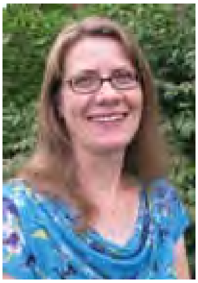
Plant Science Bulletin

Fall 2012 Volume 58 Number 3

Botanical Society of America's PLANTs Grant Recipients and Mentors

In This Issue..............



From the Editor

"Even those of the younger generation realize that within their time the feeling of the people toward botany as a science and botany applied has changed greatly for the good of the work. I believe this is due to the fact that the utilitarian side of botany has been kept largely in the foreground, and the people have come to know and understand that a substantial encouragement of the work means a direct benefit to many important interests….I may be preaching an heretical doctrine and be criticized on the ground that science has nothing to do with such material things and will take care of itself if kept pure and undefiled. This may be true, but I have long since reached the opinion that the doctrine of science for science's sake may be beautiful in theory, but faulty in practice. Some one [sic] has said that pure science and science applied are like abstract and practical Christianity, both beautiful, but one is for gods and the other for men." These words were spoken in 1903 by Beverly T. Galloway, outgoing President of the Botanical Society of America, in his Presidential Address (Science 19:11-18).

Galloway's viewpoint was not shared by the Society as it basked in the glory days of the early 20th century. But now, nearly 110 years later, we live in a society that has little understanding of our discipline and even less appreciation for its role in society. It is timely to reconsider our connection to applied plant science, especially in the agricultural fields, and this is the challenge brought to us by current President Elizabeth (Toby) Kellogg. We are happy to be able to share her Presidential Address from the annual meeting and hope that you will seriously consider her suggestion to make the connection between basic and applied plant science "more explicit more often."

-Marsh

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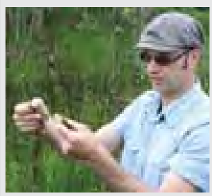

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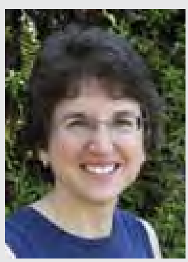

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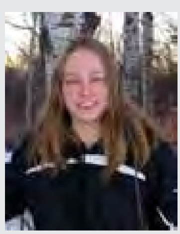

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Botany 2013
Celebrating Diversity!

abls American Bryological and Lichenological Society
ASPT
International Association for Plant Taxonomy iapt
The American Fern Society
Botanical Society of America

Hilton Riverside, New Orleans, LA July 26-31, 2013
WWW.BOTANYCONFERENCE.ORG

Erratum

In Volume 58, Issue 2 of the *Plant Science Bulletin*, Codi Yeager should have been listed as a graduate of West Virginia University, not Cornell University. We regret the error.

Botany 2012 Presidential Address

Dr. Elizabeth A. Kellogg
"Speaking of Food"

(Note: The video and slides from this lecture can be found at http://www.youtube.com/watch?v=j1Fm0oEbW54&feature=plcp.)

Since this talk is right after a reception and right before dinner, it seemed like a good time to talk about food. This may seem like an odd topic for a President's address; after all, most people choose to stick with the theme chosen for the meeting. But I've been mulling over a question in my mind for several months and decided to put it to you here today. The question is this: Why do we, in this particular scientific society [BSA], with its long and distinguished tradition of research on plants, so rarely connect what we do to agriculture? I'm not planning on answering this question. Rather I will explore it and conclude the talk with the same

Let me start with a bit of personal observation. My first course in any sort of plant biology was a plant ecology course, which I took my senior year in college. I took it because it met after 9 AM, had an early exam, and didn't have a lab. In other words, I was looking for an easy elective. After I graduated, I worked in a biochemistry lab for a while, realized that I didn't really like killing rats and started thinking about what else I could do. I thought back to that plant course and ended up working for the Forest Service for a while and then went back to grad school. There were many things from that first plant course that stuck with me, but one of them is the following quote from *Gulliver's Travels* by Jonathan Swift. "And he gave it for his opinion, that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together." Obviously I did not go into plant breeding or agronomy, but rather have had a career in basic research. But I believe firmly in the continuum of basic to applied research. I'm not out there growing crops, but I hope that the folks who are might read and be informed by the work that I do. And I'd like to suggest that the work going on in BSA should be relevant as well.

So let me repeat the question: Why don't we make more of a connection between the work presented at this meeting or published in our journals and the area of food for the planet? At this point I should clarify what I mean by the word "connect." I'm speaking of those brief sentences or paragraphs at the beginning or end of a talk or article that place the work in its broadest possible context, the sentences that link the work to issues that the general public or at least the general scientist might understand. These are sentences that might get picked up in press releases or might find their way into the Broader Impacts section of a grant proposal.

As an example, while procrastinating on writing this talk, I ran across an article that appeared in the BBC Science and Environment section earlier this week: "Antarctic moss lives on ancient penguin poo." The article, written by science writer Victoria Gill, described the work of Prof. Sharon Robinson "of the University of Wollongong in Australia, [who] has been studying Antarctica's plants for 16 years." Dr. Robinson is not a member of BSA—I checked. Her study had to do with nutrient capture and frost tolerance in Antarctic mosses, and could easily have been written by a member of the BSA. The "connector" was written by Ms. Gill: "Learning the molecular mechanisms behind plants' abilities to dry out but remain viable could help researchers to develop ways to store food or even medicines for long periods." Just a very simple question taking this basic research and putting it in a broad and agricultural context.

So back to my question: Why is it rare to find such references to food or agriculture in the talks at this meeting and the articles in our journals?

This is particularly perplexing because everybody eats plants. Therefore, knowing more about plants is essential for everyone because they have such an immediate impact on our lives, at breakfast, lunch, dinner, snack time, and banquets at conferences. When we introduce students or the general public to plants, we immediately talk about the food we eat. We tell them that grapes are fruits and onions are bulbs and celery is a petiole, that bread is endosperm, that blueberries are *Vaccinium* and cassava is *Manihot*. We point out that cabbage is the same species as Brussels sprouts and broccoli, even though the Supreme Court says that the government can't make you eat the stuff. A recent article in *Plant Science Bulletin* by Geoffrey Burrows and John Harper describes the value of supermarket botany in teaching [www.botany.org/plantsciencebulletin/psb-2009-55-2.pdf]. A search of all issues of *PSB* finds 12 references to supermarket botany, the earliest in 1958. In other words, there is an obvious and direct connection between the study of plants and the practice of agriculture and we mention it all the time.

So why do we not make the connection in our research, at this meeting, in our journals?

> *"Why is it rare to find such references to food or agriculture in the talks at this meeting and the articles in our journals?"*

I'm sure that some of you are thinking immediately of the mission statement of the BSA. We do basic research, not applied. We are botanists, not breeders or agronomists. The mission of the BSA is "to promote botany, the field of *basic* science dealing with the study and inquiry into the form, function, development, diversity, reproduction, evolution, and uses of plants and their interactions within the biosphere. To accomplish this mission, the objectives of the Society are to: sustain and provide improved formal and informal education about plants; encourage *basic* plant research; provide expertise, direction, and position statements concerning plants and ecosystems; and foster communication within the professional botanical community, and between botanists and the rest of humankind through publications, meetings, and committees." I've added italics here to the word "basic."

But we do not eschew applied research on conservation. As an exercise, I chose two random issues from the *American Journal of Botany* in 2011 and in about 10 minutes found the following two random quotes. Random quote #1: "Climate change and shifts in land use are two major threats to biodiversity and are likely to disproportionately impact narrow endemics. Understanding how such species originated and the extent of their genetic diversity will enable land managers to better conserve these unique, highly localized gene pools." (Marcussen et al. (2011), Establishing the phylogenetic origin, history, and age of the narrow endemic *Viola guadalupensis* (Violaceae). *Am. J. Bot.* 98: 1978-1988. http://www.amjbot.org/content/98/12/1978.full.pdf+html?sid=7dc0972a-7aca-4e9d-a297-2835f1f85756). Note in this case that research on a narrow endemic in a family with modest economic importance was justified in part by the direct application to land management. Yes, it's basic science. But it also has implications for a thoroughly applied discipline.

Random quote #2: "The effects of climate warming on tree growth become more significant at northern latitudes and high elevations, and the effects vary across species…. Therefore, an investigation on intra-annual growth over a large latitudinal gradient may be able to detect a systematic change in the start and end dates of xylem formation during a growing season, thus assisting predictions of forest productivity." (Huang et al. (2011), Variation in intra-annual radial growth (xylem formation) of *Picea mariana* (Pinaceae) along a latitudinal gradient in western Quebec, Canada. *Am. J. Bot*. 98: 792-800. http://www.amjbot.org/content/98/12/1978.full.pdf+html?sid=7dc0972a-7aca-4e9d-a297-2835f1f85756). Once again the article is basic research—developmental anatomy to be precise, but the authors provide a connection to forestry.

To summarize this point: we have no trouble seeing a continuum from basic to applied research in conservation and forestry. Studies that are designed to help conservation managers make practical decisions are surely just as applied as studies that provide basic information that could be translated to agriculture. So it can't be just that connection to agriculture is applied and we don't do applied stuff.

Are we concerned about working with the private sector and/or worried about issues of intellectual property? Much agricultural research and the vast majority of plant breeding in the U.S. takes place in the private sector and this brings with it concerns about ownership of germplasm and research results. And much agricultural research in the U.S. serves the needs of large-scale conventional "industrial" agriculture. But the fact that much biomedical research takes place in the private sector doesn't block public sector research; obviously the public-private interface has to be negotiated and that will happen in different ways by different people, but it isn't an intrinsically intractable problem. And there are many potential jobs in the private sector for our students.

There is plenty of agricultural research that goes on in the public sector, especially outside the U.S. And certainly industrial agriculture is only one component of world food production. Smallholder agriculture is common, whether it's this CSA [climate smart agriculture] farm in Missouri or this sorghum field in Africa. Surely basic research needs to be connected explicitly to efforts in this sector.

Let me take a few minutes to remind you why this problem is urgent, and argue that the BSA needs to help address it. You already know about projections of global population growth as shown in this projection from the UN. Barring major catastrophe, the decreasing projection will not occur, and most people focus on the middle or upper projections. This year the human population of the world hit 7 billion. Projections of future growth vary, but the median projection indicates that we will add another 2 billion people by 2050. The good news about this projection is that population may not grow a great deal higher than that; the growth rate might (emphasize "might") be leveling off. But 2 billion more people in less than 40 years is a lot. Crop yield is increasing but not as rapidly as the population. The FAO estimates that world food production will have to rise 70% to meet the demand. Food shortages have already provoked instability in other parts of the world, most recently the riots in Algeria that triggered the so-called Arab Spring. And the challenge is made more acute by climate change.

Let me also remind you of the speed of plant breeding. It is generally slow; time to development of a new crop is several years. Imagine an elite line of wheat that is vigorous, high yielding, but is susceptible to a fungus. Now suppose that you find a small, low-yielding plant that is fungus-resistant. How do you get the resistance gene into the crop? Of course, you cross them and then select for resistance; this takes about six months. But in the first generation, the resulting plant is not especially vigorous and has low yield; because it has only half the DNA from the elite line and half from the wild relative, the valuable, high-yield linkage groups are broken up. The solution is to backcross the first generation hybrid to the elite line; this takes another six months to get seed. After six backcrosses (about 2.5 years), you have mostly restored the genetic make-up of your high yielding line and have introgressed the resistance gene. It is a process that works very well, but it is not fast.

"The FAO estimates that world food production will have to rise 70% to meet the demand."

By this point you are probably thinking, yes, this is all very worrisome, but we aren't crop scientists. So let me cite a few areas that to me seem to connect to agriculture.

First I should note the special issue of *AJB* on Next-Generation Sequencing (http://www.amjbot.org/content/99/2). Many of the articles in this issue addressed evolution or genomic structure of crop plants, or population structure of weeds, or tools for crop improvement. Is it the technology itself, the particular editors, or just random chance that this issue connected work of BSA members to agriculture in way that many other issues do not? I don't know the answer.

Another area where a connection could be made: drought tolerance. Anyone living in the middle part of the country this summer knows the importance of identifying genes and developing crops that tolerate drought. A lot of us work on plants that are tolerant of drought. Their diversity, phylogeny, biogeography, and phenology all provide examples of how plants cope with water stress and could help identify novel genetic or physiological pathways that would be of value to agriculture.

Gene flow: There is certainly the direct application of the study of gene flow to determine the likely spread of transgenes from crops. I can cite the work of one of our merit award winners, Allison Snow, on this direct application. But the applied work occurs within a theoretical and empirical framework of population genetics and population structure.

Pollination biology: There is ongoing concern for the maintenance of honeybee populations and a worry that without them, fruit crops will not be pollinated. But there are many examples in evolutionary history of pollinators changing preferences. Do those examples provide any hints about how the plant-pollinator relationship might be modified to mitigate the problem? Or do all the examples from evolutionary history really say that plants who lose a major pollinator go extinct? I.e., does the phylogenetic history of pollination biology tell us that the almond crop is inevitably doomed if the honeybee population crashes? Or is there something instructive that we can learn from evolutionary history?

Model systems: As genetic and genomic tools become cheaper and easier to produce, botanists become less preoccupied with *Arabidopsis* or rice and more willing to develop systems that offer insights into particular biological problems. I've been involved in the development of green millet (*Setaria viridis*), which is being pursued for several reasons, in part as a handy species in which to study the regulation of C_4 photosynthesis, with the ultimate goal of making a C_4 strain of rice. Why was I involved? Because my lab has used *S. viridis* as a system in which to study the regulation of plant architecture (basic research). We've studied developmental morphology, quantitative genetics, molecular phylogeny of the genus *Setaria,* and written a monograph. Currently we are working on population genetics, collecting *S. viridis* from its native habitats. And yes, others led the effort to sequence the genome and develop a transformation system, but it took a lot of basic—BSA-type—research to make the model that is being used to improve crops.

I mention this because it is my own experience, but I could also cite the Planetary Biodiversity Inventory project on Solanaceae, and many equivalent projects in Brassicaceae.

I could keep going with examples, and in fact I cut about six more out of this talk. But you get the point: understanding plant evolution, systematics, diversity, ecology, development, and interactions matters as much for agriculture—which we often don't mention—as it does for conservation—which we mention a lot.

So as you proceed to the banquet, as you enjoy that fermented grape or barley product, the plate of Asteraceae leaves, the avian-processed grass, and as you conclude with your rubiaceous beverage, consider that it is really your work that helped put that in front of you in that form. BSA research does contribute to feeding the world. We all know the connection is there. Why don't we make it more explicit more often?

New Journal Joins the BSA Family of Publications

In January 2013, the BSA will launch a new peer-reviewed journal, *Applications in Plant Sciences* (*APPS*), designed for the rapid dissemination of newly developed tools and protocols in all areas of the plant sciences that are represented within the Society. This is an exciting opportunity for the BSA to take advantage of the Society's wide breadth of expertise represented by the different societal sections, and especially to address growing technological advances in many of these areas. Today our world is much different than just a decade ago as techniques, such as next-generation sequencing, GIS (Geographical Information Systems), gene and genome manipulation, and cell/tissue labeling, are dramatically propelling fields forward and becoming the standard in many laboratories. These advancements are also enabling scientists to delve into rarely studied areas; for example, researchers can now more effectively examine belowground soil dynamics and soil communities, as well as nutrient uptake and exchange within the complex root networks of forest ecosystems. The availability of social media and smartphone technology today also presents unfettered opportunities for botanical applications, such as computerized recognition of leaf and flower shapes to identify taxa. In addition, certain fields are beginning to intersect, leading to the formation of new areas (e.g., landscape genetics), and creating opportunities to combine both traditional and novel methods from different areas. *APPS* is the new source for reporting such advancements, consistent with its purpose to foster communication within the botanical community to advance research in the plant sciences. As such, *APPS* will complement and support *AJB* because the new journal will serve as the publication outlet of methodological information and techniques that can then be used in more extensive studies published in *AJB*.

As an online-only journal, *APPS* will be part of BioOne's Open Access Collection (www.BioOne.org/) so that articles will be freely accessible to readers worldwide. BioOne was specifically selected because the mission and priorities of this not-for-profit organization align closely with those of the BSA, as well as for its emphasis on serving independent society publishers within the greater community

History

Although debuting in 2013, *APPS* has been in the making for several years. The journal originated as the *American Journal of Botany*'s online-only section, *AJB Primer Notes & Protocols in the Plant Sciences* (*AJB PNP*), which was begun in 2009 to serve as a publication outlet for researchers in genetic and molecular areas. The section was created by Editors Kent Holsinger, Pamela Soltis, and Theresa Culley with *AJB* Managing Editor Amy McPherson and Production Editor Richard Hund and with the approval of *AJB* Editor-in-Chief, Judy Jernstedt. At the time, authors had very few options for where to submit primer notes papers, especially those containing a limited number of loci or limited sampling (as in the case of rare or endangered species). BSA recognized the value of these articles, especially in terms of their importance for new researchers seeking publication or scientists wishing to publish markers as the foundation for a new study. Consequently, *AJB PNP* was created in part to address these needs.

This online section of *AJB* was highly successful, with annual submissions reaching over 200 manuscripts in 2012. To handle this increased volume, Beth Parada was recruited as Online Publication Editor to oversee the *AJB PNP* section, and several other editors were subsequently invited to join the editorial board, including Lisa Wallace and Mitch Cruzan, among others. In 2011, a revolving panel of reviewing editors (typically post-doctoral researchers and junior faculty) with two-year appointments were recruited to assist in the editorial process. The majority of the early submissions were primer notes, with most reporting microsatellite or similar PCR-based markers developed in different plant species. Although some protocol papers were published, these addressed genetic or molecular methods.

