for students of all grades, and stimulant herbal drugs present themselves as a link to botany because they are also ranked with above-average interest and do not show any

differences between grades and genders. Moreover, both plant groups do not show the typical decrease of students' interest with increasing age (Kattmann, 2000) as do other plant groups (e.g., ornamental plants, edible plants).

Although ornamental plants certainly have some practical advantages for teaching botany in school, as mentioned previously, it should be taken into account that they trigger only below-average interest. Besides, ornamental plants do show strong gender differences leading to a high risk of losing the attention of male students altogether; moreover, even female students consider other plant groups more interesting. In light of the findings of the present study, ornamental plants can be only restrictedly recommended as examples to enter botany. Consequently, even the general structure of plants or flowers should be imparted using medicinal plants and/or stimulant herbal drugs as exemplars.

This study throws a first light on the structure of interest in useful plants. In order to sustainably implement botanical content in education, plants like sage (*Salvia officinalis*), tobacco (*Nicotiana tabacum*), or belladonna (*Atropa belladonna*) should be preferentially used as impressive examples. In order to extend these findings, the FEIN questionnaire should be translated and validated in other languages as well. What still remain unexplored and a field open for prospective studies are, for example, beneficial learning settings that keep students' interest focused on plants.

In summary, dealing only with plants that meet students' interests can open a window of opportunity to prevent them from perceiving plants only as scenery for animal life and to enable students to develop a more realistic view of nature, without disregarding a vast majority of the organisms building the foundation of life on earth.

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Appendix A. Items of the questionnaire to investigate the interest in useful plants

(Der Fragebogen zur Erhebung des Interesses an Nutzpflanzen, or FEIN)

English translation of the FEIN questionnaire

(This translation should only give an impression of the items used in the original German questionnaire, shown in the next column. The English items are not linguistically validated.)

How interested are you in learning about the following?

1. In which countries vegetables (e.g. tomatoes) grow naturally
2. Plants used to produce narcotics
3. Plants used to cure inflammations (e.g. a sore throat)
4. Parts of plants used to produce oregano, chili or caraway
5. Plants for decorating my room
6. Organic agriculture
7. Plants which can cause hallucinations
8. Plants which enhance the healing process of wounds
9. Spice plants
10. Taking care for house plants
11. Horticulture without pesticides
12. Producing opium and heroin from opium poppy
13. Plants which can be used to produce a soothing infusion (e.g. against cough)
14. Substances that make spices taste hot
15. Balcony flowers

German version (original language)

Wie interessiert bist Du an folgenden Bereichen?

1. In welchen Ländern verschiedene Gemüsepflanzen (z.B. Tomate) in der freien Natur wachsen
2. Pflanzen, aus denen Rauschmittel erzeugt werden können
3. Pflanzen, die gegen Entzündungen (z.B. Halsschmerzen) helfen
4. Pflanzenteile zur Herstellung von z.B. Oregano, Chili oder Kümmel
5. Pflanzen zur Verschönerung meines Zimmers
6. Biologische Landwirtschaft
7. Pflanzen, die Halluzinationen erzeugen können
8. Pflanzen, welche die Heilung von Wunden unterstützen
9. Gewürzpflanzen
10. Die Pflege von Zimmerpflanzen
11. Gartenbau ohne Spritzmittel
12. Die Gewinnung von Opium und Heroin aus dem Schlafmohn
13. Pflanzen, aus denen man einen heilenden Tee (z.B. gegen Husten) machen kann
14. Inhaltsstoffe, die Gewürze scharf schmecken lassen
15. Blumen an Fensterbänken

Appendix B. Principal components of the FEIN questionnaire (values < 0.3 not indicated)

Principal component PC1 (11.6% of variance) was equivalent to subscale "ornamental plants," PC2 (10.7% of variance) was equivalent to subscale "stimulant herbal drugs," PC3 (10.2% of variance) was equivalent to subscale "edible plants," PC4 (9.9% of variance) was equivalent to subscale "medicinal plants," and PC5 (9.5% of variance) was equivalent to subscale "spice plants."

Principal component →	PC1	PC2	PC3	PC4	PC5
Item 5 (Ornamental plants 1)	0.772				
Item 10 (Ornamental plants 2)	0.759				
Item 15 (Ornamental plants 3)	0.746				
Item 2 (Stimulant herbal drugs 1)		0.761			
Item 7 (Stimulant herbal drugs 2)		0.745			
Item 12 (Stimulant herbal drugs 3)		0.717			
Item 1 (Edible plants 1)			0.722		
Item 6 (Edible plants 2)			0.643		
Item 11 (Edible plants 3)			0.639		
Item 3 (Medicinal plants 1)				0.754	
Item 8 (Medicinal plants 2)				0.719	
Item 13 (Medicinal plants 3)				0.715	
Item 4 (Spice plants 1)					0.725
Item 9 (Spice plants 2)					0.687
Item 14 (Spice plants 3)					0.665

Botanical Education in the United States: Part 3 The Botanical Society Builds the Discipline, 1895–1960.

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Abstract

From its beginning as an offshoot of the American Association for the Advancement of Science (AAAS), the leadership of the Botanical Society of America (BSA; the Society) had a strong commitment to improving botanical education at all levels. During its early years, the BSA's major concerns were improvement of K-12 botanical instruction and implementation of botany requirements for entrance into university programs. Very quickly, however, the emphasis shifted to improving science instruction both in the schools and colleges—the theme of a 1911 symposium. By the 1920s botanical instruction in the schools was in decline and was being replaced by general biology. In 1936 botany was removed from the College Entrance Examination Board and high school botanical instruction virtually disappeared. During this period the Society's energy was focused at the college level. The Committee on Educational Standards and Methods of Teaching was very active and their work culminated in the publication of two lengthy documents: the first examining contemporary coverage of botanical topics in colleges and universities, and the second focused on aligning achievement tests with teaching objectives. The end of WWII saw major changes in college education concomitant with increasing demand by students and increased research funding from the federal government. In 1946 the Teaching Section was established by the Society, and the following year Society leaders were instrumental in founding the American Institute of Biological Sciences (AIBS). In 1952 the Education Committee was established and the following year *Plant Science Bulletin (PSB)* was founded. From the first essay in its inaugural issue, *PSB* served as a mouthpiece for the educational concerns of the Society. The educational highlight of the decade, begun during the 50th anniversary year of the Society, was a series of annual National Science Foundation (NSF)-supported summer institutes for teachers of botany at small colleges.

Key Words: botanical education, laboratory instruction, inquiry, student-active learning, Charles E. Bessey, William Ganong, Harry Fuller, Sydney Greenfield, Edmund Sinnott, Teaching Section, Education Committee, *Plant Science Bulletin*.

By the end of the 19th century, botany was one of the premier basic sciences, both in the United States and in Europe, and elements of botany could be found throughout the curriculum of schools, colleges and universities. However, it was a time of change for universities. In the American Midwest in particular, there was a movement toward democratization of the curriculum. The requirements for Bachelor's degrees shifted towards professional coursework, and the concept of electives was introduced (Veysey, 1965). Attitudes towards teaching were also changing. In 1885, the Harvard botanist William G. Farlow maintained that, "a university student must be treated, in effect, as a school boy, subject to lectures and rote learning since his capacity for observing and investigating natural objects has been blunted by a one-sided course of instruction at school" (Maienschein, 1988). Charles E. Bessey, John M. Coulter and others were eager not only to advance the discipline, but also to increase their number by promoting botanical education at all levels (Sundberg, 2012). The Botanical Society of America (BSA) played a significant role in both of these enterprises.

The BSA traces its formation to the persistence of Dr. Charles Barnes, who in 1893 convinced the members of the Botanical Club, meeting with the American Association for the Advancement of Science (AAAS), to begin the process of forming a new professional society (Tippo, 1958; Smokovitis, 2006, Sundberg, 2012). From the beginning, the purpose of the Society was to promote vigorous and active botanical research based on an ongoing record of botanical publication (BSA,1893). However, among the 10 most prominent botanists who were charged to nominate an additional 15 charter members of the Society, two were also the most vocal botanical educators of their time:

Charles E. Bessey and John M. Coulter (Coulter, 1893a, 1893b). In addition to Bessey and Coulter, the 25 charter members of the BSA included another seven authors of introductory botanical textbooks or botanical books for the general public, namely, Joseph C. Arthur, George F. Atkinson, Liberty H. Bailey, Charles R. Barnes, Douglas H. Campbell, Conway MacMillan, and William Trelease (Table 1). Clearly, botanical education was on the minds of the founders of BSA and this active promotion would persist through the next 50 years.

As was the case for many other fledgling scientific societies, the BSA continued to meet as an affiliate of the AAAS during the its annual meetings (Appel, 1988). In his address as the first outgoing BSA President, William Trelease noted that during the previous two decades, botany had become a fixture in most college curricula because of its ability "to develop the powers of observation and the reasoning faculties" (Trelease, 1896, p. 368). In fact, it was now possible for a student interested in plants to begin general studies in the lower grades and "delve into the depths of the most limited specialty" in their graduate work. The efforts of Bessey, William Beal, Coulter, and others were now bearing fruit at all levels of the educational system (Sundberg, 2012). But Trelease went on to describe how research, even though it was appreciated in the colleges and universities, was still viewed as an encroachment on the first duty of the faculty, namely teaching. His talk had quite a modern ring. On the one hand, resources tended to be distributed proportionally to the number of students enrolled. Good teachers attracted more students, and student numbers attracted resources to the college. On the other hand, time devoted to teaching detracted from the amount of original research, and it was research that established a faculty member's reputation in professional circles. Trelease was concerned that, in many places, research could be done only "during the leisure that could be found in the year's routine of instruction or during their long vacations, and with facilities nominally secured for class use, or in many instances, like those of a generation ago, the private property of the investigator" (Trelease, 1896, p. 369). But the times were changing, as he also foresaw: "…we have before our eyes the spectacle of a gradually unfolding class of institutions in which investigation is not only tolerated but expected, wither as an adjunct to instruction, as in the greater number of colleges, as a concomitant of educational displays, as in botanical museums and gardens, or, at least nominally, as a basis for technical or economic research as in several of the larger drug houses, and, notably, in various agricultural experiment stations and the National Department of Agriculture" (Trelease, 1896, p 369). Trelease was referring primarily to the relatively new Midwestern universities that actively promoted practical research and followed the German research university model—distinctly different from the staid and traditional Eastern colleges and universities (Veysey, 1965). Nevertheless, Trelease was of the opinion that innovative research and good teaching were intertwined. "I believe it to be the experience of the best investigators in this country that research is promoted by the necessity of imparting some or all of its results in the class room" (Trelease, 1896, P. 376). This opinion was not unique to Trelease. Through 1960, 18 of the 63 Presidents of the BSA were authors of textbooks designed for high schools or colleges or general readership, including three of the five twice-elected Presidents of the Society, Trelease, John M. Coulter, and Joseph C. Arthur (Table 1).

Textbooks and Pedagogy

Early 20th century

Bessey's *Botany* (1880) set a new standard for American botanical textbooks. Furthermore, Bessey, along with Coulter and Douglas H. Campbell, represented the newly formed BSA on the Committee of Ten, a committee formed by the National Education Association (NEA) to make recommendations for a national K-12 curriculum (Sundberg, 2012). Most of the new texts followed a similar format, emphasizing structure, function and increasingly ecology and evolution. They also tended to focus on plant/human relationships. Particularly in the grade schools, great emphasis was placed on providing students with class materials or field experiences that would allow them "the best opportunity for constructing thought and proper interpretation" (Atkinson, 1901, p. viii). According to Bailey (1907, p. vi) "An elementary text-book exists primarily for the purpose of teaching; and good teaching results in quickened perception rather than in absorption of facts".

At the high school level the focus of textbooks was to organize some fundamental botanical facts, provide relevant illustrations, and suggest explanations pertinent to larger questions. The textbook was meant to be subsidiary to three much more important factors: The teacher, the laboratory,

Table 1. Introductory level textbooks authored or co-authored by eventual Presidents of the Botanical Society of America, 1894–1960.

Author	Date(s) of BSA Presidency	Titles
Anderson, Edgar	1952	*Plants, man and life*, 1952
Arthur, Joseph C*	1901, 1919	*Handbook of plant dissection*, 1886, 1893
Atkinson, George F*	1907	*Elementary botany*, 1898, 1905, 1908 *Lessons in botany*, 1900 *First studies of plant life*, 1901 *Botany for high schools*, 1910, 1912
Bailey, Liberty H.*	1926	*The principles of agriculture: a text-book for schools and rural so*cieties, 1898, 1909, 1919. *Botany, an elementary text for schools*, 1900, 1907.
Barnes, C. R.*	1903	*Plant dissection*, 1893 [1886] *Textbook of botany*, 1910, 1930
Bessey, Charles E.*	1895	*Botany*, 1880, 1881, 1885, 1892, 1893, 1905 *Essentials of botany*, 1884, 1888, 1889, 1893, 1896 *Elementary botany*, 1904
Campbell, Douglas H.*	1919	*A university text-book of botany*, 1902, 1907 *Plant life and evolution*, 1911
Coulter, John M.*	1896, 1915	*Plant dissection*, 1893c [1886] *Plant relations*, 1899, 1904, 1905. *Plant studies*, 1900, 1905, 1907 *Plants, a textbook of botany*, 1903 *Textbook of botany for secondary schools*, 1905, 1910 *The evolution of sex in plants*. 1914 *A spring flora for high schools*, 1915
Cowles, Henry C.	1922	*Textbook of botany*, 1910, 1930 See Coulter, *A spring flora for high* schools, 1915
Duggar, Benjamin, M.	1923	*Plant physiology with special reference to plant production*, 1911, 1923, 1930
Fuller, Harry J.	1959	*An outline of general botany*, 1941a, 1947, 1950, 1955a, 1967. *College botany*, 1949, 1954 *Laboratory manual for general botany*, 1956, 1962, 1963, 1969, 1977 *The plant world*, 1941b, 1951b, 1955b, 1967, 1971
Gager, C. Stewart	1936	*Fundamentals of botany*, 1916
Ganong, William F.	1908	*The teaching botanist*, 1899b, 1907 *A laboratory course in plant physiology*, 1908 *The living plant*, 1913 *A textbook of botany for colleges*, 1916 and 1917, 1937

Robbins, William J.	1943	*Botany: a textbook for college and university students*, 1929, 1934, 1939
Sinnott, Edmund	1937	*Principles of genetics*, 1925, 1932, 1937, 1950 *Botany: principles and problems*, 1923, 1929, 1935, 1946, 1955, 1963
Tippo, Oswald	1955	See Fuller, *College botany*, 1949, 1954 *Humanistic Botany*, 1977
Transeau, Edgar Nelson	1940	*Science of plant life*, 1919 *Textbook of botany*, 1940, 1953.
Trelease, William*	1894, 1918	*Botanical micro-chemistry: an introduction to the study of vegetable histology*, 1884, 1886[a] *Winter botany*, 1918 *Plant materials of decorative gardening*, 1917

*Note: *indicates charter member.*

[a]*see Poulsen 1884.*

and field work. The teacher must have adequate background to be able to amplify and explain the information provided in the text. The laboratory work must be based on student observation and inquiry. Field work should relate the information gained in the laboratory to its place in nature and serve to raise new questions in the minds of students.

At the college level botany texts were more comprehensive and factual, but were still written with students in mind. In Table 2, four of the most commonly used introductory textbooks are compared to each other, and to the contemporary English translation of the standard German text (Strasberger) (Lang, 1921; also see Fig. 1). As would be true for a comparison of modern American texts with the current edition of Strasburger, a comparison of page number and reading level is not an adequate assessment of content or approach. The smaller German font, and generally smaller figures, packed in more content per page compared to American alternatives. Except for the three-volume work from the Chicago school (Coulter, Barnes and Cowles, 1910a,b,c), which was larger than the others, all of the American texts were about 600 pages long with a grade 13 reading level. Each was well illustrated with detailed line drawings. But that is where the similarities ended.

Bessey (1905) was then in its 7th edition and still followed the organization of Sachs (1875), which was continued in the Strasburger editions. Part One, General Anatomy and Physiology, was heavily weighted toward cellular and structural topics with individual chapters on protoplasm, the plant cell, the cell wall, cell division, and cellular inclusions leading up to chapters on tissues, tissue systems, intracellular spaces and the generalized plant body. The last three chapters were more focused on physiology: water relations, assimilation and nutrition, and responses to external stimuli. Part Two, Special Anatomy and Physiology, was a 9-chapter survey of the plant kingdom which comprised two-thirds of the book. Classification was based primarily on body plan and reproduction. For instance, yeasts were combined with bacteria and blue-greens, the green algae were spread over three chapters with the brown algae grouped with *Volvox* and *Oedogonium*, and the red algae, ascomycetes and basidiomycetes, were combined with *Chara* and *Coleochaete*. The final four chapters of Part Two, or nearly half of the book, focused on classification and economic botany of the flowering plants. The final short chapter was a brief summary of plant evolution.

Campbell's (1902) approach focused even more on a survey of the plant kingdom but his classification of algae and fungi was more similar to our current understanding and there was less emphasis on angiosperms. Cellular and structural topics were summarized in the first three chapters followed by 400 pages of survey. Diatoms and dinoflagellates were grouped with bacteria and the blue-greens, but the rest of the algae and the fungi

Figure 1. The most popular U.S. college botany textbooks during the early 20th century, together with the English translation (by Lang) of the European standard, Strassburger's Text-book of Botany.

were treated as distinctive groups, each with its own chapter. The classification of land plants was similar to Bessey (1905), but the seedless plants were presented in considerably more depth. For instance, the ferns and fern allies had their own chapters. Tissues and organs were covered in the large angiosperm chapter. Physiology was covered in a single chapter and the final two chapters were ecological: relation to the environment, and geological and geographical distribution.

Ganong's 1917 textbook emphasized the interaction of structure and function. Each of the 6 chapters of Part One (which comprised the first two-thirds of the book) was subtitled "The Morphology and Physiology of _____." The following filled the blanks (in this order): leaves, stems, roots, flowers, fruits, and seeds. The section on flowers included a section on heredity and Mendel. Here Ganong did a good job of summarizing the role of meiosis and illustrating and explaining Mendelian genetics (Fig. 2). But he also illustrated how the plant body is composed of cells, each containing identical chromosomes, which in turn carry multiple "determiners" (i.e., alleles). It is implicit in his diagram that crossing over occurs during meiosis so that different combinations of determiners may be passed on to the next generation (Fig. 3). The last third of the textbook covered the plant kingdom and ecology. Ganong lumped all of the bacteria, algae and fungi into a single division, the Thallophyta, and treated them in a single large chapter of 82 pages. The next three chapters covered Bryophytes (14 pages), Pteridophytes (20 pages), and Spermatophytes (46 pages). The final chapter, not quite 30 pages, covered ecology. It is interesting to note that although his laboratory reputation at Smith College was in physiology, and he authored a popular textbook in plant physiology (Ganong, 1908), he was among the pioneering founders of plant ecology (Kohler, 2002). Nevertheless, he felt that, "At present this division of the science [ecology] is little better than a series of huge guesses; very little really conclusive work has been done in it, and no distinct methods of ecological experiment nor principles of ecological evidence have been formulated" (Ganong, 1899a).

In Coulter et al. (1910a,b,c) the first book (Vol. 1, Part 1) was a morphological survey of the plant kingdom. Their classification system was the same as that adopted by Ganong (1917) with the bacteria, algae, and fungi comprising the Thallophytes and the land plants divided into Bryophytes, Pteridophytes, and Spermatophytes. Their coverage of the land plants, however, was more extensive and more equal, particularly for the gymnosperms. Like Campbell (1902), Coulter et al. discussed tissues and organs within the angiosperm chapter. The last chapter, on evolution, included Mendel's Law and heredity. This appears to be the earliest treatment of Mendelian genetics in an American botanical textbook. The concept was quite new, however, and the authors did not present a very rich understanding of the process. Their illustrative example is reproduced in Figure 4. The second of Coulter et al.'s three volumes, Physiology (labeled as Vol. 1, Pt. 2), was the thinnest, yet it contained twice as many pages as the physiology sections of the competing textbooks. Like Ganong would do

Author	Bessey	Campbell	Coulter et al.	Ganong	Strassburger
Date	1905	1902	1910	1917	1921
Pages	611	579	964 (3 vol)	604	799
Reading Level (Grade)	12.9	13.0	13.4	12.44	15.1

Table 2. Comparison of the most popular U.S. college botany textbooks during the early 20th century and the English translation of the European standard, Strassburger's Text-book of Botany.

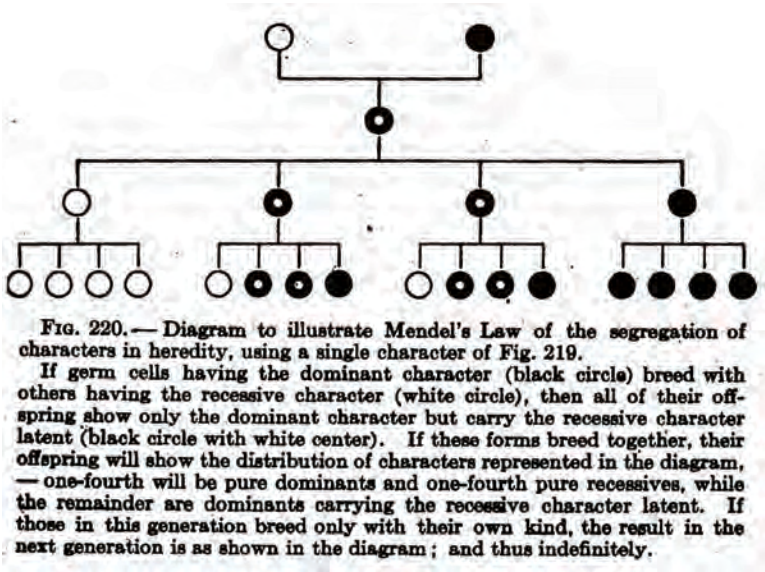


Fig. 220.— Diagram to illustrate Mendel's Law of the segregation of characters in heredity, using a single character of Fig. 219.

If germ cells having the dominant character (black circle) breed with others having the recessive character (white circle), then all of their offspring show only the dominant character but carry the recessive character latent (black circle with white center). If these forms breed together, their offspring will show the distribution of characters represented in the diagram, — one-fourth will be pure dominants and one-fourth pure recessives, while the remainder are dominants carrying the recessive character latent. If those in this generation breed only with their own kind, the result in the next generation is as shown in the diagram; and thus indefinitely.

Figure 2. Ganong's illustration of simple Mendelian genetics. In: A textbook of botany for colleges, 1917, 1937. Page 310 in both editions.

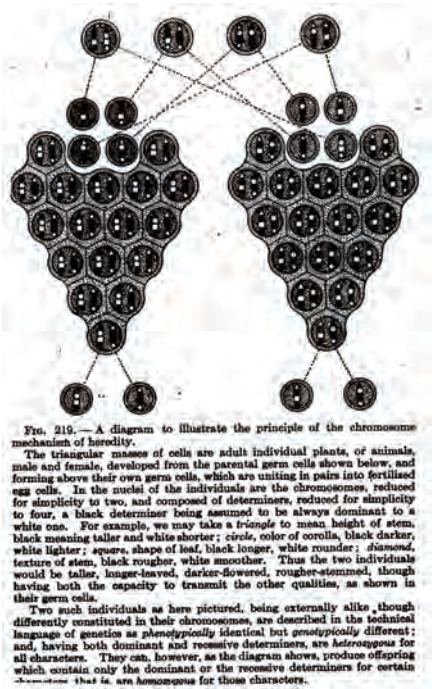


Fig. 219.— A diagram to illustrate the principle of the chromosome mechanism of heredity.

The triangular masses of cells are adult individual plants, or animals, male and female, developed from the parental germ cells shown below, and forming above their own germ cells, which are uniting in pairs into fertilized egg cells. In the nuclei of the individuals are the chromosomes, reduced for simplicity to two, and composed of determiners, reduced for simplicity to four, a black determiner being assumed to be always dominant to a white one. For example, we may take a *triangle* to mean height of stem, black meaning taller and white shorter; *circle*, color of corolla, black darker, white lighter; *square*, shape of leaf, black longer, white rounder; *diamond*, texture of stem, black rougher, white smoother. Thus the two individuals would be taller, longer-leaved, darker-flowered, rougher-stemmed, though having both the capacity to transmit the other qualities, as shown in their germ cells.

Two such individuals as here pictured, being externally alike, though differently constituted in their chromosomes, are described in the technical language of genetics as *phenotypically* identical but *genotypically* different; and, having both dominant and recessive determiners, are *heterozygous* for all characters. They can, however, as the diagram shows, produce offspring which contain only the dominant or the recessive determiners for certain characters, that is, are *homozygous* for those characters.

Figure 3. Ganong's chromosomal mechanism of heredity and the plant body. In: A textbook of botany for colleges, 1917, 1937. Page 313 in both editions.

a few years later, the authors related physiology to structure but they clearly they emphasized process and included data and suggestions for the laboratory. The most significant difference from the other textbooks was their treatment of ecology, the focus of Volume 2, Part 3. At 468 pages, Volume 2 was by far the largest of the three volumes and emphasized the ecological focus of the Chicago school. The overall organization is similar to that found in the first part of Ganong's 1917 textbook, but instead of focusing on structure/function relationships Coulter et al. looked at structure and function from an ecological perspective. Another innovation was that for the first time in an American botany textbook, citations to original literature relevant to each chapter were presented as endnotes in an appendix. It is interesting that in the 1930 revised edition (Coulter et al., 1930), an appendix was provided with suggested readings for each chapter, but the treatment of Mendel and genetics was not expanded or clarified beyond the inadequate 1910 treatment.

Special mention should be made of a text first published by Ganong in 1899, *The Teaching Botanist* (Ganong, 1899b; Fig. 5). In it he set about to answer a question that is just as relevant to us today, and the focus of as much of our efforts as it was for the founders of the Botanical Society: "What is the Optimum [sic] of training and knowledge in an ideal elementary course in the Science of

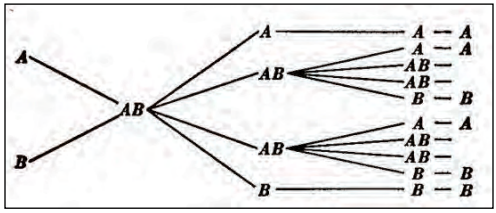


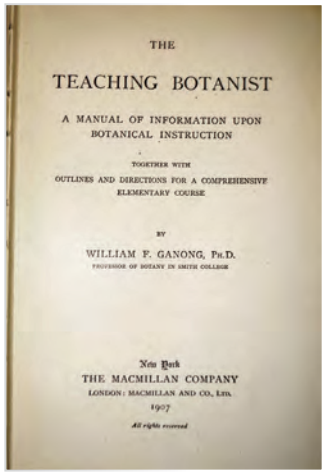
Figure 4. Representation of Mendel's law from Coulter, Barnes, and Cowles', A textbook of botany 1910, and 1930 (revised ed.). Page 293 in both editions.

Botany, and how may it most economically be realized?" (Ganong, 1907, p. 2). Ganong noted that in upper-division courses, most instruction was based on a mentoring relationship between professor and student. At the other extreme, in the elementary schools, botany was only beginning to be taught and even then it was restricted to external morphology and classification of flowering plants. The task of the introductory course, in high school or college, was efficiently to bridge that gap. His analogy for the curriculum was the design of a good topographic map. Regardless of the scale of your observation (i.e., grade level), a good map will always show the important features in good relative proportion.

To Ganong, the important features of botany were anatomy, morphology, physiology, ecology, and classification. Not only should all of these areas be included in the introductory course, but they should not be separated into distinct botanical divisions. Rather, they should be integrated; physiology should interpret anatomy and ecology interpret morphology. Above all, the plant should be considered as "…a living, breathing, working being, with its functions controlling its structure…" (1907, p. 4). To teach this effectively the laboratory was important, and the textbook should be only a supplement to the laboratory. The importance of the laboratory was a component of the New Botany, founded by Bessey and others 20 years earlier, which had resulted in a large number of laboratory manuals being produced (Sundberg, 2012). *The Teaching Botanist* (Ganong, 1899b) was a reaction against these manuals. Either they were too prescriptive or they presented an excessive number of alternative exercises, each with specific instructions. In today's terminology, they all were too "cookbook." Ganong was of the opinion that the individual teacher should adjust the laboratory to fit his particular style of instruction and the materials readily at hand (Ganong, 1899a). *The Teaching Botanist* was aimed at teachers and meant to provide the tools necessary for them to choose the methods and materials most helpful in supporting their laboratory classes. It provided model outlines, tips, and advice.

Ganong's philosophy reflected that of Amos Eaton 100 years earlier (Sundberg, 2011). Everything in the laboratory should be presented in the form of a problem, just beyond the students' current understanding, but arranged so that the students could find their own answers. At every step it was important *not* to tell students anything they could find out for themselves. Otherwise, whether students were right or wrong, responsibility for learning was shifted from the student to the teacher, and students would simply do the mechanical work and not the thinking or analysis. Ganong was adamant that the skill of observation was foremost in developing scientific instincts. "It is active seeing, not passive looking, which constitutes observation… then critical comparison and faith in causality – every phenomenon is yoked with preceding factors" (1907, pp. 33–36).

A good inquiry-based laboratory should look somewhat disorganized to a casual viewer, and there should be ongoing conversation between students as well as between students and teacher. Furthermore, it is likely that some work would be incomplete at the end of the regularly scheduled laboratory hours. For this reason, and to be able to do extra voluntary work, Ganong suggested that the laboratory should always be open to students. "Finally, it is well for the teacher to teach as far as


THE

TEACHING BOTANIST

A MANUAL OF INFORMATION UPON BOTANICAL INSTRUCTION

TOGETHER WITH OUTLINES AND DIRECTIONS FOR A COMPREHENSIVE ELEMENTARY COURSE

BY

WILLIAM F. GANONG, PH.D.

PROFESSOR OF BOTANY IN SMITH COLLEGE

New York
THE MACMILLAN COMPANY
LONDON: MACMILLAN AND CO., LTD.
1907

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Figure 5. Title page from Ganong's The teaching botanist, 1907.

possible by example, for here, as elsewhere, it is better than precept. It is an inspiration to students to see their teacher himself a student always striving to learn and advance" (1907, p. 65; see also Fig. 6).

Beyond textbooks and the individual contributions of leading botanists, the Society had very little to contribute to education. In the years immediately preceding the formation of the BSA, a few teaching papers were presented either in Section F (Biology) or in the meeting of the Botanical Club, both held during the annual AAAS meeting (Sundberg, 2012). From the founding until 1911, only two teaching papers were presented at annual meetings. In 1898, Ganong presented "Some appliances for the elementary study of plant physiology" (Ganong, 1898) at the annual meeting of the Society for Plant Morphology and Physiology (SPMP, formed in 1897 as an affiliate of the American Society of Naturalists, which merged with the original BSA in 1906). In 1906, Charles H. Shaw presented "The teaching of the subject of respiration" at the first annual meeting of the current BSA (Shaw, 1906).