In early 2012, the BSA Board of Directors, in conjunction with the Publications Committee, *AJB PNP* editors, and BSA staff, decided to graduate the online section of *AJB* to its own journal, now titled *APPS*. In doing so, the BSA wanted to expand the breadth of the new journal to focus on new protocols and techniques in all areas represented by the BSA (including, but not limited to, genetics and molecular biology). *APPS* will still continue to publish primer notes for genetic markers such as microsatellites and SNPs (see below).

The new journal has been designed to be flexible in responding quickly to the demands and needs of researchers in the years and decades to come. For example, as an online-only journal, authors will be able to incorporate multimedia files (e.g., videos demonstrating the application of a new method or animations portraying a new process) into their articles. There is also the opportunity to link data within an article directly with an appropriate online source using hyperlinks for instant access. This could consist, for example, of DNA sequence information deposited in GenBank (http://www.ncbi.nlm.nih.gov/genbank/), media housed on Figshare (http://figshare.com/), or ecological data uploaded to Dryad (http://datadryad.org/), an international repository that accepts data of all formats, including software scripts.

Theresa Culley, Editor-in-Chief, APPS

Submitting to *APPS*

All authors are invited to consider *APPS* as a publication outlet and the Editors are currently recruiting submissions for the introductory issues. Authors wishing to contribute papers to *APPS* should submit their manuscripts online through *AJB*'s Editorial Manager page (http://www.editorialmanager.com/ajb), using the article type "Applications in Plant Sciences." Online submission through the *AJB* site will continue until the official *APPS* submission site is available, which is expected in early September. While primer notes will continue to be accepted for consideration, the editorial board especially encourages submissions of protocols that improve investigations in any area of plant biology, including methods on genetic markers, and morphological, physiological, biochemical, anatomical, and ecological data collection.

Publications will include both invited papers and those submitted through the usual review process. For submission guidelines, please consult the Instructions for Authors (http://www.botany.org/ajb/APPS_Online_Instructions.html). Papers will be accepted for publication in the following categories:

- **Protocol Notes**: These papers will report new protocols and technical advancements in any area of the plant sciences. Authors must explain the rationale for the new protocol, provide a complete description, and demonstrate that the new method is advantageous over current techniques. A printable protocol sheet for the laboratory bench as well as a supply list are also encouraged as appendices.

- **Application Notes:** Longer articles incorporating and emphasizing a new protocol or method in a larger study (i.e., with more extensive sampling than that in a Protocol Note) will be published under this category. Submissions could involve any area within the plant sciences.

- **Review Articles**: In this category, available techniques and/or protocols within a given area of the plant sciences will be reviewed, emphasizing the relative advantages and disadvantages of each. Articles must describe and compare currently available techniques or protocols, as well as identify any potential new areas for development of technological advancements. These articles will usually be by invitation, although any author is welcome to discuss a review article concept with the editorial staff prior to submission.

- **Primer Notes**: These articles must report a large number of novel, polymorphic markers with evidence of wide applicability (e.g., cross-amplification with related taxa) for species of scientific, economic, or horticultural importance. These could include, but are not limited to, microsatellite markers, SNPs, or other types of markers. If primers have previously been published for a species, authors must justify the development and usefulness of additional primers. Markers developed using novel techniques are especially welcome.

As with any new journal, *APPS* currently does not have an impact factor, but will be evaluated for inclusion in the Science Citation Index (SCI) in March 2013. If the evaluation is positive, indexing will be retroactive to the first issue of the journal, and *APPS* will receive an immediacy index after one year of publication. Two years of publication are required for calculation of an impact factor; this is expected to be available in June 2015. Any questions regarding submissions may be directed to Beth Parada (bparada@botany.org), Online Publication Editor for *APPS*.

Vision for the Future

The development and launch of *APPS* this coming year is an example of the BSA's strategic plan to promote botany by pursuing new opportunities as they arise. Consistent with the BSA's objectives to encourage basic plant research and to foster communication within the professional botanical community, the new journal will serve as a conduit for information based directly on the expertise offered by the Society and the sharing of which information will directly benefit members of the Society. As the centennial year for *AJB* approaches and the BSA reflects on its critical role in promoting decades of high-quality botanical research, it is fitting that the next century brings new opportunities such as *APPS* to broaden further the role and impact of the BSA over the years and decades to come.

Call for Applications: *APPS* 2013–2015 Reviewing Editor Board

The Botanical Society of America is seeking interested applicants to serve on the Reviewing Editor Board for *Applications in Plant Sciences,* BSA's new online-only, open access journal that is launching from the *AJB* Primer Notes & Protocols section in 2013. The Reviewing Editor Board will be comprised of a select number of post-doctoral researchers and graduate students who have advanced to candidacy; Reviewing Editors will evaluate original submissions according to criteria established for the journal and provide feedback to the Associate Editor. Reviewing Editors will also assess revised manuscripts for adherence to comments and suggestions. Members of the Reviewing Editor Board will be expected to handle up to two manuscripts per month and to agree to a 2-year commitment. Members of this board will be mentored by the *APPS* Editorial Board members and receive experience in the editorial and peer-review processes. Successful editors will also receive reduced registration rates to the annual conference of the BSA.

Applications must include a cover letter from the applicant, CV, and a letter of recommendation from the applicant's supervisor or major professor. Successful applicants will demonstrate an attention to detail and an interest in gaining experience in this important aspect of academic service; information on scheduled time in the field during the commitment period, if known, should also be provided.

Applications should be sent to apps@botany.org by September 21, 2012.

Applications in Plant Sciences Editorial Board

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A Behind-the-Scenes Look at the Botany Conference: Planning Through Execution and Future Challenges

The Botany 2012 conference is just a memory, and based on the recent attendees' survey, it looks like it was a very good memory. Here are a few of the statistics that resulted from the over 222 attendees who responded to our questions: 87% of respondents rated this meeting as one of the best Botany conferences they have attended, 92% stated that registration was easy, 80% felt that the abstract submission site was user-friendly, 71% purchased or are considering purchasing a product from one of our exhibitors, and 61% stated they are unwilling to pay an extra conference fee for WiFi at the meetings.

Do you ever wonder how the Botany conference really operates? We are about to give you an insider's look into the planning of a Botany conference as well as a discussion of some of the most recent and pressing challenges for planning future meetings.

Botany 2012 planning actually began about three years ago with a decision not only to bring the conference to Columbus, but also with an estimate that 800 of you would attend. With that estimate, we negotiate and guarantee a certain volume of business to the conference location and surrounding hotels. We have to provide a guarantee to the hotels and conference center for a specific number of hotel room nights and session rooms. In addition, we had to guarantee that we would spend a minimum of $100,000 on food and beverage. All of this information goes into the contract to establish the base conference cost. If we reach the guaranteed hotel room nights and food and beverage estimates, the session rooms are free, but if we come up short from the estimates made 3 years in advance, we could incur tens of thousands in additional rental fees and penalties. It is our intent to never pay for meeting space, which keeps the conference cost down—making attending the Botany conference as affordable as possible for you. You can see that it is crucial that we meet our hotel room blocks. We try to negotiate fair hotel room rates in each city so that it's a win for both sides. Amenities including free internet, free breakfast, and free snacks make your stay more enjoyable and hopefully encourage your decision to choose one of our hotels and help us keep conference costs down.

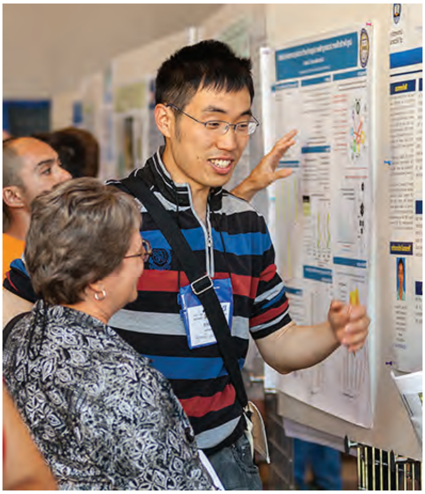
The real planning for Botany 2012 started last fall, with detailed site visits. At this time we identified the Program Committee who determined the scientific content of the conference, and began working with volunteers to determine field trip locations, guides, and costs. BSA staff builds the Botany 2012 website and more plans are finalized. Symposia are submitted and funding is determined, Special Lecture speakers are identified and planning begins for workshops and other events.

Networking remains one of the most important reasons for attending the Botany conferences.

Starting in the spring, we begin to firm up our program with the abstract submission process. April 1st is the normal abstract submission deadline. This is also a big day for the conference, as it will help validate our estimate from three years earlier of how large the conference will be. We can now determine how many sessions and programs we will have based on the number of abstracts submitted. Now the program committee goes to work—forming the sessions, their length, how many abstracts will be presented, estimated session attendance, audio-visual needs, etc. Based on these details, a schedule is created and session rooms are assigned based on what the conference center has allocated to us. At this point, we are assigning room sizes for sessions, and still guessing how many attendees will really show up!

May and June arrive, and conference registrations are rolling in. June is always the scramble month. During this time, the program and abstract books are finalized and sent to the printer. T-shirts, conference bags, and water bottles are designed and ordered, field trip buses are determined, and the biggest and most important part of running the conference begins to shape up. Banquet Events Orders, or BEOs, are submitted. BEOs are the event orders that the conference organizers request that the hotel or conference center perform for us. If an event requires food or beverage, then there is a cost that needs to be paid. BEOs include every detail of every session and event. Botany 2012 had 293 different BEOs. How many tables and chairs are needed, and how are they arranged? How many cups of coffee, cookies, scrambled eggs, sandwiches, or, most importantly, even more cookies, are needed? If it's not on a BEO, it won't happen.

The Botany conference organizers also work with many third-party suppliers and vendors. We have a number of "legacy partners" that follow us around the country and support us each year. All of our shirts, bags, and water bottles come from an Austin, Texas, partner; our printing (books and signs) is always done by the same printing broker; and our field-trip buses are arranged by the same bus broker. Among the most valuable of our partners is our AV team of Jake and Eric who make sure your presentations appear as you wish them to. Each of these partners has been part of the team for several years; they know how the conference works, and how they support the conference and you.



Turning the poster session into more of a social event has been very well received.

Then there are the variables. Each year is a different location, with a different local team. Every year, we must establish expectations. For example, some of you have been with us to Snowbird, both times. Many people said the second time was better. That's because everyone knew what was expected, and worked to do their part. Our goal is always to make it right the first time, and there are always challenges. One of this year's major challenges was that we actually met in 2 separate facilities. The session rooms, the banquets, the registration desk, and the Sunday evening Plenary Address were part of the Hyatt complex. The exhibit hall, the Sunday night mixer, coffee breaks, lunch in the mezzanine in the exhibit hall, and the poster sessions were in the Columbus Convention Center. Two different facilities, two different conference contracts, two different staffs to interface with, and two different sets of BEOs! If you never realized that, then we were successful.

Every year, we deal with potential cost impacts. In some conference centers, coffee has been upwards of $100/gallon, and we drink a lot of coffee! This year we had about 36 "no shows" for poster sessions. That means we ordered 9 more poster boards at $50.00 plus labor and services charges each. That's money we didn't have to spend. If someone needs internet service in a session room at the last minute, that equals more dollars. And the biggest cost variables: we don't hit our guaranteed hotel room nights for the conference, or we spend less than the minimum on food and beverage. That can cost us tens of thousands of dollars, and we only find that out after the conference.

Panic mode, 2 weeks before the conference! That's when we realize we planned for 800 attendees, and now 1,100 have registered online. So we scramble and double-check everything—making sure we have enough bags and program books, making sure the session rooms are big enough. Did we order enough coffee for the continental breakfast? We may need to relocate a session room, but the program book and schedule are already being printed. We are constantly revising and changing BEOs, to make sure everything is perfect and runs seamlessly. Friday afternoon before the conference starts, we sit down at the hotel/conference center with the head of each department and walk though the BEOs. It's like the conductor going through the music right before a concert. Everything is set, and then we open the doors. And then someone comes up to me and says that the room for speaker Dr. X is just not big enough….so now we have to move a session. That's ok—we can do it! It's only 2 more signs to make on top of the 275 we already planned to place around the conference. On Friday evening, registration opens and the real magic begins. Botany 2012 is alive and takes on a life of its own!

Hands-on learning activities in the exhibit hall were a hit.

The real hub of the conference is the office…. We are always there to answer questions, make snap decisions, or offer you a leftover cookie. We also hear: "We need more chairs here, it's too cold in there, can we have 5 more for this lunch, I lost my banquet ticket, I didn't know I had to pre-order audio speakers for my session, the projector is not showing the correct reds in this session room, the coffee is out and there is 5 minutes left in the coffee break session, can I print 50 copies from your computer, someone told me to come to the office and pick up my check." The list of items goes on for the next 5 days. Hopefully, we keep everything running smoothly and everyone is as happy as possible. Next time—come on in and say "hi!"

The conference has evolved over the past few years to be more than just a scientific meeting. We have added new events, more networking opportunities, and more fun! We have been working to expand and enhance the exhibit hall. We have made the poster session more of an event and social time. We have included more students in the planning process to be sure they have a voice and presence at the conference. And this year, we expanded the opportunity for the BSA incoming president to reach more people by hosting the talk before the banquet on Wednesday evening. If you would like to watch the presentation by Dr. Toby Kellogg, "Speaking of Food," it is at the BSA's YouTube channel (http://www.youtube.com/watch?v=j1Fm0oEbW54&feature=plcp).

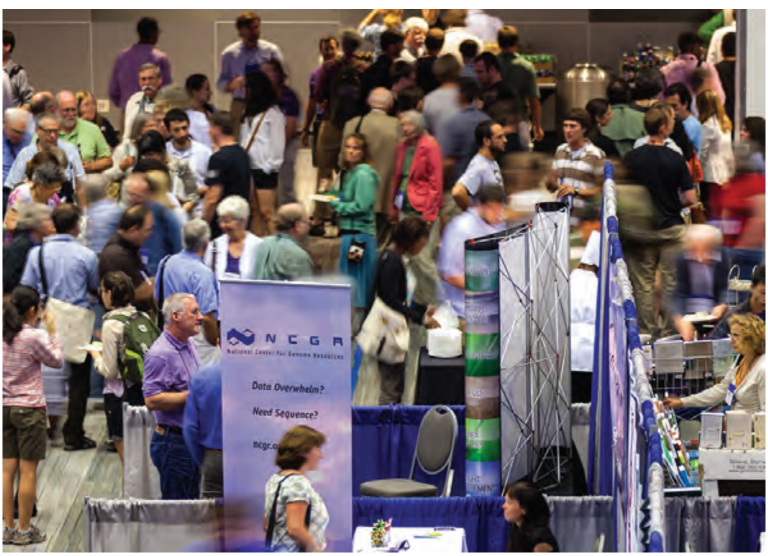
Another exciting event in the past two conferences has been the "Botany in Action" Program. This opportunity started as a way to give back to the communities that we visit. This year, about 30 eager botanists went to a local community garden, in the massive heat of July, and harvested, weeded, planted, gardened and helped with this local project (see the following page). This event will continue at Botany 2013 as we will look for another local New Orleans organization that might benefit from eager volunteer time.

Currently, the most challenging and potentially costly part of conferences is WiFi. Hotels and conference centers have farmed those services out to third-party internet suppliers, and they all know that with the explosion of personal devices, WiFi has grown to be a profit center for them and a huge cost and item to negotiate for us. You may get your home internet service for something like $39/month. For the Botany 2012 conference, the initial price quoted was in excess of $28,000. We negotiated downward from there. Sure, their initial offer is a great WiFi package, with internet access everywhere in the conference center. To provide that we would have to increase registration fees $25 per person. Not willing to raise your rates, we negotiated, argued, and complained. After a number of weeks, we were able to reduce the cost significantly to less than one third of their initial offer, but we had to reduce the coverage area. Knowing that we had negotiated for free internet in your hotel rooms, we hoped that access would be sufficient. This might be sufficient for some. However, we realize that connectivity is important to many of you for tweeting, sharing conference knowledge with those in your labs/home institutions not in attendance, and connecting with people during the conference. Don't be offended when someone opens their laptop or iPad during your talk—they just might be taking notes on the wisdom you are sharing or tweeting to their colleagues and friends with a quote from your presentation. We will look at ways to be able to provide more internet access while keeping it cost effective. Along these same lines, we are planning to release a mobile conference app which can be used on personal devices to create your own personal schedule, view it, and make adjustments to it while on site.

In the future, we are looking for more ways to keep the conference "alive" throughout the year. Many of you have participated in having your poster videotaped for our virtual poster session on the web. Many of you have expressed interest in viewing video clips from special addresses and invited speakers, as well as reviewing talks online through PowerPoint slides that are linked to the audio presentation. We hope to have some of the special addresses and talks from 2012 on the web soon, so that you can review them, share them with colleagues or in your lecture halls, or see them if you missed it the first time.

It is our hope that you continue to enjoy the Botany conferences. We certainly enjoy organizing them and working to keep it a worthwhile, economically feasible, scientifically relevant, and a fun week for you! If you have thoughts and ideas that you would like to see at YOUR conference, feel free to email me at Johanne@botany.org We will consider anything. As Bill Dahl, BSA Executive Director says, "We're Botanical—we can do anything".

-Johanne Stogran, Director of Conferences, BSA, with help from Kevin Stogran, Conference Chief Minion and Heather Cacanindin, Membership Director, BSA



Our exhibitors are a very important addition to the meeting, and 71% of Botany 2012 attendees purchased or are considering purchasing a product from one of our exhibitors.

The Botany in Action team braved the brutal heat to help the Upper Arlington Community Garden—weeding, clearing, harvesting, painting and gardening in the annual project. Watch for ways you can participate in New Orleans. (Thanks to Janice Coons and Gianinne Loerch for the pictures)

THE FACES OF BOTANY 2012 AWARD WINNERS

Congratulations to these and all the winners. For a complete listing of all awards, see: http://www.botany.org/awards_grants/2012Awardrecipients.php.

Awards from the Annual Meeting

Charles Edwin Bessey Award

(BSA in association with the Teaching Section and Education Committee)

Dr. Paul Williams, Professor Emeritus, University of Wisconsin–Madison, Fast Plants Program. Dr. Williams developed a rapid cycling *Brassica*. This simple act changed the way science is taught in the United States and around the world. Today, over 10 million students use Fast Plants, as they are also known, every year. Fast Plants complete their life cycle in as quickly as 35 days, allowing students to develop an understanding of the plant life cycle and track the results of genetic experiments. Dr. Williams is a familiar figure at conferences, leading workshops that introduce teachers to inquiry-based, innovative, and inexpensive ways to use Fast Plants with large lecture hall classes or small groups in classrooms. He was also a contributor to educational manuals such as "Exploring with Wisconsin Fast Plants," "Spiraling Through Life with Fast Plants," and "Bottle Biology." He has received many awards and honors, including being recognized as a Fellow of the National Academy of Sciences and a recipient of the Eriksson Medal from the Royal Swedish Academy of Sciences.

Drs. Les Hickock and **Thomas R. Warne**, University of Tennessee. Drs. Hickock and Warne collaborated on the development and genetics of the tropical fern *Ceratopteris*. They realized that this plant would make a powerful educational resource because of the rapid life cycle, the dynamics of sperm motility, and the potential of investigating density-dependent changes in gametophyte development. They produced instructional materials to support inquiry education, such as an intriguing exploration of sperm chemotaxis. Today, *Ceratopteris* is distributed worldwide in K–16 classrooms through the C-Fern program.

Special Awards

Dr. Judy Skog, Outgoing BSA Past-President, George Mason University.

The BSA presented a special award to Dr. Skog expressing gratitude and appreciation for outstanding contributions and support for the Society. Judy has provided exemplary contributions to the Society in terms of leadership, time, and effort.

Dr. Pamela Diggle, Outgoing Secretary, University of Colorado.

The BSA presented a special award to Dr. Diggle expressing gratitude and appreciation for outstanding contributions and support for the Society. Pam has provided exemplary contributions to the Society in terms of leadership, time, and effort.

Dr. Chris Haufler, Outgoing Director-at-large for Education, University of Kansas.

The BSA presented a special award to Dr. Haufler expressing gratitude and appreciation for outstanding contributions and support for the Society. Chris has provided exemplary contributions to the Society in terms of leadership, time, and effort.

Marian Chau, BSA Student Representative to the Board, University of Hawai'i at Manoa.

The BSA presented a special award to Marian expressing gratitude and appreciation for outstanding contributions and support for the Society.

Isabel Cookson Award

(Paleobotanical Section)

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

Ashley Klymiuk, University of Kansas. Advisor: Dr. Thomas Taylor. 2012 award recipient for the paper, "Anamorphic fungi from the Princeton Chert: New insights into paleomicrobial diversity." Co-authors: Thomas Taylor and Michael Krings.

George R. Cooley Award

(Systematics Section and the American Society of Plant Taxonomists)

The ASPT's George R. Cooley Award is given for the best paper in systematics given at the annual meeting by a botanist in the early stages of his/her career. Awards are made to members of ASPT who are graduate students or within five years of their postdoctoral careers. The Cooley Award is given for work judged to be substantially complete, synthetic, and original. First authorship is required, and graduate students or those within five years of finishing their Ph.D. are eligible. He/She must be a member of ASPT at time of abstract submission, and only one paper per candidate can be judged.

This year's award was given to **Mauricio Diazgranados** of Saint Louis University and Missouri Botanical Garden for the talk, "Geography shapes the phylogeny of frailejones (Espeletiinae Cuatrec., Asteraceae): A remarkable example of recent rapid radiation in sky islands." Co-author: Janet Barber.

Katherine Esau Award

(Developmental and Structural Section)

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

Christina Lord, Dalhousie University. Advisor: Arunika Gunawardena. 2012 award recipient for the paper, "Actin microfilaments: Key regulators of programmed cell death (PCD) in the lace plant." Co-authors: Adrian Dauphinee and Arunika Gunawardena.

Maynard F. Moseley Award

(Paleobotanical and Developmental and Structural Sections)

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

Alexander Bippus, Humboldt State University. Advisor: Alexandru Tomescu. 2012 Moseley Award recipient for the paper, "Thalloid fossils comparable to bryophyte and fern gametophytes from the Lower Cretaceous (Valanginian-Hauterivian) of Vancouver Island, British Columbia." Co-authors: Maria Friedman, Ruth Stockey, and Alexandru Tomescu.

Emanuel D. Rudolph Award

(Historical Section)

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

Kathryn LeCroy, Birmingham Southern College. Advisor: Clare Emily Clifford. 2012 award recipient for her presentation, "Botanical literature in 19th-century United States: Gift books and annuals."

THE 2011 GRADY L. WEBSTER AWARD

This award was established in 2006 by Dr. Barbara D. Webster, Grady's wife, and Dr. Susan V. Webster, his daughter, to honor the life and work of Dr. Grady L. Webster. The American Society of Plant Taxonomists and the Botanical Society of America are pleased to join together in honoring Grady Webster.

Drs. Elizabeth Zacharias and Bruce Baldwin "A molecular phylogeny of North American Atripliceae (Chenopodiaceae), with implications for floral and photosynthetic pathway evolution." *Systematic Botany*, 2010

Edgar T. Wherry Award

(Pteridological Section and the American Fern Society)

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

Weston Testo, Colgate University. Advisor and co-author: James Watkins. 2012 award recipient for his paper, "Comparative gametophyte ecology of the American hart's-tongue fern and associated fern taxa: Evidence for recent population declines in New York State."

Developmental & Structural Section Best Student Poster Award

Meng-Ying Tsai, National Taiwan University, for the paper "A histological study of microsporogenesis and pollen development of *Oxalis corymbosa* and *Oxalis corniculata* in Taiwan." Co-authors: Su-Hwa Chen and Wen-Yuan Kao.

Rebecca Povilus, Harvard University, for the paper "Auxin biosynthesis and female reproductive development in *Aquilegia*." Co-author: William Friedman.

Ecology Section Undergraduate Student Presentation Award, Sponsored by LI-COR

Megan Ward, SUNY Plattsburgh. Advisor: Dr. Chris Martine. For the paper, "Establishment of new regional herbarium leads to more than 100 new flora atlas records for New York State." Co-author: Chris Martine.

Jenna Annis and Jennifer O'Brien, Eastern Illinois University. Advisor: Dr. Janice Coons. For the paper, "Breaking seed dormancy of *Penstemon tubiflorus*." Co-authors: Janice Coons and Nancy Coutant.

Ecology Section Graduate Student Presentation Award, Sponsored by LI-COR

Roxanneh Khorsand Rosa, Florida International University. Advisor: Dr. Suzanne Koptur. For the paper, "Floral biology and pollination of an agroforestry palm, *Mauritia flexuosa*: Why field observations are not enough!" Co-authors: Suzanne Koptur and Reinaldo Imbrozio Barbosa.

Daniel Park, University of California, Davis. Advisor: Dr. Daniel Potter. For the paper, "Weed profiling: A molecular phylogenetic approach to Darwin's naturalization hypothesis." Co-author: Daniel Potter.

Ecology Section Award, Best Graduate Student Poster Award, Sponsored by LI-COR

Jennifer Murphy, John Carroll University. Advisor: Dr. Rebecca Drenovsky. For the paper, "Early life history traits in globally invasive and non-invasive *Rosa* congeners." Co-authors: Lindsay Bernhard, Maria Loya, Rachael Glover, and Rebecca Drenovsky.

Genetics Section Student Poster Award

Chrissy McAllister, St. Louis University. Advisor: Dr. Allison Miller. For the paper, "Environmental determinants of cytotype diversity in Big bluestem (*Andropogon gerardii*)." Co-authors: Paul Kron, Russell Blaine, and Allison Miller.

Genetics Section Student Research Awards

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

Ursula King, University of Connecticut, Graduate Student Award. Advisor: Dr. Donald Les. For the proposal, "Provision of genome resources for *Najas marina* and *Najas minor*, Hydrocharitaceae"

Physiological Section LI-COR Prize (Best Paper)

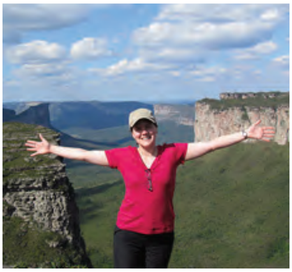
Matthew Ogburn, Brown University. Advisor: Dr. Erica Edwards. For the paper, "Anatomy of leaf succulence in the clade Portulacineae + Molluginaceae: Evolutionary jumps into novel phenotypic space." Co-author: Erica Edwards.

Physiological Section LI-COR Prize (Best Poster)

Robert "Berto" Griffin-Nolan, Ithaca College. Advisor: Dr. Peter Melcher. For the paper, "The role of green light in photosynthesis in bryophytes and higher plants." Co-authors: Peter Melcher and Benjamin Rosen.

Physiological Section Best Poster Award

Albina Khasanova, John Carroll University. Advisor: Dr. Rebecca Drenovsky. For the poster, "Impacts of drought on nitrogen resorption of grasses in the Intermountain West." Co-authors: Megan Thornhill and Rebecca Drenovsky.



BSA Science Education News and Notes

BSA Science Education News and Notes is a quarterly update about the BSA's education efforts and the broader education scene. We invite you to submit news items or ideas for future features. Contact: Claire Hemingway, BSA Education Director, at chemingway@botany.org or Marshall Sundberg, PSB Editor, at psb@botany.org.

PlantingScience

Master Plant Science Team Thanks and Call

Thanks to 2011-2012 Master Plant Science Team! We extend our gratitude to the 2010-2011 Master Plant Science Team (MPST), a special cohort of PlantingScience mentors who commit to mentor approximately four teams in both the fall and spring session and connect with a classroom teacher.

The **Botanical Society of America** sponsored: **Courtney Angelo, Wesley Beaulieu, Alan Bowsher, Katie Clark, Daniel Carter, Matthew Christians, Kate Cummings, Ben Gahagen, Katherine Geist, Kayla Griffith, Morgan Gostel, Billie Gould, Eric Jones, Caitlin Lee, Chase Mason, Allison Mastalerz, Kelly O'Donnell, Amber Paasch, Taina Price, Jeremy Rentsch, Janna Rose, Emily Sessa, Kate Sidlar, Emily Stewart,** and **Kevin Weitemier.**

The **American Society of Plant Biologists** sponsored: **Veria Alvaredo, Shajahan Anver, Elena Batista, Nathan Butler**, **Erica Fishel, Emily Merewitz, Mona Monfared, Christos Noutsos, Shayani Pieris, Marites Sales, Scott Schaeffer,** and **Mon-Ray Shao**.

Thank you for your valuable mentoring contributions. Thanks also for serving as a key link between the teachers and group of mentors working with teams in that class. Your extra efforts are a big boost to the PlantingScience community!

Call for 2012-2013 Applications

The MPST is designed to provide compensation for a cohort of graduate students and post-doctoral researchers who make a substantial contribution as an online mentor during an academic year. To support your extra efforts, there are extra benefits and support systems. MPST members receive free membership to the BSA for the year commitment and 50% off meeting registration fees.

Joining the 2012-2013 team involves:

- participating in online mentorship training
- mentoring ~4 student teams via the web during BOTH fall and spring sessions (each session lasts about 2 months)
- posting to student teams about three times per week
- providing extra support and facilitating communication for one classroom teacher and his/her class

Applications are due September 3, 2012. An application is available online at http://www.plantingscience.org/MPSTApplication.html.

If you served as an MPST member previously and would like to be considered for the 2012-2013 year, please submit a new application for this year.

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

http://PlantingScience.org/NewMentor/.

News about the PlantingScience community

Congratulations to **Naomi Volain**, PlantingScience teacher since 2008, for being awarded in Massachusetts for the 2011 Presidential Awards for Excellence in Mathematics and Science Teaching (https://recognition.paemst.org/awardees). It is a well-deserved honor!

For the second year in a row at the Botany 2012 conference, **Kara Butterworth**, PlantingScience teacher since 2010, shared her high school students' posters about their research projects supported by PlantingScience mentors. Her students at Clear Creek High School in Colorado greatly enjoyed the open inquiry opportunities with C-Fern.

Kara Butterworth and Gabriel Johnson, who has mentored some of her teams, share a laugh and some C-Fern growth tips.

Many thanks to the teachers and mentors taking part in the July focus group meeting: **Kara Butterworth, Martha Cook, Ben Gahagen, Sean Hoban, Betty Indriolo, Monica Lewandowski, Kim Parfitt, Eric Ribbens, Andrew Schnabel, Naomi Volain,** and **Dick Willis**. How fortunate the program is to have such high-quality teachers and mentors. The chance to bring you together was incredibly fun and valuable. Your input about future program directions and website redesign will help ensure that the program serves the community's needs. We'll have more to report following the next stakeholder meeting this November.

Another new development for the community this summer is the formation of an Inquiry Task Force to review proposals for new inquiry module development. This group includes members of several of the society partners: BSA, American Society of Plant Biologists, American Phytopathological Society, and Ecological Society of America.

We are excited about beginning this collaboration to broaden and deepen the plant inquiry topics available to middle and high schools. View the aims and call for proposals at http://www.plantingscience.org/file.php?file=SiteAssets/Call_InquiryModuleProposals.pdf.

Education Bits and Bobs

Improving Undergraduate Education with Discipline-Based Education Research

Research on undergraduate teaching and learning in physics, chemistry, engineering, and biology represents a collection of related research fields. While there is much to investigate about how students learn concepts in specific science fields and transfer their understandings, a recent report has findings that hold across the disciplines. Undergraduate students hold incorrect understandings about fundamental concepts, particularly when large or small scales of time and space prevent direct observation of phenomena. Students also tend to focus on superficial aspects of a problem and struggle with graphs and other domain-specific representations. Student-centered approaches can enhance learning more than traditional lectures. Considering instructional approaches by faculty across the nation, science and engineering faculty are the least likely to use student-centered and the most likely to lecture in their classrooms. The National Research Council report, "Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering," chaired by BSA At-Large Education Director Susan Singer, includes recommendations to increase the use and recognition of discipline-based education research: http://www.nap.edu/catalog.php?record_id=13362.

Naomi Volain with U.S. Secretary of Education Arne Duncan and Deputy Director of the National Science Foundation Cora Marrett.

Science Scores Edge Up Slightly, but Grasp of Science Still Shallow

Eighth graders scored two points higher in 2011 than 2009 according to *The Nation's Report Card: Science 2011*. Additional good news included a narrowed gap in scores between some racial groups and a higher percentage of students who indicated they liked science. A statistic unchanged across years is the disappointing finding that some 27%

of 8th graders reported doing hands-on science activities once/twice a month or never. A related study looking more closely into how students assessed in 2009 perform hands-on and interactive computer science activities showed shallow understanding and applying concepts. Students are particularly challenged by investigations containing multiple variables to manipulate and requiring decision making to collect appropriate data and explain their results.

http://nationsreportcard.gov/science_2011/

http://nationsreportcard.gov/science_2009/ict_summary.asp

Implementing Vision and Change at the Introductory Biology Level

This was the title of a conference, held June 28th-July 1st, in Washington D.C. as part of an NSF-sponsored program for "Using scientific societies as change agents for the introductory biology experience." The BSA was well represented, beginning with former Education Committee chairman, Gordon Uno, who is PI on the Introductory Biology Project grant. Gordon opened the meeting with an overview of the project and left us with a challenging question, "Why hasn't this been fixed before?" Most of the sessions for the next three days focused on the various components that must be integrated to actually accomplish a "fix." Susan Singer, the BSA's At-large Director for Education, led off the first afternoon with a report from the National Research Council on "Discipline-based education research: Understanding and improving learning in undergraduate science and engineering." Marsh Sundberg represented the Society in the breakout session on "The role of scientific societies in transforming the introductory biology experience" and later presented a break-out session paper: "The wheel of biological instruction in the United States: 200 years of reinvention!"

Vision and Change in Undergraduate Biology Education is an initiative sponsored by the American Association for the Advancement of Science and supported by the National Science Foundation. Its vision is to transform patterns of biology instruction in colleges and universities to take advantage of new understanding about how students learn and to implement many of the best practices demonstrated to be effective in some of the other natural science disciplines. This will require that we change how we teach by focusing more on student learning, and less on the content we are teaching. For 200 years biologists have been concerned with being more effective teachers, but in the last 20 years science educators have finally begun to accumulate data supporting their convictions. We are finally heeding the advice of one of the BSA's early leaders, William Ganong, who in his 1909 address as retiring President of the Society suggested: "In a word, the first great need of our science teaching is to make it scientific."