Several conclusions can be drawn from the information in the preceding paragraphs. Firstly, the pre-eminent botanists of the day, including several future Presidents of the Botanical Society of America, were concerned enough about effectively teaching botany, at all levels of the curriculum, that they spent considerable time and effort authoring textbooks in addition to pursuing their botanical research. Secondly, although the authors generally agreed on the major concepts that should be covered in an introductory botany course, they experimented considerably to determine the proper sequence and emphasis of topics. Was it more effective to build a logical sequence from cellular anatomy up to ecosystem function, or from the more familiar and concrete organismal interactions down to the more esoteric structure and function relationships? One thing they did agree on, however, is that lecture should reinforce the discoveries made in the laboratory. This is exactly the opposite of what continues to be the usual interpretation of the relationship between lecture and lab—that the laboratory should reinforce the principles presented in lecture!

Figure 6. William Ganong c. 1910 with botany honors class in the experimental house at Smith College. The students, Elizabeth Greene, Mabel Bray, Louise Elder, and Elizabeth Johnson (all class of 1913), are shown gathering data from Auxograph devices, constructed by Ganong to measure shoot growth. See Ganong 1908 (p. 203) for construction details. (Photo by Katherine McClennan, with permission of Smith College Archives.)

Influence in National Issues

The school curriculum and college entrance standards

Upon completion of the report of the Committee of Ten on secondary schools, the NEA began a project to standardize college entrance requirements (NEA, 1899). In 1896 Charles Bessey, President of the BSA, was appointed a delegate to act with a committee of the NEA to establish a botany entrance exam for colleges (Minutes, 1896, p. 21). Other botanists on the committee were Ganong, as the college representative from the New England Association of Colleges and Preparatory Schools, and Charles A. Barnes, who represented the North Central Association of Colleges and Secondary Schools. The recommendations of the report, published in 1899, were very similar to the report of the Committee of Ten five years earlier. In preparation for college, students should have a full year of botany with emphasis on laboratory and fieldwork. They should be skilled in keeping a notebook, and taught to make accurate drawings. The first half of the course should emphasize the role of plants as living organisms. The textbook, informal lectures, and frequent quizzes should be used primarily to reinforce what was observed in the laboratory. Observations should focus on the most obvious features and relationships, which would provide a foundation for subsequent study. Teachers should avoid excessive technical terminology and expensive apparatus whenever possible (Nightingale, 1899).

Although Ganong was a member of the committee producing the report, he was not in complete agreement with their recommendations. At the 1900 meeting of SPMP he read a paper urging a more uniform standard (Ganong, 1901). Firstly, he suggested that there should be no difference between an introductory course for majors and one for non-majors. The basic concepts of botany not only laid a foundation for future advanced courses, but were necessary to understand the place of plants in the world. Every student should have this basic understanding.

Secondly, he proposed that in a given week there should be 2 hours of recitation or lecture but 3 hours of laboratory. If there was any variation from this ratio, it should be towards increased time in the laboratory. He was particularly concerned that the report's recommended syllabus proposed too strong an emphasis on ecology, presumably an "extreme reaction from the old formal systematic studies…" (p. 6). He went on to describe the current requirements for a number of schools. For instance, the University of Chicago (Coulter's institution) required 15 points [credits] to be accepted to the University, among which 1 could be from botany and up to 3 more from other sciences. Harvard, on the other hand, required 2 out of 26 points to be from science, but specifically *not* botany. Nebraska (Bessey's school) accepted 7 points in science (of which 2 could be botany) out of 28 total required points. Stanford (Campbell's school) accepted 5 points in science out of 15 total points, of which 1 could be botany. Smith (Ganong's school) also accepted 5 science points out of 15 total points, but 2 could be botany. Clearly there were different standards and the requirements suggested that eminent botanists were able to impact their universities' standards.

In response to Ganong's address, SPMP made the first formal recognition of the importance of teaching by botanists. A committee of three was appointed to formulate a high school course in botany and produce a standard for college entrance in botany. In addition to Ganong, the committee included F.E. Lloyd of Princeton University and H.C. Cowles from the University of Chicago. Following the merger of the SPMP and the BSA in 1906, this committee became the BSA Standing Committee on Education. Between 1901 and 1908, the committee presented four reports that proposed a three-part, year-long botany course including anatomy and morphology in Part 1, Physiology and Ecology in Part 2, and Plant Groups and Classification in Part 3. Thus, from the very beginning of the current BSA, education was a formal component of the Society's organization (Council, 1907, p. 112). Although the committee was instructed to print and distribute its reports, records of them having done so do not exist in the BSA archives.

How to Improve Botanical Education

The earliest formal BSA efforts to improve botanical education focused on pre-college preparation in order to ensure that incoming college students were prepared to major in botany. However, there also was concern with improving college botanical instruction and with the growing divide between focused research, especially in the universities, and teaching, which more and more was relegated to the colleges. Ganong addressed this

growing dichotomy in his address to the Society as outgoing President in 1909 (Ganong, 1909).

Ganong noted that although botany, and science in general, was advancing vigorously as a technical field, it had low status within university general education. The first problem, according to Ganong, was that students were poorly prepared for college, both in terms of prior coursework and, more importantly, in their attitude towards study and work. Furthermore, a great many students found the laboratory to be "distasteful"; they would rather simply attend lecture and read the text (1909, p. 323). The scientist/teacher was faced with a predicament. In order to be true to science, teaching should reflect the values of science: careful observation of actual specimens, critical analysis of results, and logical testing of conclusions. At the same time, there was pressure to make courses popular because "…our success as teachers is largely judged by the number of students we can charm into our courses…" (1909, p. 324). Compound student reluctance with the expense of equipping laboratories, and the lab was often omitted. These sentiments sound remarkably contemporary today! Ganong went on to identify a second problem in the way faculty approached teaching: "In a word, the first great need of our science teaching is to make it scientific" (1909, p 325). Ninety years earlier Amos Eaton had advocated for what we now call formative assessment, and a decade before Ganong's address Conway MacMillan had promoted this concept at the annual AAAS meeting (Sundberg, 2012). But the time was not yet ripe for this kind of research.

A related problem identified by Ganong was that many faculty were content to focus exclusively on botanical content and gave very little thought to the student. Ganong suggested that these professors should migrate towards university positions, where they could focus on one-on-one mentoring of graduate students pursuing original investigation; faculty members more sympathetic to students could then fill positions in colleges. Through practicums and laboratory work, college faculty could provide the next best thing to one-on-one mentoring for a larger number of students. One impetus for this proposed dichotomization was his concern with the apparent nonchalance with which university professors were churning out high school textbooks—books that were compendiums of correct and detailed content, but which younger students could not comprehend.

Finally, Ganong was concerned with the preparation of future botany teachers. To illustrate the problem he quoted an unnamed President of a distinguished college, who said: "We have to take them [new faculty] as the universities supply them and then make them into good college teachers afterwards" (1909, p. 328). The universities were doing a good job of preparing students to be researchers, but doing nothing to prepare them to be good teachers. Ganong went on to claim that the best teachers were also active in research, but at the college level this research should have some connection to teaching. So what kind of training did he propose? First, it was important for any botanist to have some familiarity with living plants, therefore at least two summers of fieldwork should be part of the preparation. Second, students should know something about the history and biography of the specialized fields they study. Third, students should gain some introduction to laboratory administration and management: lab construction, purchasing furniture, apparatus, supplies, and materials. This was in addition to designing and implementing laboratory activities. Finally, there should be some instruction in how students learn and in effective ways for teachers to facilitate learning. It is sadly remarkable how Ganong's concerns in 1909 continue to resonate today!

At the end of his address Ganong pointed out that the University of Chicago provided an excellent example, which all botany departments should consider (Lersten, 2008). Within its School of Education, Chicago had a department of botany and natural history, administered by Otis W. Caldwell, himself a noted botanist. Finally, Ganong suggested that there was a great need for a formal journal of science education that would maintain the rigor of the several popular research journals, but focus on the concerns faced by college teachers. "I would like to edit it…," he said (1909, p. 332). Twenty-nine years later the *American Biology Teacher* would fulfill this need, with botanist Edmund Sinnott on the advisory staff. Sinnott was also a member of the Committee on Biological Science Teaching of the Union of American Biological Societies, which established the National Association of Biology Teachers in 1938 (Hunter, 1939, 1941).

Ganong did not get his journal, but his address stimulated the BSA to organize a session on botanical teaching as part of the 1911 annual meeting program. In fact, the first presenter, Charles Bessey, began his address with this

question, referring back to Ganong's remarks two years earlier, "Why is it that with the enormous classes we are having in botany there is a marked dearth of properly trained men who can serve as instructors in colleges and universities?" (Bessey, 1911, p. 633). Bessey noted that introductory botany courses at Nebraska enrolled 350 students and Minnesota's enrolled more than 500, but few of these students actually majored in botany. A good number moved into the applied disciplines such as agronomy, horticulture, and forestry, and Bessey suggested that perhaps part of botany's problem was the lack of "old time" field botany in the curriculum. He also noted that the degree requirements for the bachelor and doctoral degrees in botany were more proscriptive than for several of the other sciences, including chemistry, medicine, zoology, mathematics and geology. This was particularly troubling because during this decade (i.e., the 1910s), university administrators had began to pressure science faculty to change their instructional methods in order to improve student retention. After meeting resistance from science faculty, the solution had been adoption of the elective system, giving students more flexibility in the earning of their degrees in non-science subjects (Reuben, 1996). It is important to realize that these were not problems unique to botany in the United States. The so-called "Tansley Manifesto" in Great Britain at about the same time was also a reaction to the inability to attract good undergraduates to botany (Boney, 1991).

In his 1911 address, Bessey was also concerned that botany was splitting itself into specializations and ignoring the connections among them. Botanists were not treating botany as a profession, but merely as a subject of study. Of course research was necessary, as was teaching the knowledge acquired through research, but as a profession it was also necessary "to weave into our instruction much of the ethics of the science, whether it is to take the form of teaching or investigation. The young botanist should be made to feel that he is going to use his botanical knowledge…Let us stop saying to the young man: 'You do not know enough yet to begin' – but let him begin!" (1911, p. 637).

At the end of his talk, Bessey specifically noted that throughout his presentation he had referred to "men." This was because, in fact, most botanists were men. "I do not know why this is so. We say very pretty things about our women students, and give them good high standings, and say complimentary things about them *as students;*" yet few are employed at the universities. "Here is one thing that we ought to change. The supply of competent women is much larger than of competent men, and I can assure you from experience in my own department that they make admirable instructors" (p. 639). Bessey's Botany Department staff of 15 at Nebraska counted 8 women, including Associate Professor Elda R. Walker, Assistant Professor Leva B. Walker, and Instructor Margaret Hannah. The early decades of the 20th century saw a dramatic increase in the number of PhDs earned by women, and botany was in line with the other biological sciences (Table 3).

The second address, by Otis Caldwell, focused on botany at the high school level (Caldwell, 1911). Caldwell cautioned that preparing students for research should not be the focus of general botanical education, although one of the most important outcomes of good botanical teaching was developing well-grounded students with the desire to pursue research. He reinforced Bessey's view that botany was beginning to overspecialize, but his greatest concern was that too many botanists were "content to assume without sufficient data" the best ways to pursue instruction. "If we can devise methods of making a scientific study of botanical education, we can improve our student-product" (1911, p. 642).

The final paper in the session, "Methods of botanical teaching," was presented by Frederic E. Clements, Head of the Botany Department at the University of Minnesota (Clements, 1911). Not surprisingly, his address followed several of the themes of his former major professor, Bessey. Clements suggested that the problem of attracting majors in college began in the high schools, and it was there that more emphasis should be placed on making botany relevant. We should focus on making students want to ask questions about the plants around them, and we should always have living plants available in the classroom. In Clements's opinion, both high school and college textbooks contained much more information than any student could assimilate. For his own classes, he said, "I do not believe in text-books, or in lectures in any general course whatsoever; I would have none of them…. I would replace text-book and lecture wholly by first-hand contact with plants" (p. 645). The most significant point of his address was summarized in the last paragraph: "We should be ecologists who study the student, the method, the matter and the results, both as to knowledge and to training, in an exact, quantitative manner. If we

Discipline	Pre-1900	1900 –1938	1948–1960
General Biology			282 (16.1%)
Botany	8 (4%)	194 (12.2%)	173 (10.1%)
Genetics			20 (7.7%)
Plant Pathology			10 (3.1%)
Plant Physiology			3 (4.1%)
Zoology	7 (3%)	225 (14.1%)	260 (12.2%)
Chemistry	13 (6%)	139 (8.7%)	637 (4.7%)
Math	9 (4%)	123 (7.7%)	169 (5.7%)

Table 3. PhDs granted to women in the United States, by discipline. Actual number (and percentage of total). After Rossiter, 1982.

do this, we shall get rid of our loose opinions that for the beginner in botany any method is as good as any other method, and that the results must be good because *we* have done the work. I feel sure that the use of experiment in connection with our methods of teaching, and the measurement of results will go a long way toward changing our present methods and improving upon our present results." It would take until the second half of the century for Clements's, Ganong's, and Caldwell's recommendations for science education research to be realized.

Apparently, the gathered audience of botanists was not entirely receptive. Coulter made the point that "No teacher, however successful, has the right to prescribe for others a detailed method of teaching." To this Professor F.C. Newcombe, of the University of Michigan, responded that during the course of the presentations, he was beginning to appreciate the fact that he was trained 25 years earlier because if he was a student now, "I could have become nothing but some poor ignoramus" (Discussion, 1911). Based on the focus of the society for the next few decades, Coulter and Newcombe's opinions must have represented the majority in the audience that night in Minneapolis.

The Rise of Botany, and Biology's Decline and Resurrection

In his Past-President's address to the BSA during the 1903 meeting, outgoing President Beverly T. Galloway noted that, throughout the country, the attitude toward botany was beginning to change in a positive way. He felt that, in large part, this was because for the past 20 years proponents of the New Botany (see Sundberg, 2012) had emphasized the connection between technical botany and its utilitarian application. "Every time we have reached into new fields with the object of broadening the work and benefiting the people, the people have responded and given us most generous aid" (Galloway, 1904, p. 11). Botany was certainly growing as a science and would continue to do so for at least another decade. Evidence of this strength can be seen in the proportional representation of botanists and other scientists in state academies of science (Table 4).