During the past month you received an invitation to respond to a document identifying "Core Concepts in Plant Biology." This is part of the BSA's contribution as a scientific society to transforming undergraduate biology. But Vision and Change involves more than just outlining the core competencies of the curriculum. It involves using some of the pedagogies inspired by Amos Eaton (see PSB 57 (4)) and Charles Bessey (p. 114 this issue) that are considered "best practices" today. It follows Ganong's advice to make teaching more scientific by assessing student learning in a rigorous way. It involves professional development for faculty members to hone their teaching skills and learn new ones and it requires that faculty be rewarded for their efforts, both in home institutions and in their professional society. The BSA is already among the leading societies in promoting and recognizing student research (both undergraduate and graduate), encouraging participation of community college faculty, and providing recognition for educational excellence. Do your part to help make "this fix" work!

-Marsh Sundberg, BSA representative to the conference.

Investigating the Influence of Karrikins on Seed Germination. De Beer, Josef. 2012. *American Biology Teacher* 74(5): 324-329.

Karrikins are a cellulose derivative produced by burning and found in smoke. They have recently been shown to stimulate germination of some seeds. The author has his students do a brief literature review of karrikins and then, using stimulating questions, challenges students to design appropriate investigations to answer their questions.

Recognising Differences in Weed and Crop Species. Recognition Skills of Agriculture Students. Burrows, Geoffry, E. 2012. *Bioscience Education.* 19-9.

Burrows, Geoffrey E. 2012. Bioscience Education 19. Available online at http://www.bioscience.heacademy.ac.uk/journal/vol19/beej-19-9.pdf.

Burrows has provided another example of using high-quality digital images to help students learn plant identification, in this case about two dozen crop and weed species. More importantly, this study is longitudinal with (mostly rural) students tested before instruction, after instruction in a class emphasizing plant identification, and four months after completion of that class. Some surprises: 1) there was not a big difference between urban and rural students—all did poorly on the pre-test; 2) the greatest gains were subsequent to the course for students enrolled in other applied courses that made use of the ability to identify plants.

Red Onions, Elodea, or Decalcified Chicken Eggs? Selecting and Sequencing Representations for Teaching Diffusion and Osmosis. Lankford, Deanna and Patricia Friedrichsen. 2012. *American Biology Teacher* 74(6): 392-399.

We all have some favorite examples for demonstrating diffusion and osmosis. Lankford and Friedrichsen have summarized many of these, macroscopic, microscopic, and virtual, with a summary of pros and cons of each. You've probably tried most of these, but perhaps not all—so here is a chance to look for a new example or two. You might want to especially consider one of the several virtual activities in the public domain that are listed.

The Jacob Hoover Cowen Herbarium

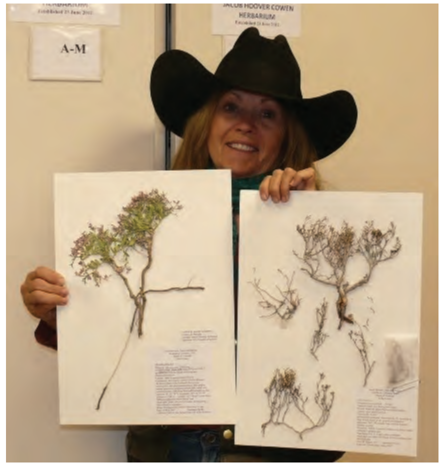
On June 23, 2012, Mrs. Carolyn Sue Savage Hall opened the Jacob Hoover Cowen Herbarium in Hotchkiss, Colorado. The Herbarium is located at the corner of 2nd Street and Hotchkiss Avenue in Hotchkiss in the VFW room of the building (13111 Wolf Park Road, Hotchkiss, CO; 970-872-7777. Soon there will be a website for the Herbarium. The goal of the Jacob Hoover Cowen Herbarium is to make the extraordinarily diverse world of Delta County wild plants, as well as from adjoining counties/watersheds (including Black Mesa, Grand Mesa, Black Canyon, parts of the Muddy Creek Drainage, and the Uncompahgre), available to the widest range of people possible from scientists with PhDs to the youngest plant enthusiast, encouraging both to explore plants from the rare and endangered to the common and plentiful.

Carolyn Sue started officially collecting and mounting specimens in 2006. She has been interested in plants and their identification most of her life. While she is mostly self taught, she has taken various identification classes and was awarded Certificate of Master Naturalist from Gore Range Natural Science Center (now Walking Mountain Science Center) in Avon, Colorado. She also took an online course in Botany from Santa Barbara Community College with Prof. Robert Cummings. She continues to study online and from books she acquires.

The Herbarium presently has almost 300 different species, including rare and endangered ones. Plants in the Herbarium have been verified or identified by curator Jennifer Ackerfield, Colorado State University (CSU) at Ft. Collins, or Ron Harmon, curator of Rocky Mountain Herbarium at the University of Wyoming. A specimen of record is kept and housed in the herbarium at CSU as well as herbaria in the Paonia and Colbran districts of the U.S. Forest Service.

Naming the Herbarium was easy after she learned from her friend Mary Hotchkiss Farmer about Mary's ancestor, Jacob Hoover Cowen, and the profound impact he had on the botany of Colorado.

Jacob Hoover Cowen was born to Elizabeth McIntyre and Jacob Hoover Cowen on March 10, 1872, probably on their property in what is now the Ken Caryl Ranch, near Littleton, Colorado. Young Jacob's father died on August 1, 1871, in a horse accident before his son was born. Elizabeth and her young son lived the next 6 years near her parents' home in Aspen Park, near Conifer, Colorado.



Carolyn Sue Savage Hall holding plant specimens from the Jacob Hoover Cowen Herbarium: *Polygala subspinosa* S. Watson spiny milkwort (left) and *Eriogonum pelinophilum* Reveal.

On October 23, 1877, Elizabeth McIntyre Cowen married Enos Throop Hotchkiss in Denver. Enos was a close friend of Elizabeth's husband, Jacob, and from 1864 to 1871 owned property in the same location where the senior Jacob Cowen resided. Elizabeth and 6-year-old Jacob (Jake) then moved to Enos Hotchkiss' log cabin near Powderhorn, Colorado, where Enos owned a ranch and a toll road to Lake City.

In 1882 young Jake moved with his family to the North Fork Valley, again into a small cabin. He attended high school in Delta, and with Ada McMurry was the first to graduate from that school. He attended Colorado Agricultural College (CAC), now Colorado State University, in Fort Collins. He helped form the Columbian Literary Society and a competitive oratorical group. He achieved the rank of major in the Reserve Officer's Training, and was captain of the CAC football team. Jake graduated at the head of his class of seven students in 1894 with a degree in botany.

Jacob took a post-graduate course in 1894-1895, after which he accepted the position of instructor of botany and horticulture at CAC. He was one of three men who began the herbarium at CAC. His large collection of Colorado plants became the foundation of one of the first floras for the state. One species was named in honor of Jacob, *Geranium atropurpureum* var. *cowenii* (Rydb.) Dorn (this is now a synonym for *Geranium caespitosum* E. James).

From 1898 to 1900 Jacob attended Cornell University in Ithaca, New York, where he graduated with an advanced degree in botany. In 1899 Jake was one of the Cornell students who organized Gamma Alpha, a graduate scientific fraternity. Also that year he published the book, *The Geography of the Apple in North America.* He graduated from Cornell with honors and was elected to a fellowship in horticulture and agriculture in Cornell University for the next year. The fellowship would pay $500 and tuition, and required him to teach classes 5 hours a week. Jake decided instead to accept the chair of horticulture and botany at his alma mater in Fort Collins, Colorado. Jacob's thesis is on microfiche in the Cornell University archives.

In July 1900, before he left Ithaca for Colorado, he became critically ill. He died on July 12 at age 28 of peritonitis, the result of a ruptured appendix. One article about Jake stated**:** "…cut short a career that promised to illumine the world with the light of as rare a genius as was ever given to mortal man… He attained a personal knowledge of the flora of Colorado and the Rocky Mountains by work in the field which no other man possessed…"

Missouri Botanical Garden Receives $25,000 Grant for Development of Advanced Plant Data Collection System

National Park Service's National Center for Preservation Technology and Training Administers Funding to Preserve Historic Resources

(ST. LOUIS): The Missouri Botanical Garden has been selected to receive $25,000 from the National Park Service's National Center for Preservation Technology and Training to develop, test and disseminate a system to modernize and streamline the collection of data on living collections in its historic landscapes. Missouri Botanical Garden's living collections, in addition to providing stunning displays, serve as a "living library" for specimen-based research, education and conservation and are utilized by an extensive network of researchers in the United States and around the world. With over 15,000 documented taxa, the living collection is ideal for studies in several disciplines including biodiversity, ecology and horticulture. The Garden's Horticulture Division develops and cares for these collections to ensure their well being, creates propagation protocols, conducts testing to determine cultural requirements and ensures these plant collections are adequately labeled, interpreted and curated. A collections management database facilitates these efforts so that the living collection can provide the highest possible value for research, conservation and education.

Data are typically recorded on paper forms and later entered into the database back in the office, which is time consuming and prone to error. The Garden's plan is to create new web-based data collection forms for mobile devices (like the iPad), enabling staff to record various management tasks, such as tree assessment, plant maintenance, or garden inventories, directly into the Garden's collections management database. Additional functionality enabled with this grant will allow staff to take photos of plants using embedded cameras, and the resulting images will be linked to corresponding records in the database. Funding will also allow quick response (QR) codes to be integrated into the collections management database, and these codes will be utilized on plant labels for inventory management and outreach purposes. These features will increase output by approximately fifty percent, resulting in more comprehensive and accurate information by which to manage the living collections.

"This grant will allow the Missouri Botanical Garden to develop, test and disseminate a modern data collection system utilizing mobile tablet computers and QR code technology, which will interface directly with the collections management database," explained Rebecca Sucher, Living Collections Manager. "The system will aid in preserving historic plants and landscape features at the Garden.

The National Park Service's National Center for Preservation Technology and Training supports projects that develop new technologies or adapt existing technologies to preserve cultural resources. For more information about the grants, visit www.nps.gov.

The Missouri Botanical Garden is located at 4344 Shaw Blvd. in south St. Louis. For general information, visit www.mobot.org or call (314) 577-5100 (toll-free, 1-800-642-8842).

American Philosophical Society Grants

Franklin Research Grants

Scope

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

Eligibility

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

Award

From $1,000 to $6,000.

Deadlines

October 1, December 1 (December 3 in 2012); notification in February and April.

Lewis and Clark Fund for Exploration and Field Research

Scope

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

Eligibility

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

Award

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

Deadline

February 1; notification in May.

Harvard University

Bullard Fellowships In Forest Research

Each year Harvard University awards a limited number of Bullard Fellowships to individuals in biological, social, physical and political sciences to promote advanced study, research or integration of subjects pertaining to forested ecosystems. The fellowships, which include stipends up to $40,000, are intended to provide individuals in mid-career with an opportunity to utilize the resources and to interact with personnel in any department within Harvard University in order to develop their own scientific and professional growth. In recent years Bullard Fellows have been associated with the Harvard Forest, Department of Organismic and Evolutionary Biology and the J. F. Kennedy School of Government and have worked in areas of ecology, forest management, policy and conservation. Fellowships are available for periods ranging from six months to one year after September 1st. Applications from international scientists, women and minorities are encouraged. Fellowships are not intended for graduate students or recent post-doctoral candidates. Information and application instructions are available on the Harvard Forest web site (http://harvardforest.fas.harvard.edu). Annual deadline for applications is February 1st.

Botanical education in the United States: Part 2, The nineteenth century—Botany for the masses vs. the professionalization of botany

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Key words: Bessey, botanical education, Eaton, Gray, laboratory instruction, new botany, Phelps, student-active learning, Wood

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Abstract

The nineteenth century saw the maturation of botany and botanical education, both in the United States and abroad. Student-active pedagogy, devised by Amos Eaton, was carried on by his student Almira Hart Lincoln Phelps, who became America's first "best seller" botany textbook author. Her major competitor, Alphonso Wood, soon dominated the market by concentrating almost exclusively on taxonomy and making it available to all school levels. Asa Gray, America's first professional botanist, focused on professionalizing the discipline through a profusion of content-rich botanical textbooks marketed to students from elementary grades through college. His preeminence attracted money to construct a dedicated botany building, including a laboratory, and eventually attracted graduate students. The "new botany," championed by Charles Bessey and others, began to move American botany toward the forefront of botanical research while promoting laboratory work and student-active learning at all educational levels. This period culminated with the founding of the Botanical Society of America.

Key words: Bessey, botanical education, Eaton, Gray, laboratory instruction, new botany, Phelps, student-active learning, Wood

As discussed in the initial paper of this series (Sundberg, 2011), Amos Eaton was a pivotal figure in the development of American botanical education. According to Kuslan (1966), prior to 1839, when the first state normal school for the preparation of teachers was founded at Bridgewater, Massachusetts, Eaton's program at Rensselaer was the only one in the country specifically preparing teachers of science; for botany and the other natural sciences, the best school in the country was at Rensselaer. The reason for his success was noted in his obituary: "The Rensselaer School enabled Prof. Eaton to prosecute his favorite plan of teaching his classes, by making them experimenters and lecturers to each other" ("D," 1842). However, the progress of botanical education, pivoting on Eaton, would swing in two different directions.

In one direction, Eaton's students and followers would continue to write and teach botany for students, common people, and practical botanists working in small towns and rural areas across the country. The Enabling Act of 1802 authorized each new state to set aside two townships of federal land for endowment of a university, thus beginning a proliferation of colleges that continued through the Jacksonian era. In 1800, 25 colleges existed in the United States, and most had a science professor; between 1800 and 1830, 44 new colleges were founded, and respectable colleges had at least two science professors (Rudolph, 1977). This was an age of nationalism, both politically and scientifically, and the classics-based college curriculum began to come under attack. The country was growing rapidly, and, particularly on the frontier, a democratic sense of individualism and social equality prevailed. There was widespread interest in learning about the local plants—to stake a claim on territory and understand something about its agricultural potential (Pauly, 2000). Eaton's student-active approach to teaching would be emulated by his disciples, and his classification of local flora remained based on the Linnaean system. This approach suited the new schools in rural areas and on the expanding frontier of the country.

In the other direction was Asa Gray's vigorous reaction against Eaton and the Linnaean system in his effort to professionalize botany and bring it to the same level in the United States that his contemporaries were achieving in England. Both in Europe and America, there was beginning to be a distinction between botanists (scientists) and botanophiles (enthusiasts). The former tended to be men; the latter increasingly were women (Shteir, 1996). The dichotomy between botanists and botanophiles is the focus of the initial sections of this paper.

Near the middle of the century, the Morrill Act of 1862 stimulated another boom in college building. From 1860 to 1870, 175 new colleges were founded, and respectable colleges had at least four science faculty members (Rudolph, 1977). This led to a new focus on using science to solve problems in applied areas. In the words of a professor from Greeley, Colorado, "The beet root took precedence over the Greek root as a subject for study" (Rudolph, 1977, p. 180). Traditional systematic botany began to be replaced by a "new botany" focused on plant structure and function, plant growth, and plant disease. By the end of the century the new botany began, unsuccessfully, to reconcile some of the differences between the two earlier camps while it modernized the study and practice of botany and botanical education.

Almira Hart Lincoln Phelps Puts Eaton's Philosophy into Practice

Early training as a teacher.

Eaton's most famous protégé from Troy Seminary was Almira Hart Lincoln Phelps (Figure 1), the subject of a major biography (Bolzau, 1936), a book chapter (Arnold, 1984), and a special paper in the *American Journal of Botany* (Rudolph, 1984). Phelps was born Almira Hart on July 15, 1793, on a farm near Berlin, Connecticut, about 12 miles southwest of Hartford. Her familiarity with plants from an early age was reflected in her later botanical textbooks. Her parents were committed to education and independent thinking for all their children, including the girls. This was a time of expanding economic opportunity in the country, and with it came time and inclination for education, beginning in the home (Kohlstedt, 1990). As we saw with Barton and Hosack, this also was a time when science was beginning to be published in journals and papers, and science, including the laboratory, was being introduced into school and college curricula (Sundberg, 2011). Even the general public was interested in science and its applications; lyceums and public lectures were becoming fashionable. This interest in plants was not restricted to the New World. Since the 1760s, botany was a particularly fashionable pursuit, for both men and women, as the European Enlightenment permeated polite society and eventually the general culture. Particularly in England, women were prolific writers of botany books for home schooling and

Figure 1. Almira Lincoln Phelps. (Image in public domain.)

informal education. Rousseau's *Letters on the Elements of Botany Addressed to a Lady* (1787) went through eight editions, several of which were translated into English (Shtier, 1996). It was a ripe time for the spread of botany in America. The young Phelps was strongly influenced by her older sister, Emma (Hart) Willard, who became one of the foremost women's education reformers of the time. By the time she was 10 years old, Phelps was attending summer school in Berlin under the tutorage of Emma, "who, as was the custom of the time, was conducting the summer school while a man was master in the winter" (Bolzau, 1936, p. 25). In 1810 Phelps moved to Middlebury, Vermont, to again study with her sister, now Mrs. Willard, and to be tutored in math by Mr. Willard's nephew, John Willard, a student at Middlebury College. Two years later she moved to Pittsfield, Massachusetts, to study in Nancy Hinsdale's (one of Phelps' cousins) Academy for Women, and in February 1816, she accepted an offer to "take charge" of an academy in Sandy Hill, New York. Like many teachers, she was accustomed to taking notes from the books she read to prepare lessons. Her pedagogical innovation was to require students to make written

Table 1. Percent of botany textbooks used in New York secondary schools. Percentages based on Keeney (1992, Table 7); number of copies from Ewan (1969).

Date	Lincoln Phelps	Eaton	Wood	Gray
1835	73	27		
1840	76	24		
1845	85	14		1
1850	63	4	32	2
1855				
1860	11		64	25
1865	3		58	39
1870			45	55
1875			37	63
1880			33	67
1885			15	85
Total Copies	375,000	18,000	800,000-1,000,000	

abstracts of their textbooks (Bolzau, 1836). Less than 2 years later, on October 4, 1817, she married Simeon Lincoln, and her teaching career was put on hold for motherhood and domestic life until her husband's death in 1823.

After her husband's death, she moved with her 2 young daughters to her sister's new school, the Troy Female Seminary, to become a teacher and vice principal. More importantly, it was here that she came under the influence of Amos Eaton, and this brought her to the forefront of botanical education.

Eaton's disciple at Troy.

The Troy Seminary was a flourishing school at the time of Phelps' arrival, with nearly 140 students, seven teachers, and three assistant teachers. It offered the most extensive curriculum of any similar academy in the country, and it included lectures on natural philosophy, chemistry, botany, and other branches of natural history. The tuition fee was $3.00 per course (Bolzau, 1836).

Before 1830, fewer than 25% of female seminaries offered botany in their curriculum, and the number was even lower for boys' or co-ed schools (Warner, 1978; Kohlstedt, 1990; Keeney, 1992). For several years, Phelps both studied botany with Eaton and taught botany at the seminary. Yet she "found want of a suitable book for beginners." She fleshed out the outline of her notes for students and said that after discussions with Eaton, "…he urged the necessity of some suitable work for beginners, and generously offered me the assistance of some manuscripts formerly prepared by himself for a similar purpose. With so able an advisor as Professor Eaton, the encouragement of my sister, the principal of this institution, and with no ordinary degree of enthusiasm for the science, I commenced preparing these lectures for the press" (Lincoln, 1829, p. v).

Phelps had no pretentions of being a scientist—she was a teacher. She made no claim to making any botanical discoveries or innovations but took full responsibility for presenting accepted botanical facts in the most effective way for students to comprehend and learn. But unlike her future literary competitors, Alphonso Wood and to some degree even Asa Gray, she was familiar with and drew on contemporary French and German work, even more extensively than on British texts, and gave credit to them when due. Bolzau (1936) suggested that the general outline of *Familiar Lectures in Botany* (Table 1) was very similar to, and probably influenced by, Rousseau's *Elements of Botany* (available in English translation since 1785). Although Rousseau emphasized that students should have real material in their hands when studying and be guided to observe the necessary structures, rather than be taught simply by lecture, his syllabus was more like Phelps' later elementary works, with each lesson following an individual plant example. Instead, Phelps' model for *Familiar Lectures*, covering basic anatomy and physiology extensively at the beginning of the text, followed the outline used by earlier American authors, Barton and Waterhouse (Sundberg, 2011), who in turn were influenced by Linnaeus (1751). Much of the plant anatomy and the history of botany in her text drew heavily on Mirbel (1815), while the Linnaean systematics section followed Eaton. If fact, her plant descriptions were taken verbatim from Eaton's manual (1829) with his permission (Lincoln, 1829, p. 29). Nevertheless, even in the first edition, she acknowledged the natural system of Jussieu (1789) with a 13-page description and examples, which she said was "highly valuable to those who wish to pursue the study of Medicinal Botany" (Lincoln, 1829, p. 106). The frontispiece was an adaptation of Humboldt's profile of Mt. Chimborazo, showing elevational zonation of plants, and she included numerous detailed illustrations throughout the book. In later editions, she acknowledged Goethe's *Metamorphosis of Plants* (Goethe, 1790; Lincoln, 1853).

The style of her book, and presumably her teaching, reflected a synthesis of some aspects of her mentor, Eaton, with a continental approach to what Morton (1981) called a "unitary theory of plants." From Eaton she drew the conviction that students should study nature directly, either in the field, in the laboratory, or in demonstration. For this, the study of plants was a distinct advantage because "Animals, though affording the most striking marks of designing wisdom, cannot be dissected and examined without painful emotions. But the vegetable world offers a boundless field of inquiry, which may be explored with the most pure and delightful emotions." (Lincoln, 1836, p. 15). But unlike Eaton, whose textbook was solely a manual, Phelps saw the need to provide students with more background about the structure and function of plants. Furthermore, basic botany should be integrated throughout instruction. She wrote: "It has been customary among botanical writers, to consider under separate heads, the physiology, anatomy and classification of plants. This division, although proper in minute investigations upon physiology and anatomy, seems not well adapted for a school book. I have not therefore attempted to keep the departments separate." It is interesting that at the same time, John Lindley, at the University of London, was writing a new textbook of botany expressing the same philosophical approach and the same basic organization (Lindley, 1831). It is also interesting that while Lindley made no mention of Phelps (although John Torrey wrote the introduction to Lindley's first American edition of *An Introduction to the Natural System of Botany…* (1831), and so Lindley was likely aware of her work), Phelps identified Lindley as one of the few British botanists whose works she regularly consulted. This lack of acknowledgement might have been an outcome of Lindley's efforts to professionalize botany. In his inaugural address to the University of London, he said, "It has been very much the fashion of late years, in this country, to undervalue the importance of this science [botany], and to consider it an amusement for ladies rather than an occupation for the serious thoughts of man" (Lindley, 1829, p. 17). It may also have been part of an effort in England to segregate amateur collectors and naturalists from aristocratic professionals (Secord, 1994; Shtier, 1996).

Because she was writing a text to complement her student-active teaching, Phelps also rejected the popular style of textbook, written to be read aloud and memorized for later recitation—the normal method of instruction at the time (compare with Asa Gray below).

…[F]rom experience in teaching others, and from observation of the operations of my own mind, I am led to believe that books most remarkable for a concise style, are not the most favourable [sic] *for the development of the mind. If a book is to be committed to memory, every word, member of a sentence, or idea, not absolutely essential, should be excluded; but this fact with regard to education seems now to be generally understood, that the memory may be burdened without improving the other intellectual faculties, and that the best method of teaching is that which tends most to develop, fertilize, and strengthen the mind.…It is desirable that school books should be easy to teach, and easy to learn.* (Lincoln Phelps, 1831, pp. v-vi)

Phelps believed that the ideal textbook had three main attributes. First, the topics should be arranged in a clear and logical fashion to develop student understanding, not just factual memorization. Major concepts should be covered in enough depth and detail that students could follow the logic of development. Second, the language used should be clear and precise, again to facilitate conceptual development. In this regard, it is interesting to note that the Flesch-Kincaid reading level of her textbook would be considered appropriate for high school seniors and college freshman today (Figure 2; Table 2). Any technical terms should be explained as they were used. Finally, writing style should be pleasing and easy to follow with the use of interesting examples and illustrations. With these guidelines in mind, Phelps produced the first

Table 2. Comparison of mid to late nineteenth century U.S. botanical textbooks with Sachs' German text-book of botany.

Author	Lincoln	Wood	Gray	Bessey	Sachs
Dimensions (inches)	5 x 8	4.75 x 7.35	5.25 x 8.25	5 x 8	6.5 x 9.5
Pages	537 + 15 pp. plates and explanations	645	528	611	858
Flesch-Kincaid reading level (grade level)	11.4	14.2	24.2	10.5	15.1

Lincoln. 1853. Familiar Lectures on Botany. New edition revised and enlarged.
Wood. 1853. Class-book of Botany. 29th edition.
Gray. 1853. The Botanical Text-Book. 4th edition.
Bessey. 1883. Botany for High Schools and Colleges. 2nd edition.
Sachs. 1875. A Text Book of Botany. English translation of 3rd edition.

Figure 2. Contemporaneous textbooks examined for data in Table 2. Left to right: Lincoln, 1853, Familiar Lectures on Botany, New edition revised and enlarged; Wood, 1853, Class-Book of Botany, 29th edition; Gray, 1853, The Botanical Text-Book, 4th edition; Bessey, 1883, Botany for High Schools and Colleges, 2nd edition; and Sachs, 1875, A Text Book of Botany, English translation of 3rd edition.

edition of *Familiar Lectures on Botany* in 1829. This book, originally written for use in girls' seminaries but later expanded for a co-educational audience in both secondary schools and colleges, went through at least 29 editions and 39 printings from 1829 through 1872. In total, more than 375,000 copies were produced (Tables 1, 3).

An interesting pedagogical device Phelps employed to aid teachers and students was to number sequentially the concepts covered throughout the book. It is probable she copied this from Linnaeus himself, who used this technique in his *Philosophia Botanica* (1751), and it was employed by all her American competitors and into the 20th century. Interestingly, it was also used in German texts as early as 1806 (Treviranus), but it was not used by the French and is found only in some later British texts, such as that of Lindley (1831).

Like her female European counterparts, Phelps modified the terminology slightly to make it more suitable for her audience. For instance, rather than "ovary," she referred to the "germ," and pollen was "a kind of powder." She expanded slightly on this in Lecture 8, "Stamens and Pistils," when she said, "…the important use of this dust in the perfection of the fruit we shall soon speak" (p. 80). "In the germ are already seeds formed, but these seeds require the agency of the pollen to bring them to the perfection necessary for producing their species" (p. 82). She acknowledged that more detail is known from her French source, Mirbel (1815), but that there was not time to go further. She began to revise the book immediately after publication but soon realized that there was too much information for younger students, so she wrote a simplified version, *Botany for Beginners*, in 1833. This smaller version went through 13 editions and 26 printings from 1833 through 1891, with more than 270,000 copies printed.

In the early editions, the butterflies, honey bees, and other insects assist the wind "in executing the designs of nature" (p. 79). By 1836, however, *Familiar Lectures* was more descriptive of the role and process of pollination in producing the next generation of plants, acknowledging that Linnaeus made clear the roles of stamens and pistil. She went on to provide a learning moment for students. "Facts that when discovered seem so simple, that we wonder a child could not have discovered them, have eluded the research of great men;—and at this moment philosophers are groping for truths, which in due time will be elicited and incorporated into the elements of science to be learned and understood by children" (p. 81). This description of the nature of science would be a relevant guide for teachers today. With this edition, she considerably revised her plant descriptions from those of Eaton, which she used in earlier works. In addition, numerous species were added. By 1853 the natural system was expanded as a 68-page appendix that provided an alternative to the Linnaean system, but she still preferred the latter for beginners because of its ease of use.

Phelps left the Troy Seminary in 1831 and moved to Vermont with her second husband, John Phelps, for a "retirement" of writing. Seven years later she accepted a principalship, and she and her family moved to West Chester, Pennsylvania. After 2 years, she moved again to the Rathway Institute in New Jersey, and finally in 1841 settled at the Patapsco Female Institute in Maryland, where she spent the rest of her career. Her *Familiar Lectures in Botany* dominated the botanical textbook market during the first half of the 19th century (Figure 1), yet Ford (1964) relegated her to a single sentence in his article on American botany textbooks. As a "faithful disciple" of Eaton, she "edited" Eaton's manual "to serve elementary, secondary, and feminine usage…" (p. 62). Perhaps Ford was unconsciously reacting to one of Phelps' statements in chapter one carried through each edition: "The study of Botany seems peculiarly adapted to females" (Lincoln, 1829, p. 12; 1853, p. 10). Nevertheless, in 1859 she became the second woman elected to the American Association for the Advancement of Science (AAAS).

Alphonso Wood, Popularizer of the Natural System of Classification

Producing a proper textbook.

For such a prolific author of botanical textbooks, with more than 10 different titles to his credit, we know very little about Alphonso Wood (Figure 3). He was born in 1810, the same year as Asa Gray, and graduated from Dartmouth, Phi Beta Kappa, in 1834, intending to be a school teacher. He had no formal training in science but learned about plants from lecturers and students in the medical school. In 1845 he published the first edition of *A Class-book of Botany*. Within 3 years it was in its 10th edition; it eventually made it to 50 editions and sold over 100,000 copies (Lyon, 1945; Table 1; Figure 2). Like Eaton and Phelps, Wood's primary interest was in teaching botany (taxonomy), and he was concerned that no proper textbook was available. In Wood's view, two major problems existed with Phelps' *Lessons in Botany*. First, she spent too much time covering basic structure and function, nearly 300 pages, with only 220 devoted to the flora. Second, Phelps still was devoted to the Linnaean system, and Wood, like Gray, understood that the natural system was more appropriate. On the other hand, Gray's *Elements of Botany* (1836) did not include a flora, and his *The Botanical Text-book* (1842), like Phelps' text, devoted only about 40% of its pages to the flora. Wood understood that he had meager botanical training even though he was a devoted amateur plant collector. For this reason, he tried unsuccessfully to convince more-qualified botanists to prepare a suitable textbook for secondary schools that would include a manual of the plants of the Northeast. Among those he approached was Gray himself. "*Wood* has called on me twice. He will I dare say produce something rather respectable—much better than anything of the Mrs. Lincoln school….that his work may do good, I dare say—though the better it prove, the more it will affect my own interest. But the field is freely open, and I wish him heartily all the success his book may deserve" (Gray, 1844).

Gray was indeed prescient. Wood's book was easy to read (compare a reading index of 14, today's college sophomore, with the graduate school reading level of Gray's textbook in Table 2), inexpensive, and devoted more than 500 of its 645 pages to the natural system of classification. His illustrations were comparable to those found in Phelps. The first edition of 1500 privately printed copies sold out immediately, and a Boston publishing house quickly produced an additional 3000 copies (Lyon, 1945). Wood had begun to make his mark challenging the established authors. In the preface of the first edition, he stated his teaching philosophy:

That there is need of a new Class-Book of Botany, prepared on the basis of the present advanced state of the science, and, at the same time, adapted to the circumstances of the mass of students collected in our institutions and seminaries of learning, is manifest to all who now attempt either to teach or to learn. The time has arrived when Botany should no longer be presented to the learner encumbered with the puerile misconceptions and barren facts of the old school, but as a System of Nature, raised by recent researches to the dignity and rank of a science founded upon the principles of inductive philosophy...; That theory of the floral structure which refers each organ to the principles of the leaf, long since propounded in Germany by the poet Goethe, and recently admitted by authors generally to be coincident with facts, is adopted, of course, in the present work.

Figure 3. Alphonso Wood. (Image in public domain.)

His textbook featured a simple key to classes that led to orders (our families), each of which had its own key to genera. Each genus had a generalized description, including vegetative as well as floral characteristics. Species were listed alphabetically, and each species entry included the common name and a complete English description, again including vegetative as well as floral parts in addition to time of flowering. "Without the talents nor the advantages of Gray, [Alphonso Wood] competed successfully in the textbook field" (Ewan, 1969, p. 44). Within a few years of its appearance, Wood's *Class-book* eliminated Eaton's market and severely cut into Phelps'. In 1845 Gray himself complained to Torrey "…Wood is just taking the market, against my 'Botanical Textbook,' mostly by means of his 'Flora.'" The reasons are apparent from the testaments published at the end of Wood's text (1853)—the lack of a suitable flora was just one reason.

Wood's Botany evidently embodies more traits of excellence and usefulness than any one of the various elementary treatises in general use. In some of these, the preliminary principles of the science are unduly expanded; from others, they are nearly or quite excluded. Mr. Wood's work combines a concise and lucid exposition of primary principles, with ample illustrations of the science, drawn from the Flora of our own immediate section.

—From Messrs. Peck, Newman, and Wentworth, of Troy Conference Academy.

I am highly gratified that at last we have an excellent Class-Book of Botany, by Mr. Wood. We have been almost obliged to abandon the study of Botany in our Colleges and Academies for several years, in consequence of the want of a suitable work as a text-book for students. In this work of Mr. Wood, we have a desideratum supplied, certainly excellent, with an arrangement beautifully simple, and even elegant.

—From Ebenezer Emmons, Prof. Natural History in Williams College

It is interesting that several testimonials, including one of the above, came from Williams College, Amos Eaton's alma mater, and that the botanical reputations of both Eaton and Phelps were founded in Troy, New York, the location of Troy Conference Academy. Clearly personal association was not a factor in textbook selection, though it may have been a factor for Wood in selecting advertising testimonials.

Expanding his range.

With his success, Wood began to travel, add to his collections, and use the work of others to expand the range covered by his manual. A particular irritant to Gray was that Wood made his own species determinations of any new collections without reference to either Gray or John Torrey. Each edition added a few new species, but, with the exception of the major revision of the 1861 edition, each edition was virtually a copy of the previous. Eventually, between 800,000 and 1 million copies were sold (Ewan, 1969). While Gray and many other professional botanists saw the *Class-book* as too elementary, it proved to be a success in the colleges. "The whole science," wrote Prof. G. H. Perkins, of Vermont University, "so far as it can be taught in a college course, is well presented, and rendered unusually easy of comprehension. I regard the work as most admirable" (Wood, 1870, p. ii).