Coincident with this growth in botany was a decline in biology at all levels. In 1875, Thomas Henry Huxley, along with Henry N. Martin, published *A Course of Practical Instruction in Elementary Biology* (Huxley, 1875; Sundberg, 2012). This began a serious movement, both in Great Britain and in the U.S., to emphasize the similarities between botany and zoology and to consolidate them into a single field of study, particularly in the high schools. Like the leaders of the New Botany, Huxley emphasized the laboratory and hands-on investigation as a pedagogical approach to promote student learning. By the late 1910s, however, a serious backlash had developed, particularly among botanists, and biology departments were in decline in colleges and universities as well as in the schools. In 1924 Downing reported that 78.7% of schools offered botany (only 70% offered zoology), a percentage surpassed only by physics and chemistry in the sciences (Downing, 1924). Botany was usually offered in 10th grade as a half-year course (while zoology was usually a full year). In

State	Botany	Chemistry	Geology	Math	Medicine	Physics	Zoology	Other	Total
Connecticut	**4**	4	12	2	12	4	7	128	172
Illinois	**63**	45	28	9	29	29	56	55	314
Indiana	**51**	24	16	10	22	23	55	30	231
Iowa	**60**	30	40	18	12	30	60	100	350
Kansas	**20**	30	10	10	12	12	10	79	173
Kentucky	**13**	24	12	9	4	13	12	9	96
Michigan	**55**	0	30	0	21	0	45	33	208
Nebraska	**13**	8	5	4	9	5	10	19	73
New Mexico	**3**	3	3	5	0	3	1	6	25
North Carolina	**13**	13	4	4	1	6	15	24	80
Ohio	**66**	6	40	4	16	29	79	18	258
Tennessee	**5**	14	6	4	0	8	1	37	75
Utah	**11**	6	4	1	5	10	14	41	92
Total	**377**	207	210	80	143	172	366	579	2147
Percent	**17.6**	9.7	9.8	3.8	6.7	8.0	17.1	27.0	

Table 4. Representation of botany in state academies of science. After Whitney, 1919.

schools where it was offered, 33.4% of the students took botany, and only general science exceeded it.

According to a survey of 66 colleges and universities in 1919, 47 had separate departments of botany and zoology and 19 had a single biology department (Nichols, 1919). Of those with separate departments, only 6 currently offered a general biology course whereas in the past 21 had done so. General biology courses decreased by 80% between 1895 and 1919. I should note that my own institution, Emporia State University, first instituted a Principles of Biology course in 1920, but it was dropped in 1929. In biology courses, botanists and zoologists shared teaching responsibilities, although in the majority of institutions more zoologists were involved. In fact, most students tended to equate biology with zoology. This explains the sharp difference in responses of botanists and zoologists to most of the survey questions. For instance, the overwhelming number of botanists opposed teaching an introductory biology course while the majority of zoologists favored offering such a course. The only question they agreed on was that if biology was offered, it should be team-taught by both a botanist and a zoologist (Nichols, 1919).

The survey identified several problems with biology courses. First, success of the course was too dependent on the teacher. For instance, Huxley's course in London virtually died with him; too few scientists were trained well enough in both botany and zoology to be able effectively to integrate the two. Although there were essential similarities between plants and animals, there were also critical differences, and these were too often lost in the hybrid course. There was also concern that the introductory biology course relied too heavily on generalized concepts and had too little factual information. "Let the student learn to be analytic before he attempts synthesis" (Nichols, 1919, p. 514). Furthermore, attempting to introduce students to the breadth of all living things permitted only superficially touching upon any particular group. (Today we would describe this approach as a mile wide and an inch deep.) As a result, the biology course provided inadequate preparation for any subsequent higher-level botany course. The basic problem was that, "The general biology course owes its perpetuation, as it did its inception, primarily to the zoologists….The general biology course is 'simply a survival of an early stage in the pedagogy of the subject and has no place in a modern educational scheme'" (Nichols, 1919, p. 515).

It appeared that the threat to botany from biological sciences was in retreat and that botany (and zoology) would continue their independent trajectories towards prominence among the American sciences. Of course, we now know differently. The change began in 1919, the same

year Nichols published his paper, with the launching of the General Education movement and the core curriculum at Columbia University (Rudolph, 1962). In 1922 Harvard introduced the general biology course "Life and its Environment" as a general science survey, without laboratory, to present the more important principles. This course, and similar ones at other institutions, was designed to explain the scientific viewpoint and to demonstrate "how man's increasing control over nature has changed his way of looking at life" (Reuben, 1996, p. 203). The rebirth of biology in general education was specifically addressed by Sinnott (1934–35) at an Iowa State University Symposium on teaching botany. Sinnott argued that botany was better situated than any of the other sciences to fulfill the objectives of general education. In addition to helping to develop a scientific mindset, the old-fashioned botany that consisted of collecting and naming plants served to introduce students (particularly urban ones) to the outdoors. More important was the clear role of botany in the development of an understanding of the ecological place of humans in the world. And, finally, botany allowed an examination of fundamental biological problems while skirting inflammatory and controversial topics such as "the hypothesis of Nordic supremacy, the debate over birth control, or the assumption of a biological necessity for the class struggle…" (p. 245).

While the threat from without (biology) seemed to be at bay, another threat to botany was growing within. In his 1903 address Galloway foresaw a danger that could result from the rapid expansion of botany and its necessary "division of labor" (Galloway, 1904, p. 14). As noted above, this division already expressed itself in the textbook treatment of botany which increasingly divided it into distinct sub-disciplines. It was also evident in the rapid emergence of specialized plant science societies. The American Fern Society (1893), American Bryological and Lichenological Society (1898), and the Society of American Foresters (1900) were already established. Within three years the Agronomists would form their society (1907), and the Plant Pathologists would split from BSA a year later. In 1913 the Ecological Society of America formed by a merger of the ecological sections of the BSA and the Zoological Society. In 1922, the American Horticultural Society split off and finally, in 1923, the plant physiologists split off to form their own society (Smokovitis, 2006).

Education in the Program of the Society in the 1910s and 1920s

Given the strong support for botanical education by the founders of the BSA, and the expansion of botany through the 1910s and early 1920s, it is perhaps surprising that there was not a single mention of teaching or education in the minutes of the BSA Council, or a single paper on these subjects presented at an annual meeting, until the 1911 teaching symposium mentioned above. Apparently there were informal discussions about teaching at the annual meetings (Botanical Society of America, 1938), but it was not until 1924 that education again appeared in the meeting program. At that year's Washington meeting, a paper titled, "The Position of Botany in the College Curriculum, with a Completion Test in Biology for Use in College Classes" was presented in the General Section while the Systematic Section held a special session "devoted to a round-table discussion of the training of systematists in college, university, and research institutions" (AAAS, 1925). Authors or participants in these sessions are not indicated; however, F.C. Gates of the Systematic Section was authorized $11.50 for expenses to study botanical education (Proceedings, 1924, p. 8).

Apparently the round-table was a success, and those present voted to publish a summary. They also appointed a committee to "study and report on this subject" the following year in Kansas City (AAAS, 1925). There is no record of a published summary or of a follow-up report. However, in 1925 the Society did vote to publish and distribute to members a monthly leaflet "popular in nature and designed to appeal to and help the teachers of botany and the amateurs interested in the subject" (Minutes, 1925, p. 13). The committee chosen to fulfill this project included Otis Caldwell, C. Stewart Gager, W.J. Robbins, David Fairchild, E.L. Palmer, and E.G. Britton. The following year (1926) in Philadelphia, Gager presented a progress report and the Council charged the committee to proceed. Fairchild and Caldwell were replaced by E.W. Sinnott and Wm. Crocker (Minutes, 1926, p. 20). At the 1927 Nashville meeting Robbins, chair of the committee, presented an informal report recommending that the Society consider publishing another journal, "somewhat less technical than the *American Journal of Botany*". The Council recommended that the committee proceed with a recommendation to establish a journal, with an editor in chief, and a projected budget. They should

consider the possibility of taking over an existing journal (Minutes, 1927, p. 29). There is no record of any further activity on this project. Nevertheless, a growing number of botanists, particularly in physiology, ecology, genetics, and plant pathology, were concerned that morphology and evolution had so taken over teaching of the discipline that it was becoming sclerified, unappealing, and ineffectual to many students. In 1923, Frederic Clements, now at the Carnegie Institution of Washington, decried the fact that botany teachers had ignored his challenge to investigate science teaching as a science a dozen years earlier (Clements, 1923).

Clements, now one of the "old guard" and no longer actively involved in teaching himself, was not alone in his discontent. For instance, Homer Sampson (Ohio State), published "A program for general botany" that emphasized a problem-discussion method of teaching botany. He called not only for a reconstruction of objectives and a reorganization of content, but also for a reexamination of the methods of classroom pedagogy (Sampson, 1931). At Iowa State they did begin a system of research on teaching effectiveness, not only to examine new pedagogies (Dietz, 1934–35) but also to develop a useful assessment instrument (Kreutzer, 1934-35.)

Teaching of Botany in Colleges and Universities Project

During the 1920s little attention was paid to what was going on in biology education, particularly K-12, but a tsunami had occurred. In the early 1920s, botany was the most popular life-science course in high schools around the country, but by 1928 fewer than 2% of high school students elected to take botany and by 1934 the figure was less than 1%. In 1936, when it was removed from the list of the College Entrance Examination Board, botany virtually disappeared from high school curricula (Caldwell, 1924; Rosen, 1959). According to Rosen, this change was primarily due to a rebellion of high school teachers who wanted to put science into the context of social use and improvement, against the traditional formal science promoted by university professors, particularly botanists.

At the 1931 New Orleans meeting the BSA Council discussed a proposal to "recommend to the Society the establishment of a Committee on Educational Status and Methods of Teaching." The concern was for the university level; high school was already lost. The proposal, brought by W.G. Waterman of Northwestern University and seconded by B.C. Tharp of the University of Texas, failed (Minutes, 1931, p. 77; Proceedings, 1931, p. 77). Two years later, in Boston, the secretary reported that the previous year (1932) the American Council on Education had requested that the Society provide a list of botanists who could report on the graduate work in American colleges and universities. The Council took this up and asked E.W. Sinnott (Columbia University) to chair a committee of five. He could select the other members of the committee and was charged "to consider whether the Society should undertake any action with regard to the Teaching of Botany, and in the event that this committee decided that some action should be taken, to recommend further what action should be taken, and the means to accomplish it" (Minutes, 1933, pp. 96, 99). Two years later, at the 30th annual meeting held at Washington University in St. Louis, the Council voted to approve the Sinnott Committee request and instructed the Secretary to have nominations for this committee forwarded to the Council as soon as possible (Proceedings, 1935, p. 131). The Committee on Botanical Teaching, consisting of E.L. Stover (Eastern Illinois State Teachers College, Chair), F.K. Butters (Minnesota), O.W. Caldwell (Boyce Thompson Institute), H.M. Jennison (Tennessee), H.C. Sampson (Ohio State), E.W. Sinnott (Columbia), I.C. Wiggins (Stanford), and C.L. Wilson (Dartmouth), was approved by mail the following year (Proceedings, 1936, p. 135). At the Council meeting, in Atlantic City, the Committee was formally charged to study the teaching of botany in colleges and universities with the purpose of improving instruction "by the following and other methods":

- By obtaining a list of objectives which college teachers of botany seek to attain.
- By obtaining the opinions of teachers of botany upon this list of possible objectives, thus discovering those most commonly emphasized and those considered most important.
- By finding [out] the means which are now used by various college teachers in attempting to achieve each of these objectives.
- In the case of the more promising and more unique procedures, by obtaining through visits a detailed description of the teaching procedures, with a view to publication and distribution to teachers of botany throughout the country.

- By describing the methods now used and others which may be used for testing, in order to find out to what degree these objectives are being realized.
- By finding in these ways the points at which the committee might direct its efforts most effectively in helping the beginning teachers of botany in improving their work.
- By publishing the report of the present status of college botany teaching so as to stimulate interest in further experimentation in botany teaching and so as to outline more promising procedures now in use which might be suggestive to college botany teachers throughout the country.
- By encouraging a cooperative study by botanists, zoologists and biologists to determine through experimentation the values obtained by separate courses in botany and zoology.

In addition the council provided a 1-year salary of $2500 for an executive secretary to oversee the project and $400 for a stenographic assistant. A stipend of $600 was provided to support one meeting of the committee and an additional $600 was to support travel by the executive secretary to visit institutions "in which significant work is in progress." Two hundred dollars was supplied for postage and $600 to defray the cost of publication. Finally, $100 was set aside for contingencies, bringing the total cost of the project to $5000.00. After discussion, the Council raised the total to $5600.00 by increasing the salary of the executive secretary to $3000. They also voted to add the retiring Secretary of the Society, Loren C. Petry (Cornell) to the Committee (Proceedings, 1936, p. 149, 151; Minutes, 1936, p. 139). A grant in this amount (equivalent to more than $93,000 in today's dollars) was submitted to the Education Board and the award was funded. Dr. Clark W. Horton (Ohio State) was engaged as a research assistant to oversee the project. The following year, in Indianapolis, the Council granted a request by the Committee that it be continued, and that the "General Education Board" be asked to provide sufficient funds to continue supporting this activity (Proceedings, 1937, p. 163).

The committee began by drawing up an extensive questionnaire divided into 5 major areas: general features, objectives (59 likert-scale questions), content (58 likert-scale questions), procedures and methods (40 questions), and evaluations of student achievement (28 questions). This was sent out to 638 universities, colleges, normal schools, technical schools and community colleges in early 1937 (Table 5); 264 usable surveys were returned. Dr. Horton then visited a large number of institutions to gather supplemental information. As expected, the committee found great diversity in botanical teaching. They viewed this as a good thing, and stated in the introduction of the final report that they had no interest in making value judgments when comparing one institution with another. Furthermore, they felt that any attempt to standardize the teaching of botany in the general education program would "inhibit the continuation of experimental change and improvement." Instead, individual teachers should be given the freedom to teach students in the way they are most comfortable, and to include advances in the discipline as appropriate. The hope was that publishing the results would stimulate teachers' interest in improving their own teaching (BSA, 1938).

The committee's report noted that by 1937 approximately 60% of the responding colleges (159 of 264) reported that a biology course was offered to meet the general education requirements of a significant number of their students. Ninety reported that botany and zoology were treated about equally in the biology course at their institution, but 46 characterized their course as "largely zoology, little botany." More than 70% of students in general biology took no further botany courses, and at nearly half of the schools 90% took no further botany. Most botany courses were for 3 credits, and included 2 hours of lecture and a 2- or 3-hour lab. According to the report, all botany courses included laboratory (BSA, 1938). This may have contributed to the general decline in the number of students taking botany. In the 1930s most high schools dropped laboratories because they were too costly and were considered inefficient in helping students to "accumulate facts" (Hurd, 1961). At most, teachers provided demonstrations. The majority of college students would have had little or no prior experience with labs, which could thus be threatening, and would certainly be more time-consuming than a biology or zoology course without labs.

While the section on course objectives contained 59 questions, respondents had the opportunity to propose additional objectives, and 14 more were added. The general conclusion of the committee was that the major discoveries of the previous 30 years had not been effectively incorporated into the introductory course and, in fact, "except for certain

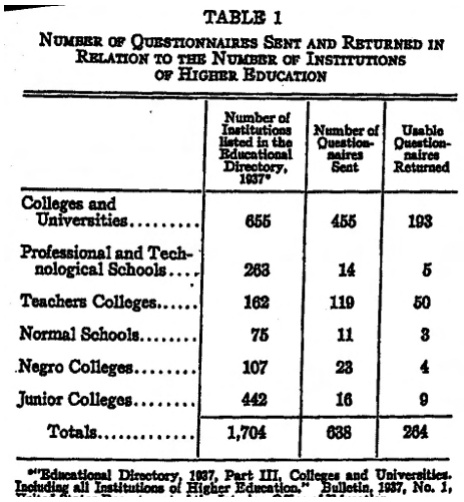

TABLE 1

NUMBER OF QUESTIONNAIRES SENT AND RETURNED IN RELATION TO THE NUMBER OF INSTITUTIONS OF HIGHER EDUCATION

	Number of Institutions listed in the Educational Directory, 1937*	Number of Questionnaires Sent	Usable Questionnaires Returned
Colleges and Universities.....	655	455	193
Professional and Technological Schools....	263	14	5
Teachers Colleges.....	162	119	50
Normal Schools.....	75	11	3
Negro Colleges.....	107	23	4
Junior Colleges.....	442	16	9
Totals.....	1,704	638	264

*"Educational Directory, 1937, Part III, Colleges and Universities. Including all Institutions of Higher Education." Bulletin, 1937, No. 1,

Table 5. Institutions surveyed for 1937 study by the BSA's Committee on Botanical Teaching. Reproduced from BSA 1938. An exploratory study of the teaching of botany in the colleges and universities of the United States. Miscellaneous Series Publication No. 119.

technical details some of the current courses in general botany can scarcely be distinguished from those of 1900" (B.S.A., 1938, p. 11). In terms of content, about half of the questions demonstrated a near unanimity of coverage, while the remainder exhibited great diversity. The former seemed due to "the very natural tendency to teach others what one has been taught and to teach it by the same method" (p. 15), and to the general uniformity of textbooks. The latter was related to the individual specialization of instructors, and to the selection of advanced courses offered in particular departments. Of particular concern was that general botany was frequently less popular than general zoology, and that one area particularly disliked by students was traditional diversity: comparative morphology from algae through flowering plants. There was also a concern that too many facts were being added without underlying principles or extension to applications. "Perhaps one of the most significant things the committee can do is to encourage experimentation in botany teaching, at the same time encouraging the improvement of techniques and devices for evaluating the effectiveness of these experimental procedures" (p. 17).