With his success in the college market established, Wood went on to produce new books targeting the elementary and secondary schools. *First Lessons in Botany* (1851) was a small (6¼ x 5 inches) volume summarizing the major topics of the *Class-book* in much simplified form with many illustrations. The principles of education, enumerated in the introductory "Suggestions to Teachers," were a reflection of Eaton's and Phelps' approach. First, "...in the study of any science, the discipline of the mind is an attainment of at least equal value with the acquisition of knowledge." Second, difficult concepts should not be avoided, but enough detail should be provided to make them understandable. And third, "…the first lessons which children learn, since they are most likely to be permanent, should contain truth, however small the portion, neither simplified to childishness nor glossed over with error" (p. 5). He went on to provide a script of a teacher interacting with 10 pupils for a new teacher to use to introduce the study of botany on the first day of class. *The New American Botanist and Florist* (1870), Wood's *Illustrated Plant Record* (1877), and *Fourteen Weeks in Botany* (1879a) were targeted to secondary schools. *Botanist and Florist* was based on the *Class-book*, with a slightly simplified first half. A new feature was a series of synoptical tables that outlined and integrated the main concepts of several chapters and that were "intended for the blackboard." This was a new aid for both the teacher and pupil to facilitate understanding and memory.

Wood's Illustrated Plant Record was essentially a laboratory notebook for taxonomy. It began with an extensive, illustrated glossary of botanical terms followed by about 50 two-page specimen check tablets. Each tablet was a checklist of descriptive terms, organized by organ or by the key characters identified on a single specimen. At the back of the book was a label for collection data, classification, and remarks—essentially a specimen label for that plant. At the end was an index template for students to organize the materials documented in their check tablets. *Fourteen Weeks in Botany* was part of a "Fourteen Weeks" series in the natural sciences known for their simplicity. To accompany *Fourteen Weeks*, Wood prepared an equally short text, *How to Study Plants* (1879b). This book consisted of 73 chapters, each focusing on a single species with one page consisting of illustrations of the plant and diagnostic parts and a second providing an analysis of the key characters and classification. At the beginning were two pages of instructions for teachers. Perhaps more significant than the text itself, Wood, like Eaton, saw the need to prepare teachers to teach effectively. The last edition of this text, published posthumously in 1895, was subtitled *An Illustrated Flora for Teachers' Reading Circles.* Four years later, Ganong (1899) would publish the first full textbook dedicated to how to teach botany.

The reaction of professional botanists to Wood and his books was summed up by Moses Curtis (1857) who asked, "How is it, that the most profitable Text Books are prepared by sciolists?... [he] will make a four months' tour through the South,—in winter too—take a rapid survey of a locality or two in each State…pump every collector who will submit to the operation…[giving the book] an appearance of singular authenticity." The *Botanical Gazette* summed it up in Wood's obituary notice: "As a scientific botanist his work can never rank very high, but as an educator his name will always be remembered" (Obituary notice, 1881).

Asa Gray and the Professionalism of American Botany

Botanical training.

In 1964, Ford suggested that "…what was published in America in the way of botanical texts, prior to Gray's ascendancy was inconsequential" (p. 62). Asa Gray was the preeminent American botanist of his day, but he was only an ordinary teacher (Figure 4). Nevertheless, his impact on botanical education was enormous thanks to the series of textbooks he produced. Gray was born in 1810 in Sauquoit, on the upstate New York frontier. He began to attend the district school early and became an avid reader. At 13 years old, Gray enrolled in the nearby Hamilton College, where he studied the traditional classics for 2 years. In 1825 he transferred to Fairfield Academy. We do not know what classes he took, but the third-year curriculum approved for the Academy in 1808 included botany and *materia medica* as required courses (Dupree, 1959, p. 9). After only a year, Gray again transferred, this time to the College of Physicians and Surgeons of the Western District of New York, where he took classes in chemistry, mineralogy, and botany from Dr. James Hadley. In 1828 Gray bought a copy of Eaton's (1822) *Manual* and began collecting plants in earnest. The summer before graduation, his internship supervisor sent Asa to New York to buy

Figure 4. Asa Gray in 1857. (Image in public domain.)

medical books, and while there, he left some plant specimens for John Torrey. Gray received his M.D. degree later in 1830 and began practicing medicine to earn money to support his botanizing habits, which included periodic teaching appointments at local academies and lyceums.

Two years later, Gray and Torrey finally met on a collecting trip to the New Jersey Pine Barrens and thus began a life-long friendship and collaboration. This was a period of both social and botanical unrest in American history. Andrew Jackson was recently elected President of the United States, and the founding political parties were in retreat. The nation was in an egalitarian mood. Eaton was convinced that although the natural system rising in Europe was "*…the grand climacteric in botanical science*" (Eaton, 1836, p. iv), the Linnaean approach was preferable for introducing botany to the masses. He also thought it was better suited to his educational approach of field and laboratory inquiry at the introductory level. Thus, he retained Linnaeus' classification in all the revisions of his manual. Gray, influenced by Torrey, was convinced not only of the botanical superiority of the natural system but also of its place in the curriculum. Already in 1833, he wrote to Torrey complaining that in his current teaching position "…the principal wishes to retain too much of the Eatonian plan to suit me" (Gray, 1833). It is not clear whether he was referring to Eaton's use of the Linnaean System, Eaton's student-active approach to teaching, or both. Later that year he expressed his attitude toward teaching: "I have just finished at Hamilton College a long tedious course" (Dupree, 1968, pp. 40-41). The animosity of Gray toward Eaton would continue until the latter's death in 1842.

The *Elements of Botany.*

As early as 1835, Gray was convinced that he had to write an American botanical textbook with content equivalent to that found in European texts but smaller, less intensely illustrated, and more affordable than was available from abroad (Gray, 1836, p. x). Phelps' and Eaton's books were completely unacceptable because of their use of the Linnaean system; at least Phelps included basic botany at the beginning of her text, but it was too elementary. Torrey warned Gray that it would take more than a few months to write such a textbook. This was a prescient observation. *Elements of Botany*, like others of Gray's books, would turn out to be a much more time-intensive writing task than he anticipated. It is interesting that Gray was driven by an ulterior motive—supplemental income. Medicine was always a possible fallback, but at this stage of his career, he was functionally an assistant to Torrey and/or a part-time instructor of botany.

The following year, *Elements of Botany* (1836) was published. Not unlike Phelps, Gray felt that the "whole science of Botany rests on the foundation of vegetable organography and physiology" (p. 296), so it was important for students to have a solid foundation in structure and function before applying these skills to natural classification. The first four chapters covered morphology and physiology, the fifth treated the flowerless plants, and the final chapter treated the flowering plants. This book was 438 pages long compared with 340 in Phelps; both were well illustrated. It did not include a flora, nor was it written at an introductory level, and both these factors were detractions compared with his competition's textbook (Table 1).

In 1837 Gray was offered a faculty position at Louisiana College in Jackson, Louisiana, but with new income from his textbook and his part-time work, he declined the offer of $1500 per year. He wrote his father simply, "I do not like the Southern States" (Gray, 1837). The next summer, however, he accepted a position as botanist at the University of Michigan. This was the first time in America that a professor was hired specifically as a botanist (Dupree, 1959). His first responsibility was to travel to Europe to purchase books and equipment for the new university. Most of his time was spent in England, where he worked and lived for a time with William and Joseph Hooker, becoming an especially good friend of the younger Joseph. In London he met and worked with Robert Brown, who introduced him to George Bentham, Charles Lyell, Richard Owen, and Charles Darwin. He was not impressed with the English universities: "I can't express … the profound contempt I feel for the English University system of education." There was simply not enough science. Even so, with the exception of de Candolle in Switzerland, he was less impressed with what he saw while visiting the botanists on the continent.

First American professional botanist.

While Gray was in Europe, America was experiencing the worst economic downturn in its short history, the Panic of 1837. On his return to Michigan in 1840, with the books and equipment purchased in Europe, he was asked to forgo his salary for a year until the financial situation improved. With time on his hands, and a renewed need for income, he began a new textbook. *Elements of Botany* was out of print, and its publisher was out of business. In 1842 *The Botanical Textbook* was published, and Gray was offered a $1000 salary as Fisher professor of natural history at Harvard but with his responsibilities restricted "…to instruction and lecturing in Botany and to the superintendence of the Botanic Garden…." (Dupree, p. 110). Gray and his Harvard colleague, the historian Jared Sparks, were the first college faculty members to have limited classroom obligations so as to do their own research (Rudolph, 1977). His new book, *The Botanical Textbook,* was basically a revision of *Elements of Botany*; the major difference was a formal division of the content into two major parts: part I, an introduction to structural and physiological botany, and part II, the principles of systematic botany. Embracing Goethe's philosophical doctrine of morphogenesis, the total number of pages, 413, was actually slightly reduced from *The Elements of Botany,* but its reading level

Table 3. Numbers of botany textbooks in the United States (1800-1899), based on 390 unique printings, by Rudolph.

			Numbers of Authors			
Quarter of the Century	Total Number of Textbooks	Percentage of Authors: American	American	English	French	German
First Quarter (1800-1824)	**32**	**31**	**10**	**22**	**0**	**0**
Second Quarter (1825-1849)	**87**	**79**	**69**	**16**	**2**	**0**
Third Quarter (1850-1874)	**104**	**94**	**98**	**2**	**4**	**0**
Fourth Quarter (1875-1899)	**167**	**90**	**150**	**11**	**0**	**6**
Totals	**390**	**94**	**327**	**51**	**6**	**6**

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was not reduced (Table 2, Figure 2). According to a reviewer, "With this Text Book in their hands, the teachers of botany in our seminaries may speedily elevate the study [of botany] to its legitimate rank among the natural sciences" (Darlington, 1842).

Finally, in the spring of 1843, Gray, a hesitant speaker, stood in front of a classroom as a full-time teacher for the first time in nearly 10 years. At that time Harvard was following the "scale of merit" system whereby an instructor had to grade each student during each class meeting. This approach encouraged drilling and rote memorization. Gray organized his course by dividing the class into four sections, with each one meeting in one recitation per week. Gray's self-assessment was that he was "pretty good at questioning" and would "give them plenty of illustration, explanation, and ideas not in the book" (Gray, 1843). At least one student, however, had a quite different opinion, writing that "the matter was very good…the manner was positively shocking. I never saw a person more awkward in delivery" (DuPree, 1959, p. 123). Four years of experience did not seem to improve Gray's delivery. In 1848 another student referred to the predictable manner of Gray's recitations, admitting that he "did not study much on my Botany.… The way that I and in fact by far the greatest part of the class do is to read their lesson over once and get it in the recitation room…as we can tell about on what part we shall be taken up, we can get that part perfectly and thus make a squirt" (DuPree, 1959, p. 123). According to Bessey, even in 1872, "The more nearly that the student's answer corresponded word for word with the text, the better was his recitation considered to be" (E. Bessey, 1934-1935, p. 228.). Gray's difficulties presenting botany were not restricted to the classroom but were also evident in public lectures. "Dr. Gray is a poor speaker, but his facts are very interesting, & his illustrations by paintings are beautiful" (DuPree, 1959, p. 130). Unlike Eaton or John Torrey, Gray did not enjoy presenting botany to the general public, and he stopped doing so after 1844.

While he was confined by the system to a dull recitation format for his freshman students, Gray had more latitude in his elective upper-level course. Here he made extensive use of large illustrations (originally prepared for public lectures) and provided a general outline with only major headings and significant ideas written down. But to elaborate on ideas, he would write them out in full. In 1847 and 1849, Gray offered a special month-long advanced training of "particular instruction in botany, with microscopical illustrations" at the botanic garden. These were the first steps toward both upper-level botanical laboratory training and graduate training in the U.S.

But innovations in classroom teaching were not his forte. Instead, he focused on his textbooks.

Because of his research, he was now recognized as the greatest professional botanist in America, and this authority would spread his influence, even if it did not at first help sell books (Table 1). As mentioned above, Alphonso Wood was a follower of Gray's promotion of the natural system, and he actually encouraged Gray to write an introductory text using that system. However, Wood found *The Botanical Textbook* to be unacceptable for his purposes. He saw no need for the basic botany, certainly not half the book, and there was not enough detail in the systematics section. Publication of Wood's *Class-book of Botany* in 1845 was a warning shot to Gray and Gray's ambition to raise the standard of American botanical instruction. Gray's revision of *The Botanical Textbook* came out the same year, but it quickly became evident that Wood's was more popular. Gray's solution was not to expand the *Textbook* but to write an entirely new book meant to directly out-compete Wood. The first *Manual of Botany* (1848) came out 3 years later.

In 1857 Gray moved into the high school market with *First Lessons in Botany and Vegetable Physiology.* The focus was structure and function, much as was the first part of *The Botanical Textbook.* The terminology and content were reduced to be more appropriate for a lower level. Gray noted that it was intended for common schools and high schools, although it could be used as an introduction to botany in colleges, where it would provide the foundation for using the *Manual*. He noted that those wishing additional information about general botany should consult *The Botanical Textbook.* Elementary students got their textbook the following year—*How Plants Grow* (Gray, 1858a). According to Keeney, choice of textbook for schools in the 1860s and 1870s was a regional preference. Wood remained popular in New York and the East, while Gray became the standard in the Midwest. Such regional differences also were starting to percolate up to the college level as discussed below (Table 3).

Gray must have been a bit embarrassed for spending valuable research time writing elementary textbooks. In 1858 he wrote George Bentham, "My last book in elementary botany is now just off my hands, and will be out in a fortnight. I hope it will be of use. Forgive me for writing horn-books, and I am now done with that sort of work. There were several convincing reasons for doing it." (Gray, 1858b). Dupree suggested that a factor influencing all Gray's textbook writing was supplemental income, $500-$600 per year on a flat-fee basis, and this, apparently, was common for college faculty (Kohlstedt, 1990). For whatever reason, Gray persisted in his textbook writing. He published an even smaller companion volume to *How Plants Grow* in 1872 titled *How Plants Behave.*

A graduate program.

The year 1857 is when Darwin revealed to Gray that he was writing his "big book" on species, but it also was another milestone for Gray and for botanical education: his last year without a graduate student. For the first 15 years of his tenure at Harvard, not a single student earned a graduate degree in botany. The following year, 1858, Gray accepted his first graduate student. Ironically, it was a student who already had a well-developed appreciation of plants. His name was Daniel Cady Eaton, the grandson of Gray's nemesis, Amos Eaton. Daniel had learned systematic botany while completing his bachelor's degree at Yale. According to Dupree (p. 200), "Eaton's Cambridge training shows clearly Gray's lack of any concept of what a graduate school might be. The professor made no effort to push his student into the higher and more technical aspects of science or give him an overall view of the field of botany. The degree requirements were for undergraduates and not well adapted for graduate work…." Eaton, after earning his degree with Gray, returned to Yale to become the second full-time professor of botany in America.

Higher education in the United States changed dramatically in 1862 with the Morrill Act establishing land-grant universities in every state. The Morrill Act was particularly important in the Midwest, but it also had an effect at Harvard, where it offered the potential for developing the graduate program. The new Harvard president requested that a plan be devised to reorganize the curriculum of the Lawrence Scientific School, Harvard's graduate school of science. Gray was so disappointed with the results that he encouraged his friend and collector, George Engelmann, to send his son to Yale, not Harvard. "We have really—thanks to Agassiz and Peirce thwarting all good plans—no Scientific School at Cambridge. They have one at Yale, but here are separate schools: in one they teach Chemistry thoroughly, in one Engineering—in another [the Lawrence Scientific School] there are lectures on Zoology and Geology—of no use to a young beginner, and very little to an older hand" (Dupree, pp. 315-316). In spite of this, botany students began to come to work with Gray. One of the first was William James Beal, who came from the University of Michigan in 1862 and earned his botany graduate degree in 1865. Against Gray's advice, Beal took a position at the new Michigan Agricultural College. New and capable students, however, did not change Gray's classroom attitude. He wrote to an acquaintance, "…I am so driven, so distracted. Bless your stars you are not a professor …this year is far worse than ever. Besides the bother of my classes, unusually bothering on the new arrangement…" (Gray, 1866).

Laboratory instruction.

In 1871 a private donor contributed monies to build a new classroom and student laboratory building adjacent to the botanical garden building to handle the growing number of students interested in botany. Although Gray was averse to the kind of laboratory instruction Eaton promoted at Rensselaer, laboratory space would be convenient for students to spread out specimens. It is also possible that some space envy was involved. "An 1858 Junior elective in chemistry with required laboratory work was probably the first Harvard course where students worked in a laboratory rather than observe a scientific demonstration in a lecture hall" (Rudolph, 1977, p. 145).

That summer Gray offered a special class for school teachers in the new building to meet the growing demand for new science teachers following the Civil War. This was the first summer workshop in botany for high school teachers offered—at least in the United States. The new building was an attraction for the plant physiologist George Lincoln Goodale, who left Bowdoin College to join Gray's botany program. Gray could now concentrate on morphology and taxonomy while Goodale brought physiology up to date. In the laboratory, students of morphology and taxonomy were mostly confined to filling in checklists of characters, and physiology students were introduced to some experimental work. The potential for laboratory work must have been appealing to students; in 1874 botany became the second science at Harvard, a year after physics, to require an entrance examination for acceptance to the program (Leighton, 1880). Gray and Goodale collaborated on *The Botanical Textbook* beginning with the 1879 edition. This was also the year that Goodale offered a winter course for teachers on how to teach botany (Goodale, 1879; Bessey, 1880a). The goal of the course was to teach teachers how to induce students to learn for themselves and do their own thinking. This was accomplished in the laboratory by using interesting and attractive living plants, asking leading questions to guide the student's inquiry, and directly answering only student questions that a student could not answer for himself with direct observation. This is a good model for inquiry-based learning today. Goodale credited Henslow in England, not Bessey (see below) and certainly not Amos Eaton, for developing this inquiry approach (Henslow, 1858).

The European influence.

For the rest of his career, Gray continued to revise his collection of books, bringing the botany up to date in the textbooks and expanding the range of species covered in the manuals. He continued his close ties to the British botanists, particularly Joseph Hooker and Charles Darwin, but even though he was aware of the stirrings in Germany, they did not have an effect on his teaching or writing nor on that of any of the other American botanists until the 1870s. This was in part because most Americans did not read German (Ford, 1964). But English translations of some German botany texts appeared quickly, so the language barrier suggested by Ford was not a compelling argument. It was also because the primary American focus, like England's, was on taxonomy. During the middle years of the 19th century, Gray and Hooker were leading the professionalization of botany in the United States and England, respectively. Both were working against the popular stereotype that botany was a subject of natural history best suited to women (Adams, 1887). Both developed centers of plant collection and focused their work primarily on systematics. Both recognized that an understanding of plant structure was essential to be able to recognize natural systematic relationships, but morphology and anatomy were the handmaidens of taxonomy.

Quite a different approach was developing on the continent and particularly in Germany. As early as 1849, the second edition of Schleiden's botanical textbook, which strongly emphasized cellular and anatomical studies, was translated into English. In the early 1860s, the great Hofmeister published his 4-volume work *Handbuch der Physiologiche Botanik*. Some considered this to be one of "two epoch-making works" influencing botanical science; the other was Darwin's *On the Origin of Species* (Green, 1967, p. 8). Volume 4 of that work (1865), was written by the brilliant Julius von Sachs, who 9 years later published his own *Lehrbuches der Botanik* (1874, Figure 2). Gray was certainly aware of the *Lehrbuches* because his colleague, Goodale, wrote reviews of both the 3rd German edition (Goodale, 1873) and its English translation (Goodale, 1875) in *The American Journal of Science* for which Gray was an editor. Of the latter Goodale said, "This conscientious translation is a valuable and timely gift to botanical students." However, of the first section on general morphology he says, "Most of this chapter is a literal translation of the least satisfactory portion of the third edition." Of the third chapter, in his own area of expertise, Goodale says, "The excellence of this digest is apparent on a hasty perusal. It becomes more obvious when the book is used with advanced students as a handbook in daily work.… When it is supplemented by the Experimental Physiology of the same author, the laboratory is well equipped…. It is a great pleasure to commend this volume, most heartily, as a good translation of the German hand-book to advanced botanical students." More important than the books, however, was that the Germans developed a new style of graduate studies that focused on laboratory work under the direction of the major professor.

Hofmeister may have had some influence on the overall construction of Gray's *Botanical Textbook*. With the 6th edition (1879), Gray's intent was to produce a four-volume compendium of botanical science, much as Hofmeister had done nearly 20 years earlier. He would author the first book, on structural botany (Gray, 1879). Goodale was responsible for the second book on physiology, which was finally produced in 1885. William Farlow never published the proposed volume 3, *Introduction to Cryptogamic Botany, both Structural and Systematic,* and Gray himself never completed volume 4, *Sketch of the Natural Orders of Phaenogamous Plants: their Special Morphology, Useful Products, &c.* Sachs, however, did not have much of an effect on Gray. Whereas Sachs' first chapter was a detailed description of the plant cell, Gray made no mention of cells. Following Hofmeister's (1865) lead, Sachs recognized that all plants shared alternation of generations and treated cryptogams and phanerogams equally. In Gray's view, "As respects the organs of vegetation, the higher classes of cryptogamous plants exhibit this same type [as flowering plants]; it is only in the most general or in a recondite sense that this can be said of their organs of reproduction, and of the less differentiated structure of the lowest classes. Wherefore cryptogamous plants are left out of the present view, to be treated apart" (Gray, 1879, p. 5). Most conspicuously absent in Gray was reference to evolution and plants through time; Sachs' last chapter was 25 pages on the origin of species.

Gray's last textbook, a final revision of *Gray's Lessons in Botany,* was curiously re-titled *The Elements of Botany* (1887), the title of his first text. By this time, dozens of credible botany programs existed at American universities around the country, but a rift was developing between the old East and the new West. Gray still dominated botany in the former, but a "new botany" was rising in the midwestern land-grant universities, influenced by the German model and Sachs' textbook.

Charles E. Bessey and the New Botany

Botanical training.

Charles Bessey was born in Ohio in 1845 and entered Michigan Agricultural College in 1866, the first of the midwestern land-grant institutions (Figure 5). The Morrill Act had specified that each state could establish "one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life (Morrill, 1862). This sounded like a perfect fit for Bessey. Unlike in the eastern universities, a significant amount of the curriculum was science and required a full year of botany in the sophomore year (Beal, 1908, p. 89). Bessey later recalled that "with the possible exception of Harvard, this college [Michigan Agricultural] then gave the most extended and thorough course in botany in this country" (Bessey, 1908, p. 87). For his degree, he completed semester-long courses in systematic botany, structural botany, vegetable physiology, and horticulture and was employed in the college greenhouse. Unfortunately, his classes, even in botany, were mostly the traditional textbook reading and recitation with some simple dissection to help identify plants. His most memorable moment, however, was when he was given the cabinet key for the Ross compound microscope. "It was never taken out for use in class, but always stood there as a challenge to us. I do not know what anyone else did, but at last I could stand it no longer, and getting permission from professor Prentiss, who gave me the key to the case, I locked myself in the classroom, and taking out the ponderous instrument, looked it over, studied its complex machinery, and made myself familiar with its structure and use" (Bessey, 1908, p. 86). He completed his B.S. degree in November 1869 and began his first position at Iowa Agricultural College the next month. He started doing simple experiments in the lab, collecting information from local farmers, and developing exchanges with other botanists. The curriculum was nearly as extensive as what he experienced in Michigan. In the sophomore year, students began with structural botany, using Gray's text, while they learned dissection and analysis in the laboratory. Systematic botany was taken up "as soon as the student is far enough advanced to do so" and continued throughout the year. The first term of the junior year was split between vegetable physiology, economic botany, and cryptogamic botany—all making use of the herbarium and college microscopes (Pool, 1934-1935, p. 236). In 1872 the AAAS met in Dubuque, Iowa, where Bessey, a new member, first met Asa Gray, who was the current President. Bessey arranged to spend his 3-month winter break at Harvard, where he also worked with George Goodale and studied fungi and systematics (6 years before Goodale's winter laboratory course). The following year, back in Ames, he moved one table, one microscope, and a few reagent jars into a small room at the end of a corridor with a sign over the door—"Botanical Laboratory." Bessey claimed that this was the "First botanical laboratory outside of Harvard." It was certainly the first botanical laboratory for undergraduates in America.

Figure 5. Charles E. Bessey in about 1912. Inset, Bessey's $1200.00 Beck microscope from Iowa State University. (Used with permission of Special Collections Department, Iowa State University Library.)

Laboratory instruction.

By 1874 the botanical laboratory was an integral part of Bessey's teaching. The laboratory, and particularly microscopy, became the centerpiece of laboratory instruction at Ames. Within 2 years there were seven compound microscopes and graduate courses in physiological botany and systematic botany. Four years later, in 1880, there were 11 compound scopes in a new building with a large botanical laboratory on the first floor. Three years later, the lab had 21 student compound microscopes and a "first class microscope, with accessory apparatus, and high power objectives" (Pool, 1934, p. 237). The microscope was necessary for making careful observations, not only of the anatomy of flowering plants but of a variety of cryptogams. Detailed and accurate sketches would not be sufficient. Later Bessey would write, "In our botanical laboratories the student should be not only taught to make measurements of everything he studies, but the making of such measurements should be *a part of the study* of the object" (Bessey, 1889a, p. 52). Bessey later took pride in recalling that the administration and his faculty colleagues believed "that the professor of botany was slightly 'queered' or out of his head when the subject of microscopes was under discussion." In 1882, when a storm destroyed part of the science building, Bessey's only concern was for the state of his research microscope, which he found undamaged (Anonymous, 1934). The university president "never really fully understood my insatiable thirst for buying more microscopes" (Overfield, 1993, p. 25).

At Harvard, Bessey was also influenced by Louis Agassiz, whose philosophy was similar to Amos Eaton's—to really learn biology, the student must study nature, not books. Bessey made every effort to bring into the laboratory living plants as opposed to dried or pickled herbarium or museum specimens. The student had to be able to touch and work with the organisms to really investigate them. Laboratory instruction became Bessey's trademark (Figure 6). While at the University of California in 1874-1875, he introduced botany students there to the laboratory method and did the same during a visit to Minnesota in 1881, where he offered a summer school botany course for teachers (Bessey, 1881). By 1885, a dozen colleges had botanical laboratories equipped with microscopes for student use (Arthur, 1885). All the while, Bessey remained active in his own research and was developing a national reputation. In 1880 he was elected a fellow of AAAS and also began a 17-year span of providing the botanical editorial notes for each issue of *American Naturalist*. From 1897 through 1915, he did the same for *Science*.

There is no doubt that Bessey was the driving force behind introducing modern laboratory instruction into the botany curriculum in this country, but he was not working in a vacuum; similar changes were occurring in England. Sir W. T. Thiselton-Dyer later wrote, "The 1873 [botany] course commenced on June 24 and lasted for six weeks. The lectures presented no difficulty, as the ground had already been gone over in Dublin. The plan was that adopted by Huxley: a lecture at 10 o'clock and then an adjournment to the laboratory, where each student was provided with a place, microscope, and necessary instrumental appliances. The work continued from 11 to 1 P.M. and from 2 till 4. It was expected that, with the assistance of the lecturer and his assistants, the students would then have succeeded in verifying every material statement made in the lecture" (Thiselton-Dyer, 1925, p. 711). It is not clear whether either man knew of the other's work at that time, but it is clear that similar trends were brewing, and others in this country were aware of them (Rothrock, 1881). In both England and America, it was beginning to be recognized that "German science is the professional investigation of detail, slowly attaining generalizations. English science is the opposite of this,—amateurish rather than professional" (Anonymous, 1883, p. 456). It was time to follow, and improve on, the German model.

Bessey's botanical textbook.

In the early 1870s, Henry Holt and Company planned a series of textbooks in the sciences and approached Goodale at Harvard to write their botany textbook. The resulting manuscript was apparently not "sufficiently general," and rather than modify the text, Goodale suggested that Bessey might be a more appropriate author for

Figure 6. Bessey's botany laboratory in 1914. (Used with permission of the Archives and Special Collections, University of Nebraska – Lincoln Libraries.)

the project, given the successful series of lectures he presented in California in 1875. The book had to be suitable for a general introductory-level audience, have an American orientation, contain original illustrations, and include evolution. Before accepting the project, Bessey contacted Gray to get his opinion. Gray responded, "I wish you success but [I] must not do more for your Holt and Company book because it is intended to be one of my rivals in that field, which is why Goodale could not touch it" (Overfield, 1993, p. 26). One wonders if Gray recalled his response to Wood's request decades earlier.

Botany for High Schools and Colleges (1880) was published 2 years later. The approach of the book was to help the student "to become himself an observer and investigator, and thus to obtain at first hand his knowledge of the anatomy and physiology of plants…" (Bessey, 1880b, p. iii). The content and organization was based on Sachs' *Lehrbuch der Botanik* (1868), and Bessey acknowledged his reliance on Hofmeister, de Bary, Nageli, Strassburger, Schwendener, and others. Here was an American version of current botanical research coming out of the best labs in Europe. Bessey noted that he provided only a few major innovations beyond Sachs. In *Part One, General Anatomy and Physiology,* he recognized seven distinct tissue types: parenchyma, collenchyma, sclerenchyma, fibrous tissue, laticiferous tissue, sieve tissue, and tracheary tissue, which was more similar to the treatment of DeBary (1877). In *Part Two,* his major innovation concerned his treatment of algae and fungi. Rather than two divisions, one for Charophytes and one for all the rest of the thallophytes, Bessey raised the slime molds, bacteria, and blue-greens to a division of their own: Protophyta. The diatoms, desmids, water molds, and some green algae he included in the division Zygosporae. The majority of the green algae, some water molds, and the brown algae were grouped into division Oosporeae, and the red algae, ascomycetes, basidiomycetes, and Characeae formed the Carposporeae. He also followed the British, rather than the German, classification of flowering plants. Ford's comment that "Sachs's and Bessey's work combined and viewed as essentially the same document…" is a gross oversimplification (Ford, 1964, p. 65).

Bessey's last chapter contained a brief section on "The Distribution of Plants in Time." He realized that Darwin's theory of modification of species was already having an impact on classification, but even more importantly, Darwin's growing body of work was providing new insights in a wide field of botanical study. "For the botanist of to-day, plants are living, moving, feeling beings, whose habits and movements, and the secrets of whose lives are deemed worthy of the closest scrutiny and observation. In this work, the proper work of modern botany, Mr. Darwin led, and where he did not enter himself, he pointed out the way. The titles of his books alone, almost outline the whole work of the student of plant life" (Bessey, 1882a, p. 507). While Bessey never used the word "evolution," he understood that natural selection would gradually lead to classification systems showing gradual modification and differentiation of organisms, generally from more simple to more complex.

Bessey was clearly inspired by Sachs, but his text was certainly not as encyclopedic, nor written at the same level, as its German model (Table 2, Figure 2). Nevertheless, it was accessible, it was modern, and it was American. John Coulter's (1880) review in the *Botanical Gazette* expressed some of the most positive opinions.

Of necessity the work could not be entirely or even mostly original, but rather in Part I a following of that done in the German laboratories and based chiefly upon Sachs' great "Lehrbuch." In Part II the higher plants of course conform to the system of Bentham and Hooker. The classification and treatment of the lower plants seem to be the author's own work and is probably the part of the book that is most original.

The book also contains constant suggestions with regard to laboratory work, such as the best plant from which to get certain tissues, etc., and the best method of treatment. This enables the student to go into the laboratory alone, or rather with the aid of the experience of Prof. Bessey, one of the most successful of teachers, and perform satisfactorily all the elementary work in the histological structure of plants. We would most cordially commend the work to the use of all professors and students of botany not only as the best American book upon the subject, but the only one.—J.M.C.

On the other hand, many criticized the book, saying it was too difficult, and the laboratory approach was not an effective way to teach students. According to Professor Eugene Hilgard at California, the book may be "valuable for the advanced student who wants to know more than names and morphology, yet I find few of this type of student." He "tried to keep classes interested in the details of vegetable anatomy and of microscopic life but found year after year dropping more to the view of Gray that it is first necessary to create proper interest of what the student can see" (Overfield, 1993, p. 34). Gray's (1880) review in the *American Journal of Science* was complimentary in a backhanded way. "It speaks well for the progress of science in the United States, when a professor in a college in so new a State as Iowa, situated mid-way between the Mississippi and the Missouri, can produce so creditable a book as this. The work concerns itself throughout with what the Germans call 'Scientific Botany,'—largely with vegetable anatomy and development, and with particular attention to the lower Cryptogamia…. It will indeed form a substitute for it [Sachs' *Lehrbuch*]; and the systematic part, so far as it goes, is an improvement upon the model…. Prof. Bessey's volume is a timely gift to American students of a good manual of vegetable anatomy and of the structure and classification of the lower cryptogamis, which was very much needed. Here at least is a commendable beginning." An anonymous reviewer in 1881 wrote, "It seems to us, nevertheless, that he is a little infected with German dryness as is not unnatural in a first edition of a book on a technical subject, in which the Germans are masters. The book was intended as a companion for the laboratory, and as such, perhaps, we should not complain of it, but it was also intended for the general reader, and in his interest we recommend a little greater solution of the solid contents. For it must be borne in mind that many will want to learn from this book who have not the advantage of witnessing Professor Bessey's skill in working" (Anonymous, 1881). Given the reading level of Bessey's book, compared with the alternatives (Table 2), one wonders if this reviewer had ulterior motives.

Holt wanted a second edition within 4 months and also contracted with Bessey to produce a more elementary text. *The Essentials of Botany* came out in 1884. As noted above for the previous authors, issuing new editions of textbooks was of common occurrence in the United States, but the last quarter of the 19th century set new standards for competing textbooks (Table 3). Most of these were reviewed by Bessey and/or the *Botanical Gazette*. By the late 1880s, we begin to see the review title "Another School Botany," which usually signaled a mundane text—or worse. "Verily in botany 'of making many books there is no end,' … Without question the book cost the author a great deal of hard work, and it is a pity that it has been such a waste of energy" (Bessey, 1889b, p. 54-55). *The Essentials of Botany* was not one of these. The general organization was the same as in his larger book, but he suggested that he considerably modified the language. He noted that many technical terms were anglicized, particularly in classification. For instance, *Zygophyta* became *zygophytes*. (Perhaps students with Latin training would have appreciated this?) "Distribution of Plants in Geological Time" was moved forward to the introductory chapter on classification. Despite his attempts to simplify the reading, the Flesch-Kincaid reading level of this elementary book was also about 10th grade, no different from that of his larger text (Table 2). However, in the preface, Bessey does exhort teachers to use the text only as a guide for students, not as facts to be memorized: "Every effort should be made to have the pupil see things for himself" (Bessey, 1884, p. iv).

The New Botany.