The message of the section on procedures and methods was that, like evolution, changes in pedagogy were slow and incremental. Seven schools were highlighted for their exceptional innovations. Ohio State divided its course into sections of 36 students emphasizing discussion and demonstration; all class activities were in the laboratory or in the field. North Carolina State College revised its laboratory work to mimic conference discussions based on intensive questioning and discussion of about 600 lantern slides. Iowa State College developed the Group-Conference method—essentially the inquiry method based on small group projects. As noted above, they also developed a rigorous quantitative assessment program. Barnard College replaced the traditional laboratory with individual research projects. The University of Tennessee developed an "Honors" section for their best students beginning during the second quarter of the full-year course. Tulane University focused on teaching the outline-method for note taking and included an individual literature-review treatise, in outline form, as a course capstone. Goucher College incorporated an independent project on plant nutrition into the first semester. From today's perspective, perhaps the most unexpected outcome of the evaluation section was that essay and short-answer subjective questions were considered "old fashioned" whereas the new technique was objective multiple-choice questions. The treatment of objective testing was expanded into a separate volume that provided multiple questions applicable to all areas of botany (BSA, 1939a). A very useful addition to the end of the report was a 3-page listing of supplemental readings, both books and journal and magazine articles, applicable to a general botany course.

At the 1938 meeting in Richmond, VA, the Committee presented its final report, which was accepted (Minutes, 1938, p. 163). The Committee would resign at the completion of their activities the following March. The Council voted that a new, smaller committee should be appointed, but that there would be no further financial commitment (Proceedings, 1938, p. 181). There is no record of the make-up of the new committee, but Dr. Stover presumably remained as chair, for he presented the Committee reports in 1939 and 1940 (Council, 1939, p. 3; 1940, p. 27). The Treasurer's report of 1939 showed the receipt of $1000 from General Education Board for the Committee on Teaching Botany. It further showed

that the Committee submitted expenses of $159 and $328.80 was refunded to General Education Board [the disposition of the remaining $652 was not explained] (BSA, 1939b). This meeting, held in Columbus as part of the AAAS annual meeting, also included the newly formed National Association of Biology Teachers (NABT) who sponsored two sessions with 11 papers. In addition to papers focused on teaching, there was discussion of larger issues including the relationship between schools and colleges. "There seemed to be universal agreement that the main hindrance to good biology teaching hitherto has been the retarding influences of the colleges, albeit unintentionally" (Jeffers, 1940).

At the 1940 meeting, the Council voted that the President should appoint a new Committee for the Teaching of Botany and that, "This committee look into the field for new projects …" (Council, 1940, p. 27). Except for the *ex-officio* member of the committee (the Secretary of the Society), the make-up of the Committee remained the same throughout the war years: W.F. Loehwing (chair, Iowa State), C.W. Horton (Ohio State), O.W. Caldwell (Chicago), H.J. Fuller (Illinois), I.L. Wiggins (Stanford), J.F. Stanfield (Miami University), R.T. Wareham (Ohio State), H.L. Dean (Iowa), G.C. Couch, and P.D. Voth (Chicago) (Yearbook, 1940-41; 1942-43; 1944–45). The only activities reported were bills for $21.11 (1942) and $23.53 (Council, 1943).

It is worth noting that while little BSA educational activity occurred during the war years, government support for science shifted dramatically. "For American scientists, the world changed on 23 September, 1941… universities could charge the government a percentage for overhead on all their research contracts" (Pauly, 2000, p. 239). This had a major impact on the status of colleges vs. research universities in the post-war era as support for basic biological research increased from $8,000,000 in 1953 to $189,000,000 in 1962 (Pauly, 2000). Another significant national change was brought about by the 1945 Harvard University report *General Education in a Free Society* (Report, 1945). Among their recommendations were that direct observation and precision are among the values that science should contribute to general education. Therefore, laboratory work was essential to science teaching.

Evolving the Modern Structure of BSA Education

At the 1946 Boston meeting, a report of the Committee on Survey of Supply and Demand of Trained Personnel in Botany was accepted by the council and ordered to be printed in the *American Journal of Botany* (*AJB*) (Chester, 1947; Council, 1946, p. 47). Later, at the business meeting there was a poll for the formation of a Section for Botanical Teaching; the vote was 299 in favor, 133 against. Authorization was postponed until the second council meeting 3 days later. On December 29, 1946, "The signed petition of 52 members requesting the authorization of a section on Botanical Teaching was presented by Dr. C.L. Wilson and accepted." The annual budget was amended to include $200.00 for the new section (Council, 1946, p. 49, 53; Table 6). The BSA now had a Teaching Section, although the officers and terms of office would not be approved for five years (Minutes, 1951, p. 21). In 1946 a single teaching paper was presented at the annual meeting. Livingston and Heimsch presented "The use of leaf peel preparations in teaching leaf anatomy" in the general section (Livingston and Heimsch, 1946). Also in 1946, the AAAS began an annual forum on science teaching, and established the AAAS Cooperative Committee on the Teaching of Science and Mathematics. Glenn W. Blaydes served as the BSA representative (Council, 1946).

At the 1947 Chicago meeting, the council voted to join the proposed American Institute for Biological Sciences (AIBS) (Council, 1947, p. 123). The concept of the AIBS had been vigorously discussed by individuals and professional biological societies since 1944, but it was not until 1947 that the minimum of 10 professional societies voted to join this umbrella organization. The BSA was one of 11 charter member Societies, and botanist Ralph Cleland was elected Chairman of the Board (AIBS, 1972). The Society was beginning to take on its modern form and to be concerned with modern questions. The 1949 New York meeting was the first to specifically address a concern we still address today: "In view of the growing tendency of colleges and universities to eliminate departments of botany per se or to incorporate them into Biology departments…", J. Fischer Standfield proposed to the Society that it appoint a committee to study the problem. This proposal was unanimously adopted, and it was voted that the incoming President, A.F. Blakeslee, appoint the committee (Council, 1949, p. 175). Sydney Greenfield (Figure 7) was appointed

Year	Chair, Teaching Section	Chair, Education Committee
1946	Carl L. Wilson	
1947	Carl L. Wilson	
1948	Glenn Blaydes	
1949	Neil E. Stevens (deceased) Harriet Creighton	
1950	Ernest L. Stover[a]	
1951	Ernest L. Stover	
1952	I. Kenneth Jones	
1953	Wendell H. Bragonier	Sydney Greenfield
1954	Fred Norris	Sydney Greenfield
1955	Irving Knoblock	Harriet Creighton
1956	Eric Steiner	Victor Gruelach
1957	Robert Paige	Victor Gruelach
1958	Donald Ritchie	Victor Gruelach
1959	Harriette V. Bartoo	Victor Gruelach

[ac]Also Chair, Committee on Botanical Teaching, 1939.

Table 6. Chairpersons of the Teaching Section and Education Committee of the BSA from their founding through 1959.

to chair a committee to study the role of botany in American colleges. The committee also included R. F. Dawson, V. A. Gruelach, William P. Jacobs, O. Tippo, and M. Winokur.

In 1950, the Teaching Section brought several proposals to the Council. The first was to ask the Council for a statement of policy on publishing teaching articles in the *AJB*. The Council voted that the section "shall investigate other possibilities" (Council, 1950, p. 79). The Section also proposed that the Society establish a Placement Service Committee and this proposal passed. Finally, the Section proposed that the Society establish an award for distinguished teaching of botany. This proposal was tabled. In addition, Greenfield's Committee on the Role of Botany presented a plan to describe the present status and trends at the undergraduate and graduate levels in colleges and universities, and to recommend a policy to improve the present status. They also proposed to devise a permanent mechanism for addressing "bad practices and grievances", and for career advising (Council, 1950, pp. 7–13). That same year the AAAS sponsored three education symposia at the annual meeting: 1) current research trends, to update faculty; 2) science in general education; and 3) improving college science teaching (Blaydes, 1950).

Greenfield's committee submitted their preliminary report on the Role of Botany to the Council at the 1951 Minneapolis meeting. The report consisted of four parts. The first described the essential role of plants in the world, with 8 inclusive examples to illustrate the essential role of

Figure 7. Sydney Greenfield. (Photo compliments of Edward G. Kirby.)

botany as a basic science and essential component of a liberal arts curriculum. The second specifically addressed the role of botany in general education. The third and largest section summarized the trend toward biology courses and departments, and identified 12 particular widespread problems associated with these trends. Finally, two major recommendations were made: to complete the present study, and send the final report to college presidents, deans, and department chairs, and second, to dissolve the committee and replace it with a standing Educational Policies Committee of the BSA (Council, 1951, pp. 49–58). The report precipitated a lively discussion about whether the scope should be broadened from just botany vs. zoology in biology courses and departments, to a broad consideration of educational policies and accreditation. The consensus was to limit activities to avoid "stirring up trouble" (Council, 1951, p. 86). However, because the situation was so critical, they voted $100.00 to complete the survey of colleges and universities already begun, but not to extend it to teachers colleges or junior colleges. Furthermore, the Committee would terminate its activities in 1952.

"Stirring up trouble" probably referred to a paper published earlier that year by Harry Fuller (1951a). Based on his address as retiring president of the University of Illinois Chapter of *Phi Beta Kappa,* Fuller stridently argued that "The emperor's new clothes" was an apt description of the "debasement of liberal education" (p. 32) by colleges of education. He accused the latter of being anti-intellectual and directly responsible for the poor training of high school graduates. A major problem was their substitution of "socially significant" (p. 33) courses for traditional training in the arts, humanities and sciences, and all of this was presented with a "rich, purple prose and the grandiose and bombastic vocabulary they are wont to use" (p. 39). This was one of the earliest, and certainly most polarizing, attacks on schools of education for poorly preparing teachers, who in turn poorly prepare students for college work in all areas of the liberal arts, including the sciences. Paul Hurt called the 1950s the "decade of confusion and crisis in science education (Hurt, 1961, p. 108). Complaints about the efficacy of schools of education can still be heard in today's discussions of how better to prepare students for teaching careers.

The final report of the Educational Policies Committee was submitted and discussed in 1952 (Council, 1952, pp. 102–118). It included a brief introductory section and altered the order of sections from the previous preliminary report. The bulleted points of the preliminary document were expanded into a narrative, as were the recommendations. The primary recommendation was to establish a Committee on Education with seven specific charges. The second recommendation was to publish the objective data of the questionnaire. The third was to appoint a committee to promote professional unity among all plant scientists, and to study the problem of an all-inclusive plant science society. The final recommendation was to encourage all botanists to use the terms 'Botany' and 'Plant Science' as synonyms. Virtually every point of this document is relevant today and it is included, in full, in the supplemental materials. Following the Committee's recommendation, the Council voted to establish a permanent Committee on Education (Council, 1952, p. 80).

In early 1953 the Education Committee was organized with the following members: Harlan Banks (Cornell), Vernon Cheadle (California, Davis), Ralph Cleland (Indiana), Harriet Creighton (Wellesley), A. Orville Dahl (Minnesota), Victor Greulach (North Carolina), Irving Knobloch (Michigan State), William Steere (Stanford), Oswald Tippo (Illinois), and Sydney Greenfield (Rutgers, Newark) as the Committee's first chair (Table 5; Table 6). At the Madison meeting in September, the Committee recommended establishing an informal bulletin of news, notes, discussions, and reviews to supplement the *American Journal of Botany* (Council, 1953, pp. 201–203). The Executive Committee voted to establish the *Plant Science Bulletin (PSB)* with Harry Fuller as editor. The editorial board was directed to meet before the Society Business Meetings and to report its decisions at that time (Executive Committee, 1953, p. 214). The Education Committee was authorized to enlarge itself, as needed, and to formulate a budget, not to exceed $1200, in order to begin publication of the *PSB* prior to the next annual meeting (Council, 1953, added page modifications).

In the same year, Dr. Blaydes reported on a statement by the AAAS Cooperative Committee Subcommittee on the Content of High School Biology, of which he was a member. The subcommittee recommended that the proposed new course should be offered in the senior year and be preceded by a general biology course at the 9th or 10th grade level. The instructor should have at least a master's degree, and the basic principles of plant, animal, and human biology should be emphasized. The central themes of the course should be

evolution, ecology, and conservation, and a primary objective should be to develop observational skills, discovery, and problem solving—through the solving of real problems. Although botany had now been displaced from the high school curriculum, the pedagogical principles espoused by botanical educators 50 years earlier were still being extolled. Indicative of the problem is the report from the BSA Committee on Guidance, which stated, "There appears to be a growing concern about recruitment of promising high school and college students for life sciences…" (Minutes, 1953, pp. 197–200).

At the 1954 Gainesville meeting, the Education Committee recommended that the *Plant Science Bulletin* should be published by the Society, not the Committee, and that the Committee would serve as its editorial board. In addition to Editor Fuller, and members Banks, Creighton, and Greenfield, George Avery (Brooklyn Botanic Garden) and Paul Sears (Yale) were appointed to the editorial board. The Committee also discussed its own organization, including rotating 3-year terms with the Chair appointed by the Council. The Committee also recommended that the Teaching Section plan conferences and symposia on various aspects of teaching botany at the annual meetings. Finally, the committee reported on an examination of the Educational Testing Services Graduate Record Examination and College Entrance Examination in Biology. In both cases the exams were considered to have a strong zoological bias, and it was recommended that they not be used for botany students (Council, 1954, pp. 241–243).

In his outgoing address to the Society, President Wetmore suggested that the Society should consider sponsoring a summer workshop for small college faculty to update their skills and become acquainted with the latest findings. Harlan Banks and George H.M. Lawrence of Cornell rose to the challenge and wrote an NSF proposal based on this idea. Unfortunately it was submitted too late for funding (Banks, 1956).

In response to the Education Committee's recommendation the previous year, the Teaching Section sponsored 15 papers in two sessions at the 1955 meeting (the morning session was co-sponsored by the National Association of Biology Teachers (NABT)). Seven of the presenters used visual technology to supplement their oral presentations. Five used the new medium, 2 × 2-inch slides, a sixth used 3 1/4 × 4-inch lantern slides, and one used 16mm movies (Table 7). The Section also sponsored a demonstration room for exhibits of teaching materials and co-sponsored, with NABT, a symposium on "The Botanical Content of a Biology Course at the College Level". The symposium presenters were Earl Core (West Virginia), Wolfgang Pauli (Brandford Junior College, MA), Lorus and Margery Milne (New Hampshire), and John Karling (Purdue) (AIBS, 1955). At the business meeting, Dr. Creighton reported that the Education Committee felt that there was an urgent need for the Society to increase the public's knowledge of botany. They therefore proposed that the Council allocate funds for public relations, and that the Committee should work with any other group in the Society to accomplish this aim (AIBS, 1955).

50TH ANNIVERSARY MEETING

A flurry of educational activity surrounded the 50th anniversary meeting in 1956. The previous year, in the *PSB's* inaugural article, Sydney Greenfield noted that while botany was growing with the other sciences in many institutions, in others it was not keeping up. Among the factors contributing to this "special retardation" was that in many places general biology was mostly zoology, taught by zoologists, with a consequent reduction in botany hires and upper level botany offerings. "It is our responsibility to clarify the issues here [to administrators] and to define biology, especially for those who think it is a synonym for zoology" (Greenfield, 1955, p. 3). A significant reason for this, claimed Greenfield, was due to the reluctance of botanists to engage in general biology or general education courses – botanists must become involved. We were also at fault for accepting "mediocre" students in some programs, and for not being proactive enough at encouraging "dynamic and energetic young men to enter the profession" (p. 3). Yet, despite these problems, Greenfield argued, dedicated resolve could improve the conditions (Greenfield, 1955).

In the third *PSB* issue of 1955, Robert Miller (Nevada) presented a "snapshot" image of the current state of the introductory botany course. Miller sent a 25-question survey to 53 botany departments in the U.S. and Canada and received responses from 37 of them. The survey covered all aspects of the lecture and laboratory. For instance, most courses consisted of a single semester with two 50-minute lectures and a two hour lab per week, which fulfilled general education requirements and were a pre-requisite to further courses. Most began with plant morphology and anatomy, and

Session 5, morning, jointly sponsored with National Association of Biology Teachers			
Presenter	**Affiliation**	**Title**	**Illustrated**
Creighton, Harriet	Wellesley	Graduate Record Examinations, Advanced biology test	
Fuller, Harry	Illinois	Thought questions for general botany examinations	3 ¼ x 4 slides
Bartoo, Harriette	Western Michigan	The role of botany in a teachers college: the testing program.	
Davidson, John	Nebraska	An experimental approach to teaching botany as a science	
Hard, Gustav	Minnesota	Terminology and television	2 x 2 slides
Sass, John	Iowa State	Subject matter and presentation of a one-quarter course in microtechnique	
Clover, Elzada	Michigan	Applied botany, a new approach for the non-science student.	2 x 2 slides
Hatch, W.R.	Washington State	The Socratic method in modern dress	
Session 5, afternoon			
Taylor, Marie	Howard	Newer objectives in dynamic botany	
Hoshaw, Robert and Sanford Tepfer	Arizona and Oregon College of Education	Teaching pant distribution in elementary botany	2 x 2 slides
Thompson, Betty	Connecticut College	The "Y-shaped" biology-botany-zoology course at Connecticut College	
Dodd, John	Iowa State	Simple method for demonstrating the mechanism of movement in *Oscillatoria*.	16mm movie
Gruelach, Victor	North Carolina	Research and the teacher of general botany.	
Hansen, Harold	St. Olaf	The wedge interference filter for the examination of chlorophyll.	2 x 2 slides
Larsen, Victor	Adelphi	The place of botany in programs for general education.	

Table 7. Teaching Section paper presentations, 1955 Annual Meeting of the BSA. After AIBS 1955, pp. 54–55.

used the formal lecture/laboratory method. Fuller and Tippo's (1954) *College Botany* and Wilson and Loomis' (1952) *Botany* were the most commonly used texts. In the laboratory, teaching assistants (TAs) were the primary instructors at about half of the institutions, but they only assisted the professor at the other schools. About half of the respondents gave lab practicals, and about half gave midterm lecture exams. About half graded on some kind of curve, and there was no pattern to the most common type of exam questions used. Only 1% to 4% of the students went on to major in a plant science. In conclusion, Miller suggested that to justify the expense and space required for laboratory instruction, it would be useful to develop valid and reliable instruments to quantify the effectiveness of different methods of teaching botany, and for evaluating curricula (Miller, 1955).

As noted above, two botany books dominated the market, although at least 14 were available (Fuller, 1957). Fuller had two texts on the market. The larger, *College Botany*, was intended for majors in a full year course and was nearly twice the size of the smaller, *The Plant World,* which was intended for one-semester courses. Wilson's *Botany* (1952), the new text, was comparable in size to *The Plant World*. By this time *General Biology* was becoming entrenched in college curricula, and at many institutions this course served as a pre-requisite for subsequent one-semester courses in both botany and zoology. An interesting general trend is evident in Figure 8. Sinnott's *Botany* and Fuller's *The Plant World* were evolving to a smaller size, as was the case for many life science textbooks during the 1950s and 1960s. The Wilson and Loomis text began at a comparable size but adopted the increasing growth

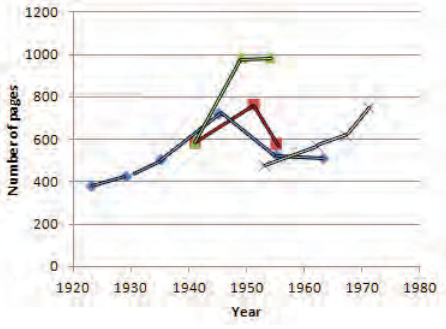

Figure 8. Changes in botany textbook page lengths in revised editions over time: ◊ – Sinnott's Botany: principles and problems, 1923, 1929, 1935, 1946, 1955, 1963; Δ – Fuller and Tippo's College botany, 1949, 1954; Π – Fuller's The plant world, 1941, 1951b, 1955; X – Wilson and Loomis' Botany, 1952, 1957, 1967, 1971.

pattern that has been typical of texts for majors since the 1970s (Figure 8). It is also interesting to note that the reading level of Fuller and Tippo's big botany text of 1949 was 12.9—exactly grade-level for a freshman text. In contrast, Wilson and Loomis' 4th edition (1967) had a reading level of 17.7!

Another interesting "snapshot" of botanical education is "The Academic Origins of American Botanists" by Victor Gruelach (1956a), published in the first *PSB* issue of 1956. Of 2015 botanists in the U.S. and Canada in 1955, 1381 were members of the BSA. Sixty-three percent of the total received their bachelor's degrees from only 51 colleges (of about 800 total). Not surprisingly, in the U.S. land-grant universities produced the largest number of undergraduate botanists (29%) but liberal arts colleges (23%) were next, and among them 12 colleges produced almost 40% of the total. Gruelach noted that at these dozen institutions it was clear that one or two individuals were making a dramatic impact on the profession. At the doctoral level, nearly half (48%) of the PhD's were awarded by land-grant universities, followed by private universities (36%), state universities (9%), and state land grant colleges (6%). There was also a clear geographical bias towards the Midwest and Northeast.

In his *PSB* editorial, Fuller (1956b) noted that botany was facing a challenge, both then and in the future, and that success in meeting that challenge would depend on how botanists chose to teach the subject. He questioned whether botanists would employ "dynamic and thought-provoking" new ideas, or "continue along the old traditional paths that may lead to extinction" (p. 2). With that in mind, the issue (*PSB*, 1956) was devoted to the teaching of botany. Essays included: "Time for another look: A point of view" (George S. Avery, Brooklyn Botanic Garden; Avery, 1956); "How to get more students into science" (E.M. Hildebrand, USDA; Hildebrand, 1956); "Research and the teacher of general botany" (Victor A. Greulach, North Carolina; Greulach 1956b); "Doorstep botany" (Robert W. Schery, Scotts, Marysville, Ohio; Schery, 1956); "Applied botany in liberal arts colleges" (J. Fisher Stanfield, Miami University; Stanfield, 1956); "Some thoughts on general botany courses. Another way to judge their content" (Betty F. Thompson, Connecticut College; Thompson, 1956); and "Botany for non-botanists" (Benedict A. Hall, State University Teachers College, Cortland, New York; Hall, 1956).

As noted in the previous section, in 1955 the Education Committee proposed that the NSF be approached to fund summer workshops. The Society has no record of the grant proposal itself, but in 1956, the 50th anniversary year, Harlan Banks headed the first Summer Institute of Botany for College Teachers, hosted by Cornell University. The Institute was sponsored by the BSA and funded by a $31,400 grant from NSF (Banks, 1956; BSA, 1956). The six-week program was taught by 12 distinguished botanists from around the country (Figure 9) and provided $300 stipends to 51 participants out of 110 applicants; an additional 14 college teachers participated at their own expense (Minutes, 1956, 2/56; BSA 1956). The purposes were to: (1) improve subject matter competence, (2) strengthen the capacity of these teachers to motivate students, (3) establish connections between teachers and research scientists and, (4) stimulate teachers to initiate or continue small research programs at their home institutions. Participants came from 29 states, the District of Columbia, and three Canadian provinces. Equipment was provided by Bausch and Lomb, and 18 publishers displayed books. Banks noted in his report that he had already submitted a proposal for 1957, but that considerably more money was available from the NSF to support similar workshops for high school teachers. Based on discussions with the participants, he increased the requested stipend support to $1000. In fact, $43,900 was provided in 1957. Out of 150 applicants, 39 received full

PROGRAM

1st week July 2-6
PLANT GEOGRAPHY
Prof. Herbert L. Mason
ANATOMY OF PRIMARY BODY
Prof. Ernst C. Abbe
PHOTOSYNTHESIS
Prof. Robert E. Emerson

2nd week July 9-13
PLANT GEOGRAPHY
Prof. Mason will continue his series
ANATOMY OF PRIMARY BODY
Prof. Abbe will continue his series
RESPIRATION
Prof. David R. Goddard

3rd week July 16-20
PLANT GEOGRAPHY
Prof. Mason will continue his series
ANATOMY OF PRIMARY BODY
Prof. Abbe will continue his series
NITROGEN METABOLISM
Prof. Robert Bandurski

Daily Schedule

Usually there will be three lectures each morning, Monday through Friday.

Demonstrations, discussions and field trips will be held in the afternoon.

Stipend holders will be obligated to attend all lectures and formal afternoon sessions.

4th week July 23-27
THE ALGAE
Prof. Gilbert M. Smith
HISTOCHEMICAL APPROACH TO ANATOMY
Prof. D. S. Van Fleet
LIGHT EFFECTS
Prof. Arthur Galston

5th week July 30-Aug. 3
THE ALGAE
Prof. Harold Bold
COMPARATIVE STUDIES OF SHOOT APICES
Prof. Ernest M. Gifford, Jr.
GROWTH
Prof. Kenneth Thimann

6th week Aug. 6-10
NON-VASCULAR CRYPTOGAMS
Prof. Harold Bold
APPLICATION OF SURGICAL TECHNIQUES IN ANATOMY
Prof. Ernest Ball

Exhibits and demonstrations

Various textbooks, laboratory equipment, microscopic equipment and teaching aids will be on display or will be demonstrated during the session.

Figure 9. Program of the first BSA Summer Institute for Teachers of Botany in Small Colleges, July 2–August 11, 1956, Cornell University.

stipends, and there were 12 additional participants (Minutes, 1957; BSA, 1957). A third institute was held at Indiana University in 1959 (BSA, 1959) and a fourth in 1961 at Washington State University (BSA, 1961).

Two final educational matters were brought before the Council in the 50th anniversary year. The first was the information that the "Career Opportunities in Botany" booklet was now published (Minutes, 1956, p. 9). Second, the council directed the editor of *PSB* to survey the membership, through a questionnaire, to gauge interest in continuing or abandoning the publication. Of the 1868 regular members of the society at the end of the year, 293 returned a vote to continue, with 2 opposed (*PSB*, 1957a, 3(1)).

The highlight of the 50th Anniversary meeting in Storrs, Connecticut, was the presentation of the Golden Jubilee Merit Citations, the original BSA Merit Awards. Among the 50 recipients were several whose citations noted botanical education contributions: Irving Widmer Bailey, an "inspiring teacher", Ernst Athearn Bessey, for "magisterial presentation of the science of mycology", Benjamin Minge Duggar, "for his wise and patient counseling to many students for whom be [*sic*] provided inspiration, imagination, and high standards of scholarship", George Wannamaker Keitt, "for his patience and kindness in counseling many students", Louis Otto Kunkel, "for his wise counseling of associates and students", Andrew Denny Rodgers III, "His biographies of well-known botanists and histories of phases of the development of botanical science are readable, scholarly, and authentic", Elvin Charles Stakman, "for his genius in inspiring students and workers", Edgar Nelson Transeau, "for support and encouragement of botanical science in its broadest sense, both in its education and scientific aspects….substantial contributions… to botanical education at all levels, from high school to graduate school", and Truman George Yuncker, "for his lifetime of effective teaching at the undergraduate level which has resulted in launching many able young scholars into careers in botany" (*PSB*, 1956; Meyer, 1958).

The education highlight of the meeting was the Teaching Section Symposium on Trends in Botanical Teaching. The papers, by Drs. Sinnott, Palmquist, Cleland, and Fuller, were printed in condensed form in *PSB*. Sinnott began with a review of botanical teaching over the previous 50 years (Sinnott, 1956). Sinnott's paper could serve as an abstract for the present paper.

Cleland followed with a discussion of the impact of enrollment on the teaching of botany. He began by anticipating the coming "baby boom" generation, and questioned whether botany would be able to compete with the other sciences for new students. In his opinion, three things would be necessary. First, botanists would have to become more proactive in recruiting students, and in educating the general public about botany. Most people have no idea of what botanists do, he said, or have the misperception that all they do is collect and dry plants. Second, especially in biology departments, botanists would have to aim to keep the number of botany courses roughly comparable to the number of zoology courses. Third, plant scientists must see themselves first as botanists, not as biochemists, agronomists, geneticists, physiologists, etc. The tendency towards splintering weakened the overall impact of the plants sciences. Fourth, the emphasis in botanical instruction must shift from structure and observation to function and experimentation. Especially in the non-land grant schools, he suggested, we should place strong emphasis on making the introductory botany course "dynamic and exciting" (Cleland, 1956).

Edward Palmquist picked up on Cleland's final theme in the following paper. He suggested that the fact that students didn't know about botany was actually an advantage for teachers. In addition, the economic importance of plants allowed botanists to illustrate the role of botany in things familiar to students and then expand into basic biological processes such as respiration, cell division, photosynthesis, genetics and evolution. He also noted that as a visitor to the first Summer Institute, held earlier that summer (figure 9), he had had the opportunity to informally survey the participants, and had posed three questions: (1) What awakened their interest in plants? (2) What led them to choose a career in botany? (3) What did they find most captured the interest of their students? In answer to the first question, nearly half (22 of 53), indicated informal day-to-day childhood activities and nearly as many (19) indicated participation in planned activities such as courses or Boy Scouts. Twelve indicated that it was a particular person, usually a teacher or parent. In answer to the second question, for nearly half (25 of 53) it was a particular teacher who influenced their career decision. Add to this the 7 who indicated a particular graduate assistant, and it is clear that personal example was a major influence. A variety of class activities were mentioned in answer to the third question, but among the most common were field work, experiments in plant physiology, first-hand study of living plants, economic importance of plants, and individual student projects. In summary he left us the "Ten Commandments for the Teaching Botanist" (Figure 10; Palmquist, 1956).

The final presentation in the symposium was "The role of botany in a liberal education" (Fuller, 1956c). It was clear that the general education program was now dominant in higher education and so the question was, how can botany participate in this program? Fuller identified eight ways botany could be argued to support the principles of general education. The first was to recognize and appreciate the beauty of plants, not only as components of the landscape, but particularly the beauty of plant structure both at the macro and micro levels. Second was the opportunity that education in any science has to develop critical thinking skills, including recognition and evaluation of evidence, and rejection of misinformation. Third was to develop an understanding of the interdependence of all nature, from nutrient cycles to ecological relationships. Furthermore, this understanding could be used to demonstrate that science is not inherently a-religious, but can complement a student's religious beliefs. Fourth, we could demonstrate that the scientific method was not some "esoteric technique peculiar to white-coated gents…" but is a way we all approach problem solving in everyday life. Fifth was to emphasize the connections not only between the sciences, but between botany and other fields of thought, for instance, anthropology, archaeology, geography, history, and philosophy. Sixth was to emphasize that the practical application of science is due to prior research in basic pure science. Botanists must make connections with agricultural production and environmental protection more clear. Seventh, we must change the general public perception that botany is primarily involved with plant identification and the study of disease and management of cultivated plants. Although these are useful applications, they do not form the core and central purpose of botany. The final general relevance of botany was, "Organic evolution and its implications, which are so obvious that they do not require further comment" (p. 6). Having listed these connections, he now asked how should we teach general botany to achieve these ends? In answer, he quoted Neil Stevens (1944a): "Teaching may be a little like love-making. If the available literature is to be believed, many techniques have

been successful in the field, but there appears to be no written record of a successful lover who was not interested in his subject". The most important thing about teaching general botany, according to Fuller, was to have a broad background and a passionate feel for the subject (Fuller, 1956c).

The month before the meeting, Fuller published an invited article in *AJB* that would become part of the forthcoming 50 Years of Botany compilation (Fuller, 1956a, 1958.). Three of the 40 chapters in *Fifty years of Botany* were devoted to botanical education and all three were concerned with the plight of botany. Cox, from AIBS, and Behnke, from Ronald Press, noted that science was booming at mid-century and the BSA was thriving. Controlled experimentation was expanding in basic and applied science, and new instrumentation was constantly being invented. Although new scientific disciplines were developing, and older ones were expanding, there was greater interdependence of the sciences than at any time in the past. Yet, despite this, "botanical education is a sad plight" (Cox and Behnke, 1958, p. 484). Who was to blame? Botanists themselves. "They have been at times meek and aloof, at times bullheaded and uncooperative… With the world inescapably dependent on plants… they have sought to hide plants with strange labels and newly created categories. Their success in making the study of plants virtually unintelligible to the layman would almost seem to be by design prompted by some strange idea that by multiplying baffling terminology, botany would gain intellectual stature" (p. 484). Part of the problem is that although chemistry, math and physics had been made required coursework, little of these disciplines were incorporated into the botany courses themselves. What, then, were their solutions? (1) "Sacred cows in the form of traditional content of courses must be under constant critical scrutiny." (2) Teaching the process of science must start in the beginning courses, especially in the introductory *biology* course. (3) Except at the largest universities, departments should concentrate on developing a few fields in depth, rather than trying to cover the expanse of botany, and even here care should be taken not to "splinter course offerings" in a way that arbitrarily divides botany into many distinct courses (p. 487).

While expressing many of the same ideas as Cox and Behnke, Fuller adopted a more positive tone. The "odor of botany," he suggested, is perhaps more noticeable to botanists than others, yet we must do some things to sweeten its pungency. First, he noted, a disproportionate number of botanists did their undergraduate training at small liberal arts colleges, "which, probably through their greater emphasis upon the value of inspired undergraduate teaching, succeeded in encircling in that disproportionately large number of young people a passion for plants and for botany" (Fuller, 1958, p. 491). Much of the problem was in the introductory course where students are all taught as if they are

Ten Commandments of the Teaching Botanist.

1. Thou shalt have no other goals before leading students to learn.
2. Thou shalt not take unto thy class any dried or pickled plants, or graven images thereof, when living specimens can be found.
3. Thou shalt not take the name, "Great Scientist," unto thyself, nor be vain.
4. Remember the sabbatic leave, if any; take it regularly to keep thee wholesome.
5. Honor thy students and thy colleagues, and respect them as equals except only in thy special field.
6. Thou shalt not kill-the enthusiasm of thy students by over-burdening them with trivial busy-work.
7. Thou shalt not commit adulteration of student grades, even for a pretty face or pres sure from the parents or the Department of Athletics.
8. Thou shalt not steal-away from the laboratory classes, leaving them solely to student assistants.
9. Thou shalt not bear false information to thy students, nor bluff, nor improvise before them.
10. Thou shalt not covet the zoologist's space, nor his budget, nor the bright man students and the maid students he receiveth from the premedical and nursing programs, nor anyother thing that is zoological.

Figure 10—The Ten Commandments of the Teaching Botanist, from Palmquist (1956).

botany majors, but for most this would be their only botany course. Second, "we are a slave to tradition" in the introductory course syllabus. Third, we are too concerned with the insides of plants, rather than the plant as an organism, and laboratory study was too mechanical. Finally, graduate education was too specialized.

Finally, Clarence Hylander (1958) emphasized that there was a need and opportunity for botanical outreach to general education students and the lay public. People were beginning to move to the suburbs, which was, in a sense, a return to nature, and they didn't know much about it. Families were taking trips to parks and recreation areas and were generally living longer. Why, he lamented, "do so few professional botanists contribute articles of a popular nature" (p. 500)? Fuller's chapter, like 37 of the other chapters in *Fifty years of botany*, had been published in the *AJB*. The chapters by Cox and Behnke, and by Hylander were the only two not also published in the BSA's journal.

And then came Sputnik: a summary

As noted above, the 50th anniversary celebration in 1956 was not only a banner year for the Society, but also for educational activities within the Society. Unfortunately, there followed a rapid drop-off. As Gruelach mentioned in his Education Committee report for 1957, "…the Committee on Education has not been as active as in some of the past years…" (Minutes, 1957, p. 7a). The April 1957 issue of *PSB* included a 3-page table of 16mm instructional films for college botany prepared by a subcommittee formed the previous year (Taylor, 1957). A second successful summer institute was held at Cornell (BSA, 1957), and a conference on the role of botany in college biology was held in Washington, D.C., February 2–3. Although this conference was sponsored by BSA and supported by the NSF, there are no other records of the conference except in the Committee report (Minutes, 1957, p. 7a). Only 2 papers were presented in the teaching section that year (Program, 1957).

In addition to Taylor's summary, *PSB* included abridged reports of Cleland's and Fuller's presentations from the previous year's symposium, and a few smaller notices. The April issue noted that a committee of the National Academy of Sciences had obtained funding from the NSF to implement a trial of a new method of designing advanced undergraduate biology courses. Of the two pilots chosen, one was systematic botany. A panel system would be used and the botany panel included Lincoln Constance (Berkeley, Chair), Harlan Lewis (UCLA), Reed Rollins (Harvard), Robert Thorne (Iowa State), and Herbert Wagner (Michigan) (PSB, 1957b, p. 8). Finally, and most prescient, the editorial in the July issue noted that while there were many benefits of increased national organization and support for science, there were also disadvantages in the development of bureaucracy, support for conformity, and preferences for certain fields or disciplines (PSB, 1957c, pp. 7–8). Three months later, on October 4, 1957, the Russian satellite, Sputnik was launched with resulting major changes in national policy towards science education. Those changes would affect botanical education in the coming years and will be the subject of the final installment of this series.

How can we summarize the impact of BSA on botanical education during the Society's first half-century? Two words may be sufficient – wax and wane.

Periods of waxing were headed by leading botanists, including many Presidents of the Society. At the turn of the 20th century the major concern was to attract enough students into the pipeline feeding botany. Botany was growing as a discipline, and high school and college education was expanding rapidly. There was a need to attract more students to botany, both into the classroom and into the profession. This led directly to concerns about teaching larger numbers of students more effectively. At the same time, biology was in decline as an alternative to botany or zoology and this, perhaps, resulted in the quiescent period from the mid teens to the late 1930s. During this time there were major changes in both the high school and college curricula. Biology began to replace botany in the high schools, while the general education and electives movement in the colleges greatly reduced the demand not only for botany in particular but also for science in general. "Scientific illiteracy became a characteristic of college-educated Americans some time toward the middle of the twentieth century, if not before" (Rudolph, 1977, p. 255). A new group of botanists picked up the torch for botany education, beginning with a thorough study of the current state in colleges and universities. Despite a slow down during the war years, the influx of a new group of education proponents in the late 1940s and 1950s rose to the challenge from biology and significantly altered

the structure of education in the Society, founding the Teaching Section, the Education Committee, and the *Plant Science Bulletin* in quick succession. Botany, along with the other sciences, rode the incoming tide of national concern and support for improving science and technology education in the 1950s and 60s and this resulted in a flurry of activities coincident with the 50th anniversary of the Society.

A striking aspect of the first 50 years was the role of preeminent botanists in leading botanical education. Apparently this was not unique to the BSA during the first half of the 20th century when all of the life science societies were growing. The mycologist, and future BSA President (1946), Neil Stevens related a story about the American Society of Agronomy meeting in 1942. The dinner speaker had several times repeated the remark that teaching ability was not rewarded as well as research ability in our colleges. After this had gone on several times, Dr. H.K. Hayes of Minnesota interrupted saying that, in fact, teaching ability in that field *was* recognized and rewarded, and that he could present proof. The discussion went on, but eventually Dr. Hayes was asked for his proof. Stevens reported that his reply was this: "I have objective proof. It is here in this room. I do not wish to embarrass anyone so I will not name individuals unless someone insists, but I see here a goodly number of individuals of recognized standing and influence in their fields whose positions rest on their recognized ability as teachers rather than as investigators." That ended the discussion. Stevens was in full agreement with Hayes. He went on to state that, "A list of Presidents of the Botanical Society of America will serve… one finds a large percentage of those who are known first and foremost as teachers" (Stevens, 1944a). It is also interesting that in 1943 Stevens sent out a survey to 1700 members of the BSA and the American Society of Agronomy in which he asked them to rate the characteristics of the teachers who were most influential in their careers. The 1100 respondents named more than 400 individual teachers, but Charles Bessey was "in a class by himself" (Stevens, 1944b, p. 323). It was not surprising to learn that Bessey did his best teaching in the laboratory. However, I was surprised to learn that Coulter "rarely went into the laboratory." This reinforces the concept that there is no one best way for everyone to teach.

While it was true of the early years that many of the most prominent botanists also were leading botanical educators, the situation was changing by the 1950s. During this period, Neil Stevens and Harriett Creighton were the only chairs of the Teaching Section or Education Committee (Creighton served as both) also to be elected President of the Society. In the 1970s Bill Jensen would serve as chair of the Teaching Section and President of the Society. Sydney Greenfield was the spearhead of a change in this pattern that continues today. He was not a leading botanist in the traditional sense, but he was a leading figure in the Society's Education programs during the transition to the second half-century. The specialization of botany educators will be a focus of the final part of this series.

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Book Reviews

Bryological

England's Rare Mosses and Liverworts: Their history, ecology and conservation.....62

Developmental and Structural

Plant Roots: The Hidden Half, Fourth Edition 64

Economic Botany

Catalogue [of the] 14th international Exhibition of Botanical Art & Illustration 64

Phycological

Stress Biology of Cyanobacteria: Molecular Mechanisms to Cellular Responses.....64

Systematics

A Field Guide to the Flowers of the Alps 65

Native Orchids of Singapore. Diversity, Identification and Conservation 66

Bryological

England's Rare Mosses and Liverworts: Their History, Ecology and Conservation

Ron D. Porley
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England's Rare Mosses and Liverworts is a brilliant and valuable contribution to the field of botany broadly and to bryology specifically. Such seminal efforts and contributions will help popularize the subject of botany. The volume is characterized by high-quality color plates, technical descriptions, detailed plant geography, ecological perspectives of different species, and their corresponding conservation efforts and measures.

The volume provides an elegant introduction to the world of bryophytes, including liverworts, hornworts, and mosses, that introduces readers to the subject with comparative ease and minimal technical jargon. The simplicity of the language is worth mentioning as the author's straightforward style will help readers navigate this short but thorough volume featuring 84 bryophyte species. This seminal work provides the first detailed account of bryophyte diversity in England, along with the corresponding conservation measures. The volume is also notable for publishing photographs of several species in their specific habitats for the first time. The author provides in-depth coverage on the current status of individual species, information on their distribution, ecology, and relevant conservation measures, as well as excellent coverage of the factors contributing to extinction/conservation status and loss. The origin of names, cultural history of different species, and their distribution also add depth and interest for the reader.

The volume's introductory materials include a general introduction, an overview of bryophytes and their importance, a note on their rarity, a detailed discussion of conservation efforts and the contributions made by individual researchers to the field, and a summary of Red List and IUCN criteria as applied to English bryophytes. Out of 916 different English bryophytes, 87 are on the British Red List and have been designated as "threatened" by the IUCN. The remaining part of the volume is dedicated to species profiles for 84 species of English bryophytes. Descriptions for individual species include distribution maps, biogeographical information, general species descriptions, information on specific ecology, habitat, and history, as well as conservation measures.

The volume is valuable in exploring both internal and external morphology of the described species. This approach is quite a variation from conventional plant handbooks that predominantly focus on external morphology. An excellent bibliography is

also provided, along with a well-organized glossary, helpful appendices on British Red List species, and a colorful presentation of the species status summary that are useful for quick reference.

Future editions could be improved by a brief section on the fossil remains of extant bryophytes from this ecological zone along with a discussion of their evolutionary history. To provide more complete and exhaustive coverage, it would also be interesting to include any hornwort species occurring in this ecozone.

This handbook will be a collector's delight for bryophyte researchers and will also attract general readers who are interested in diverse plant life and ecology. Scholars will find this concise handbook to be essential for their backpacks on regular field trips for identification and quick field reference. The volume will be extremely helpful for those specializing in botany, bryology, plant geography, ecology, and conservation.

–Saikat Kumar Basu, Department of Biological Sciences, University of Lethbridge, Lethbridge, Alberta, Canada

Developmental and Structural

Plant Roots: The Hidden Half, 4th ed.

Amram Eshel and Tom Beeckman (eds.)
2013. ISBN-13: 978-1-4398-4648-3
Hardcover, US$199.95. 848 pp.
CRC Press, Boca Raton, Florida, USA

This book presents a collection of 42 review articles that consider many aspects of the important topic of root biology. The editors have assembled a group of international experts in their fields to write these individual reviews. The articles are grouped together into several larger thematic sections including: The Evolution and Genomics of Roots; Root Structure; Regulation of Root Growth; Soil Resource Acquisition; Root Response to Stress; Root–Rhizosphere Interactions; and Modern Research Techniques.

As with any book of this type and scope, two issues that emerge are the variability in quality of each review article and the currency of the literature cited. Regarding the second issue, since the publication date is 2013, many (but not all) chapters have references up to 2012. Some reviews appear to be up-to-date only until 2011 (and perhaps a few before this date). Most of the articles are good quality, and some cover a more expansive range while others are more focused to a smaller portion of the literature. An example of the former, more expansive type is the review on the cellular patterning of the root meristem (Chapter 3), and an example of the latter is the article on the role of strigolactones in root development (Chapter 18).

Two strengths of the book are that root biology is considered from the cellular/molecular to ecological levels and that recent developments in the genomic and post-genomic era are considered. Thus, *Plant Roots* represents an interesting, interdisciplinary effort. In addition, there is substantial incorporation into several chapters of some of the latest data resulting from -omics technologies.

Since my research area is focused on tropisms, I particularly enjoyed the chapter on root gravitropism (Chapter 19). This chapter reviewed the literature with an emphasis on the work since the last edition of this book, which was published in 2002. The authors also provided nice diagrams and microscopic images—although all images in this book are half-tone and black-and-white with no color figures. There was also a nice synthesis as well as a perspective on future research, and many chapters have a section on outlooks and perspectives.

Given that the book is expensive, who should own and use this volume? Of course, if your research area is in root biology or intersects in a major way in this field, the book would be a wise purchase. I also believe that it would be a useful text or supplement to certain advanced undergraduate or graduate courses in plant biology.

–John Z. Kiss, Department of Biology and the Graduate School, University of Mississippi, Oxford, Mississippi, USA

Economic Botany

[Catalogue of the] 14th International Exhibition of Botanical Art & Illustration

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Paperback, US$28.00. 108 pp.
Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA

This spectacular catalogue elegantly presents the botanical artwork (watercolors, drawings, and prints) exhibited at the 14th International Exhibition of Botanical Art & Illustration at the Hunt Institute for Botanical Documentation from 27 September to 19 December 2013. The volume is a compilation of 41 botanical illustrations from 41 separate artists, representing 10 different countries. The catalogue includes beautiful botanical art and illustrations, along with biographical information and portraits of the artists. This initiative to bring together international botanical artists from around the world was started by the institute in 1964, and the exhibit occurs every three years. This showcase of botanical art, shared with the public, researchers, and botanical enthusiasts, is in keeping with the broad philosophy of the organization, i.e., "…our collections and exhibitions are intended to educate and inspire growth."

This catalogue provides an excellent glimpse of a diverse body of work and showcases spectacular floral illustrations. The catalogue has been prepared with great care and will be a valuable resource for botanical art collectors as well as for professional and amateur botanists. All illustrations are provided with their complete scientific names and authorities, corresponding plant families, and a brief description of the species, making the collection both visually appealing and informative. The level of detail and vivid color of the illustrations is impressive; a few could easily be mistaken for color photos rather than drawings. Furthermore, the illustrations are extremely loyal to the original specimens and even capture their morphological dimensions.

A few improvements to future catalogues should be noted. A unique identification number has been assigned to each artist in the current catalogue; if the corresponding page number had also been included with the author identification number, it would have made it very convenient for readers to quickly connect the artwork with the corresponding artist while flipping back and forth across the catalogue. It would also be more convenient if the artist information and portrait were placed on the left page and their corresponding artwork on the right page. Lastly, including a small inset color picture of the natural specimens and/or wild species with its corresponding illustration would provide additional appeal to this beautiful, well-produced volume.

–Saikat Kumar Basu, Department of Biological Sciences, University of Lethbridge, Lethbridge, Alberta, Canada

Phycological

Stress Biology of Cyanobacteria: Molecular Mechanisms to Cellular Responses

Ashis Kumar Srivastava, Amar Nath Rai, and Brett A. Neilan (eds.)
2013. ISBN-13 978-1-4665-0478-3
Hardcover, US$159.95. xiii + 375 pp.
CRC Press, Boca Raton, Florida, USA

As wonderful as the "blue-green algae" are, a book on cyanobacteria might appeal to, and be useful to, a relatively small number of readers. A book covering molecular mechanisms to cellular responses in the stress biology of cyanobacteria might appeal to, and be useful to, an even smaller population of readers. Thus, I cannot recommend (as I recently did in another review) that everyone should read this book. However, for students and professionals in phycology, microbiology, and stress biology, this book is an outstanding reference. The 19 chapters are organized into two sections: Bioenergetics and Molecular Mechanisms of Stress Tolerance, and Cellular Responses and Ecophysiology. Although specialists in the fields covered by each chapter might quibble with me, I thought the 19 chapters were fairly uniformly well prepared and well written. Similarly, the introductions to the individual chapters each did a good job of introducing the specific topic as well as the broader importance or significance of the topic. There was, as one would expect, some redundancy among these introductions; however, that is a small price to pay for 19 chapters that can each stand on their own. Some of the chapters provided comments on the evolution of the processes or mechanisms

being discussed in the chapters, and I found these observations to be interesting additions. Although I may not have been looking closely enough, I thought the volume was well prepared in terms of not be filled with obvious typos, etc. I do believe there were some minor formatting inconsistencies among the chapters (e.g., use of italics for particular terms), but overall this is a well-prepared, well-edited book. It would have been even better if the color plates could have been inserted with each chapter rather than clustered as an insert about two thirds of the way through the volume, but if this minor inconvenience helped to keep price down, it was probably appropriate. It can perhaps be suggested that some of the chapters (e.g., the ones on symbiosis and microcystins) were a bit peripheral to the core focus of the volume; however, since I found those to be among the most interesting chapters, I am quite happy that they were included.

This book is an important reference because it pulls together so much diverse information on stress biology in cyanobacteria. Pulling together diverse information on this topic is very important given not only the major ecological importance of the cyanobacteria, but also because global climate change, diminishing natural resources, and our concern for sustainability demand that we better understand how cyanobacteria cope! This is not a book for everyone, but a very fine reference for some.

–Russell L. Chapman, Professor Emeritus and Founding Dean, School of the Coast and Environment, Louisiana State University, Baton Rouge, USA

Systematics

A Field Guide to the Flowers of the Alps

Ansgar Hoppe
2013. ISBN-13: 978-1-907807-40-4
Paperback, US$32.99. 192 pp.
Pelagic Publishing, Exeter, United Kingdom

The Alps are one of the most diverse natural landscapes in Europe. The mighty mountain chain rises from the Cote d'Azur of the Mediterranean, stretching from west to east and separating Europe into the cooler north and the sunny south along 1200 kilometers before it sinks back into the Pannonian Plain south of Vienna. Across this wide arc, a fascinating world of mountain peaks, wide valleys, and diverse landscapes stretches through seven countries. Because of their size and important geographic location, they are a unique mountain region with a fascinating biodiversity. Today, the Alps are among the most popular tourist destinations in the world, and the names of the amazing rock formations of Mont Blanc, the Matterhorn, Grossglockner, or Zugspitze are known to everyone.

Less known are the beautiful landscapes and ecosystems of the mid-altitudes, between 700 and 1800 m, with their long history as agricultural and rural management areas. The Alps have been populated for more than 6000 years, beginning with a Neolithic nomadic way of life that slowly transitioned to farming and livestock raising in village communities. Since the early Middle Ages, the sustainable use of nature as a protection against natural hazards shaped the landscape, especially in the northern alpine region. The plants and animals we find today in the Alps are a mix of species that immigrated in the course of agricultural and pasture development, glacial relicts, and native endemic species.

In Europe, there is already a plethora of field guides available for the alpine region. Why then another book on alpine flowers? A Field Guide to the Flowers of the Alps is a translation of a well-known field guide available in German. On the one hand, its translation into English will provide some assistance to the botanist, student, or biology teacher from abroad, and on the other hand it presents sufficiently detailed facts on alpine flowers for tourists who might otherwise overlook the beauties around their feet. Therefore, it is well suited for the excursion backpack, the small pocket, or for the 21st-century traveler with limited time, but with an interest in the environment and the beauty of plants.

The author, Ansgar Hoppe, is a botanist and research associate at the University of Hannover, Germany. He has published corresponding field guides in German, and is interested in geobotany and plant ecology. Many of the photographs in the book are by Michael Hassler, who is a well-known plant photographer and botanist. Several other botanists contributed pictures to the book.

On the first few pages, the book briefly explains the formation of the Alps, their structure, and ecology. Two pages illustrate how to use the book and how to locate plant species of interest. Some short botanical basics are provided at the end of the volume, together with a map of the alpine

zonation and main geologies. As plants usually appeal by their flowers, the book is classified and sections are color coded according to flower colors (red, white, blue, yellow, and greenish). An icon provides additional segregation according to flower type and symmetry. Each page lists three plant species, and plant descriptions consist of a typical photograph depicting the flowering species in its natural environment, along with the common English and scientific names. The corresponding text box contains a very (!) short description of flowering time, distribution, and a few important details. Only features that can be recognized with a magnifying lens are used for description. A few symbols indicate the protection status and the toxicity (very toxic and mildly toxic) of a given species.

Some of the photos included are of good quality and express the beauty of the flowers. Others are of intermediate to lower quality, and a few fail to clearly identify a species, due to the complexity of the plant shape or its size, as might be the case for the umbelliferous plants, Apiaceae (habit and leaf form would be essential here).

The overall goal of this book, though, is to provide a comprehensive guide to the alpine flowers, in their diversity and beauty. In this, I think the authors have done quite well. The guide lists 500 species, and the content is easy to read and provides an efficient overview. With some practice and regular use, this book will be a nice field guide for first use and occasional reference and will stimulate the user to seek additional information from more comprehensive textbooks.

It is also a book that awakens curiosity and the anticipation of an excursion into the mountains. For example, have you ever met the "King of the Alps" (*Eritrichium nanum*)? From my office window here in Munich, I can see the Alps in the distance on a clear day like today. I think I will pack the field guide into my backpack when I go out for my next excursion.

–Peter Schröder, Department of Microbe-Plant Interactions, Helmholtz Zentrum München, Munich, Germany

Native Orchids of Singapore: Diversity, Identification and Conservation

Yam Tim Wing
2013. ISBN-13: 978-981-07-8078-4
Paperback, US$8.50
National Parks Board, Singapore

Singapore is well known for its clean streets and subway, strict law enforcement, anti–chewing gum law, excellent schools, caning of criminals, a superb airline, and hybrid orchids that can be seen everywhere, including in its ultramodern Changi airport. What it is not well known are the about 220 native orchid species that were found on the island before many of them became extinct as a result of habitat loss. Remarkably, several species have survived, some of which are well known and visible on street trees today, for example, *Dendrobium crumenatum* (Anggrek Merpati in Malay, meaning the dove [merpati] orchid [anggrek]); others can be found out of sight in various locations (in the environs of water reservoirs, a few remaining areas of secondary growth, and even in spots between housing estates). Dr. Yam Tim Wing (Western style: Tim Wing Yam; full disclosure: he was my postdoctoral fellow in 1990 and 1991) of the Singapore Botanic Gardens (SBG) and others discovered and are still discovering some of the surviving species and are making every effort to protect and propagate them. (Even I had to agree to secrecy before being taken to a site off a busy main road to see what was believed at the time to be the single surviving plant of a climber species.) When these surviving plants flower, they are hand pollinated and the seeds they produce are germinated in the SBG seed germination and micropropagation facility. The availability of seedlings and, later, larger plants made repopulation and reintroduction possible, and Dr. Yam undertook the task.

Grammatophyllum speciosum, the tiger orchid, was the first species to be planted in nature preserves, parks, roadsides, and other areas. I saw some of the first plants not long after they were attached to trees in 1999 on Pulau Ubin, a small island off Singapore. Some of the plants had died, but most were doing well enough for Dr. Yam to hope that they would flower someday. Over the years (I used to visit Singapore, which I consider my second home, almost annually until 2011), I saw the plants grow, and eventually observed many of them in full bloom on many trees throughout Singapore. Some even set seeds. The assumption is that the pollinators are

still present in Singapore, but self-pollination and/or apomixis cannot yet be fully excluded. Nearly 20 other species have been reintroduced since 1999. All are doing well, most have flowered, and a number have produced seeds. Now the hope is that the seeds will spread, germinate, and reestablish these and other species in their ancestral home.

At first, Dr. Yam labored in relative obscurity, often working independently, but also with support from Dr. Kiat Tan, former director of SBG and CEO of the National Parks Board. This changed when Mr. Ng Lang, Dr. Tan's successor as CEO of the National Parks Board, became aware of his efforts and gave him official encouragement. With this encouragement, Dr. Yam emerged from obscurity, expanded his efforts, and affixed orchid seedlings on trees in many parts of the island city-state. When Dr. Nigel Taylor became director of SBG, the reintroduction of extinct species became part of the institution's mission in the hope that "Singaporeans will become more aware of the many native orchids" (foreword, p. v).

Now, after 20 years of repopulation and reintroduction, "Dr. Yam and his team are already being rewarded by the successful flowering and fruiting of many of the thousands of reintroduced wild orchids, and it is only a matter of time before we will have evidence of their natural regeneration independent of the work of humans," and "while most botanic gardens around the world might wish to claim they are doing similar work with rare and endangered species, few are actually managing to rise to the challenge" (foreword, p. v).

The challenge was not only to come up with the idea and want to carry out the work. It was also to collect seeds, germinate them, grow seedlings, and develop methods to affix them to trees in a manner that ensures survival. The process is lengthy and complex. This may be daunting and discouraging to some; others simply may not know how or where to start and proceed. Dr. Yam's book describes the process in detail in the section "Practical Guide" (pp. 87–103), which is instructive and easy to read. The information he provides is about orchids, but could easily be applied to other plants.

Case studies (pp. 104–113) follow. A glossary (114–115), a checklist of Singapore orchids (pp. 115–118) listing their status, acknowledgments (p. 119, full disclosure: I am acknowledged for having reviewed the manuscript), and a bibliography (pp. 120–121), which is not as extensive as it should be, complete the book. And, oh yes, the book opens with an uplifting foreword by Dr. Nigel Taylor (p. v) and an introduction (p. vi). These are followed by a concise, but excellently illustrated and very good description of the orchid family (pp. 1–11, full disclosure: one of the illustrations is from a paper coauthored by Drs. Yam, K. M. Cameron, and myself) and a well-illustrated field guide to the orchids of Singapore (pp. 12–86). These sections are good and interesting and add to the book, but in my view they play a supporting role to the parts of the book describing the practical aspects of reintroduction and repopulation because "Singapore is leading the way in orchid conservation and [Dr. Yam and his major and important supporters] can be proud!" (foreword, p. v).

–Joseph Arditti, Professor of Biology Emeritus, Department of Developmental and Cell Biology, University of California, Irvine, California, USA

Books Received

Honey in Traditional and Modern Medicine. Laïd Boukraâ. 2014. ISBN-13: 978-1-4398-4016-0 (Cloth US$139.95) 454 pp. CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA.

Land of Enchantment Wildflowers: A Guide to the Plants of New Mexico. Willa F. Finley and LaShara J. Nieland. 2013. ISBN-13: 978-0-89672-822-6 (Paperback US$29.95) 392 pp. Texas Tech University Press, Lubbock, Texas, USA.

Photosynthesis in Bryophytes and Early Land Plants. David T. Hanson and Steven K. Rice (eds.). 2014. ISBN-13: 978-94-007-6987-8 (Cloth US$279) 342 pp. Springer Science & Business Media, New York, New York, USA.

The World as Garden: The Life and Writings of David Fairchild. David W. Lee (ed.). 2013. ISBN-13: 978-1-4937-6523-2 (Paperback US$12.68) 352 pp. CreateSpace Independent Publishing Platform, North Charleston, South Carolina, USA.

Thank-you

The Editor is deeply grateful to the following reviewers who have generously given their time to review material submitted to the *Plant Science Bulletin* in 2013.

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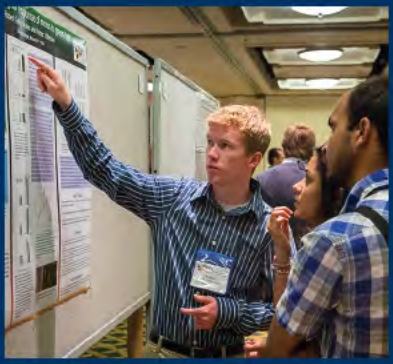

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