Bessey's textbook was one of the first salvos of "the new botany" in America, a term coined by Beal (1880), at Michigan Agricultural College, but soon taken up by other, mostly younger, midwestern botanists including Bessey, Bessey's undergraduate and Master's student, J. C. Arthur, and their mutual friend John M. Coulter. In 1875 Coulter founded the *Botanical Gazette,* which was to become the mouthpiece of the younger generation of botanists. In addition to traditional taxonomic reports, it published anatomy, physiology, and a mix of news, teaching, and advocacy for modern botany. In 1880 J. C. Arthur published the first teaching paper in an American botanical journal, which suggested that pumpkin is a most useful example of a dicot stem to use in the laboratory (Arthur, 1880). Two years later, Bessey suggested that *Asparagus* stem is an optimal monocot for teaching (Bessey, 1882b). The new botany involved both a change in the emphasis of botanical study and also a change in the methods of botanical instruction. Microscopy was essential, and cells and tissues of a variety of plants, particularly algae, fungi, and nonflowering plants, were included in the curriculum. In the early 1880s Beal outlined his pedagogical approach in the *Botanical Gazette*. In the first class, students were challenged to make careful observations and comparisons of specimens specifically chosen to highlight subtle characters to emphasize their self-reliance and capabilities. The second day, students would be required to make written descriptions of their observations, and credit would be given for this as well as for their recitations. Many of these essays would be accompanied by drawings to help explain certain points. All this was based on living plants before the students were given assignments in their textbook (Beal, 1881, 1885).

However, another new kind of textbook was published in 1886 to guide students in their laboratory investigations. The outline for the *Handbook of Plant Dissection* (Arthur et al., 1886) was drawn from Bessey's botanical portion of the 1881 Minnesota Summer Science School. It provided a guide to studying the macro- and microscopic structure of 12 plants beginning with two blue-greens, *Spirogyra*, an oomycete and an ascomycete, a liverwort and a moss, a fern, a pine, oats, *Trillium*, and shepherd's purse (the host of the oomycete). The format of instruction was based on Huxley and Martin's (1875) biology manual published a decade earlier in England. The introductory chapter provided a brief listing of the materials and equipment needed and a description of how to use the microscope and razor. (If you author your own lab manual, you should read the descriptions of "Section Cutting," "Mounting," "Applying Reagents," and "Drawing" before you do your next revision!) Each chapter began with a general introduction to the organism's ecology and life history followed by the laboratory instructions. Students were directed to begin with gross anatomical observations and then move to minute anatomy, utilizing whole mounts, peels, and hand sections. The text provided simple directions as to the type of preparation to make and then told the student what to "notice." Annotations at the end of the chapter summarized what the student should have seen and put this into the context of the biology of the organism. Although it covered only plant structure, this book was a model for a plethora of laboratory manuals published in the next decade in the same way that Bessey's textbooks provided a model for an explosion of new botany texts. It was soon clear that the problem in promoting the new botany was not one of available materials to support instruction, nor in the students' difficulty in learning about such material, but rather it was the average instructor's deficiencies in understanding physiology, internal structure, and nonvascular plants (Overfield, 1993, p. 92).

The impact of the new botany can be seen by the rapid development of teaching laboratories in colleges around the country. By 1885, 12 universities had adopted laboratory instruction in their botany program (Table 4; Arthur, 1885; Bessey, 1886a). Except in the case of Harvard, where a laboratory was part of the original design of the building, most of the early laboratories made use of re-fitted existing rooms. By 1885, however, most of the universities with laboratories had their own new buildings, constructed with the laboratory in mind. In most cases, these laboratories were dedicated specifically to botany, but occasionally a lower-division room was shared with zoology. Harvard, Cornell, and Penn were conspicuous in being the only older Eastern schools, and Penn was unique in requiring an introductory biology course, with laboratory, as an introduction to both advanced botany and zoology courses. Wabash, the home base of Coulter, was the only small liberal arts college represented. The majority of schools supporting the new botany were midwestern, and most were land-grant colleges. Twelve years later, the universities of California, Chicago, Columbia, Johns Hopkins, Stanford, Minnesota, and Smith College could be added to the list (Anonymous, 1897a). Except for Columbia and Smith, these again were new colleges. This dichotomy between the (old botany) East and the (new botany) Midwest and West was likely an expression of the attitude of professors: "In many of our universities, and we are not now speaking of agricultural colleges, which must be classed with technical schools rather than with universities…" (Farlow, 1876, p. 288). Proponents of the new botany were not just interested in educating their students and advancing knowledge in the discipline, they were concerned with applying knowledge to solve problems for the general good and welfare of the people of their state or region (Anonymous, 1887a, 1894).

Yet, the two schools of thought recognized some similarities. First, of all the natural sciences, botany was most easily, and cheaply, applied to the classroom. Second, the first requirement for a good teacher was that he be thoroughly grounded in the subject. And finally, school teachers must be taught how to teach as well as what they should teach. They also agreed that the task of a college professor was made difficult by the diversity and motivation of their students. Students could be divided into three groups: those few with a passion and natural aptitude for botany; generally good students taking the course to fulfill some requirement; and those "…whose principal aim in coming to college seems to be to get as little good out of it as possible" (Farlow, 1876, p. 289; Bessey, 1886 a, b, c, d, 1887a, b, c).

During the 1880s and 1890s, the new botany

Table 4. Botanical laboratories in U.S. colleges and universities by 1885.

School	First Laboratory	Number of Labs	Number of Microscopes	Hours Available to Students
Harvard University	1872	1 General 3 Specialized	21 Compound	9-5, MWF
Cornell University	1872	2 Upper Division 3 Specialized	11 Dissection 12 Compound	8-5, M-Sat
Iowa Agricultural College	1873	General Laboratory	21 Compound	2-5, M-Th
University of Michigan	1874	Microscopy lab General lab	43 Compound 6 Compound	8-12:30, M-F
University of Illinois	1876	General Laboratory	21 Compound	8-12, 1-5, M-F
Michigan Agricultural College	1880	General Laboratory	27 Compound	n.a.
Purdue University	1881	General Laboratory	25 Dissection 25 Compound	9-4, M-F 9-12 Sat
University of Wisconsin	1881	General Lab Advanced Lab	11 Dissection 25 Compound	n.a.
University of Pennsylvania	1884	Junior Lab Senior Lab	24 Dissection 24 Compound	9-5, M-F
Wabash College	1884	General Lab Advanced Lab	magnifiers 20 Compound	9-4, M-F
University of Nebraska	1885	General Laboratory	25 Dissection 22 Compound 1 Research-grade	9-4, M-F
Shaw School of Botany	1885	General Laboratory	16 Dissection 1 Compound	n.a.

Data derived from Arthur (1885) and Bessey (1886). n.a., hours available not reported.

made dramatic inroads into college and university curricula. Bessey and Coulter, from their editorial positions in *The American Naturalist* and *Botanical Gazette*, respectively, were cheerleaders for the change and provided a sounding board for others. "Botany in America was never in a more flourishing condition than at the present time" (Anonymous, 1886, p. 2). Plant anatomy, plant physiology, and plant ecology were becoming established disciplines, both in terms of research publication and in their incorporation into the botanical curriculum. Bessey, Beal, and others were pushing to include practical botany, especially agricultural botany, not only as research areas but as educational fields on a par with more traditional "basic" botany (Bailey, 1885, 1892; Bessey, 1886b, c; Campbell, 1887; Anonymous, 1894; Arthur, 1895; Beal, 1895). Bessey was also adamant that it was the duty of botany teachers to encourage their students to become proficient in German, French, and Latin as part of their botanical training. "The literature of Vegetable Anatomy and Physiology can only be known to him in the meager translations of men fortunately better trained than himself, while the mass of the literature of systematic botany must forever remain sealed to him…"(Bessey, 1887a, p. 767).

Bessey was particularly concerned that these changes were not having enough impact on the introductory-level courses and in the high schools. He thought this was particularly important because the introductory course was the only exposure most students would be given to the subject. At the same time, it had to provide an adequate foundation for subsequent courses for those going on in botany. On the basis of his experience, he felt that a general view of the entire plant kingdom was critical. To do this, a few typical examples of the major groups should be collected by the students to be examined for their general appearance, structure, and life cycle. A few examples of these then should be selected for closer analysis of anatomy, physiology, and development using appropriate equipment (Bessey, 1886b). Of course, this approach would be more time consuming than a traditional approach, but "…botany is a science of observation, and that botanical study on the part of the pupil must consist largely of training and practice in the observation of plants" (Bessey, 1887b, p. 768).

Although the new botany gradually permeated botanical instruction through the end of the century, controversy continued to exist, not only with those clinging to tradition but also over the best practices for implementation. From the beginning, Bessey valued collections and taxonomy, as he and many of his students published on the flora of Nebraska. His main concern was that collections go beyond the flowering plants (Bessey, 1886d, 1887c). Yet his advocacy for anatomical and physiological work, his interests in fungi and cryptogams, and his concern for practical applications in agriculture gave the impression to many that there was no room for "old-fashioned" taxonomy. The first soundings of a problem echoed across the Atlantic in 1884 in an exchange between George Henslow (1884) and W. T. Thiselton-Dyer (1884) in *Nature,* which was picked up and reported by Bessey (1885; Anonymous, 1885). The controversy, and the way toward resolution, were summarized thusly:

> *THE TWO EXTREMES of botanical teaching are frequently referred to. They may be called the ancient and the modern, and neither alone is productive of the best results.… The ancient method gives a wide range of acquaintance with external forms, a general knowledge of the plant kingdom and its affinities, a living interest in the surrounding flora; but it disregards the underlying morphology of minute structures and chemical processes, the great principles which bring plant life into one organic whole. The modern method, on the contrary, takes a few types, carefully examines their minutest structures and life work, and grounds well in general biological principles; but it loses the relation of things, as well as any knowledge of the display of the plant kingdom in its endless diversity, and worse than all for the naturalist, cultivates no love for a flora at hand and inviting attention. The former is the method of the field, the latter of the laboratory. The wise teacher will adopt both methods and thus avoid the greatest disadvantage of either.* (Anonymous, 1887b, p. 87)

Differences of opinion also existed as to the most effective sequencing of diversity. Bessey, in his text and writings, encouraged teachers to begin with the simplest organisms, bacteria, and end with the flowering plants. Others argued that students are most familiar with flowering plants, so you should begin with what they know, and move gradually to the less familiar. The point, simple to complex, and counter-point, familiar to less familiar, were argued succinctly in two articles titled "A mistake in teaching botany" (Fink, 1893; Claypole, 1893). While most of these discussions concerned teaching botany at the college level, high school teachers also entered the lists on the side of their college champions (Hudson, 1894).

Botany vs. biology.

The example of the University of Pennsylvania, noted above for its early implementation of laboratories but with general biology as a prerequisite to both botany and zoology, illustrates the rapid inroad of a competing philosophy developing at about the same time the new botany was rising in the Midwest and in England. Biology was transplanted from England and found root in the East, particularly in the medical schools. As early as 1854, Thomas Henry Huxley stated that "…the educational bearings of Biology, in general, *does* precede that of Special Zoology and Botany…" (Huxley, 1897, p. 39). Huxley, sometimes referred to as "Darwin's bulldog," was also an educational reformer who was a strong advocate for teaching science at all educational levels, beginning in elementary school. In 1875, Huxley, along with his protégé Henry N. Martin, published *A Course of Practical Instruction in Elementary Biology,* which was basically a laboratory manual for a course he designed in 1872 for elementary school teachers. In 1875, Daniel Gilman, the newly appointed president of the yet-to-be-opened Johns Hopkins University, met with Huxley and was duly impressed. Not only did he offer a position to Martin, but he invited Huxley to be the inaugural speaker the following year at the opening of the university.

Johns Hopkins was founded as a new kind of research university, based on the German model, and it was tied to its medical school. In his address, Huxley elaborated on his philosophy of education, much of which resonated with the new botany. Science instruction should begin at the elementary level and continue through the college years. He stressed learning from observation and experimentation and promoted laboratory instruction as an effective pedagogy. Student research was an essential component of instruction, and when any lecturing was done, it should be extemporaneous from notes, not read from a book or manuscript. Students should be taught how to learn, not how to memorize what others had written. He also advocated having examinations at the end of each course, rather than a comprehensive examination at the end of a curriculum. In fact, the only conflict he had with the proponents of the new botany, was botany itself. "He [the student] will study not botany and zoology, which I have said take him too far away from his ultimate goal, but by duly arranged instruction, combined with study, in the laboratory, of the leading types of animal and vegetable life, he will lay a broad and at the same time solid foundation of biological knowledge… (Huxley, 1876). Although his audience for this address was a special case where many graduates of the new school were expected to go on for professional medical training, it is clear that Huxley's new biology was meant to replace both botany and zoology in the curriculum (Huxley and Martin, 1875; Huxley, 1876, 1897; Jensen, 1993).

The botany/biology controversy came to a head in the last decade of the century. Here there was no argument about the importance of the laboratory and the roles of anatomy and physiology in a modern curriculum. There was also no argument that the traditional fields of botany and zoology had broadened and that specialization, and specialists, were needed in the modern areas. The difference was whether botany and zoology should coexist independently or be joined in a broader biology. C. O. Whitman (a founder of the American Society of Zoologists) fired an opening shot with an article on biological instruction in universities (1887). Through most of the article, the only thing Bessey and the new botanists might have taken exception to was the admonition that colleges were becoming too concerned with general education and practical application and were not concerned enough about the higher aims of generating new knowledge through research.

Controversy erupted 4 years later with the publication of *Biological Teaching in the Colleges of the United States* (Campbell, 1891). This report, commissioned by the Bureau of Education, U.S. Department of the Interior, charged its author to survey the dramatic changes in biological education that had occurred in the previous 20 years. An interesting side note is that, even then, Campbell acknowledged that changes in chemistry and physics were ahead of those in Biology—something that holds true in science pedagogy today (Campbell, 1891, p. 9).

The botanical response to the monograph was immediate. An editorial in the *Botanical Gazette* noted the inequities in distribution of teaching, with most universities having "two usually able men teaching zoology, and practically no botanical instruction" (Anonymous, 1890a, p. 180). If there was botany instruction, it was usually limited to the flowering plants, and in general, the older institutions were the slowest to adopt laboratory instruction. Two issues later, a contribution from "a prominent botanist" editorialized that "The one-sided method of teaching biology pursued in one of our great universities and emphasized in more than one text-book is distinctly deplorable. One even notes in certain circles a tendency to read botany out of the scientific party altogether" (Anonymous, 1890b, p. 236).

The following month, "a prominent zoologist" retorted that not long ago, when there was no biology but only natural history, "Life and biology—a discourse on life—lelbowed [sic] its way into the curriculum. It was not until the living Amoeba (the animal is not a myth) thrust out its pseudopodia right in the very face of the student, not until the action of the frog's heart was studied by every pupil, that biology came in. Zoology brought the impetus and the idea and in many a college where the botanist still goes his weary round of finding out whether the *ovule is orthotropous* or *anatropous* and of looking at the placentation of the ovule, all study of *life* is still left to the zoologist" (Anonymous, 1890c, p. 276.). The zoology editors of *The American Naturalist* entered the fray the following month, noting that at most universities, biology is devoted almost entirely to animals, but it is not their fault. "Fully half of the teachers of botany are utterly unable to give any of the living side of their subject. Analysis is all that they know, and so when the zoologist goes as far as he can, and teaches all that there is taught of life, is he to be blamed for claiming the name?" (Cope and Kingsley, 1890, p. 1050).

In reply to the zoological assertions that the major concepts of biology can be taught solely with zoological examples, Humphrey provided the opposite tack with some examples in which plants are better exemplars. But he also quoted one of his zoological colleagues who "…could not understand why botanists remain silent while chairs of biology are repeatedly filled with zoölogists [sic] … 'If I were a botanist, I should be heard from'" (Humphrey, 1890, p. 341). Biologists continued (and continue) to have the loudest voice; this was best summarized by W. G. Farlow in his retrospective on the change from the old botany to the new botany in the United States. "I refer to what may be called the biological epidemic which broke out soon after I returned to America [in 1873 from studying in Germany] and threatened for a time to drive botany from the field" (Farlow, 1913).

In November of 1884, Bessey left Iowa State University and assumed the duties of Professor of Botany and Horticulture and Dean of the Industrial College at the University of Nebraska in January 1885. He vowed that the program at Nebraska would not "still regard botany as a pleasant pastime consisting mainly of flower hunting…" or where "the scientific botanist was one who collected, dried, and pressed into dead flatness the plants of his neighborhood, only to attach to them afterword [sic] certain Latin names…." He distinguished between two classes of research, both of which would be important in the department. One type was more practical, with the goal of achieving immediate results; the second was more fundamental, "in which the aim is to discover some profound principle, or establish beyond dispute some fact in nature … the two great wants are a better knowledge of principles and greater intelligence to apply them" (Bessey, 1885). Throughout his career, Bessey complained that botanists were not doing the kind of physiological and pathological work that was needed and that they generally tended to neglect cultivated plants.

Nebraska and Sem Bot.

The following year, his second at Nebraska, seven of Bessey's undergraduates informally banded together to form a "club" of field botanists calling themselves "*Sem Bot*" (the botanical seminar). Originally a "secret society" organized as an alternative to the "Greek" societies in the humanities and languages, Bessey saw the opportunity to harness this energy in the form of a German-style seminar devoted to research. Membership was opened to all botany students, becoming a type of honorary academic society who gathered for research seminars where key and controversial botanical ideas were discussed, and Bessey could reinforce his ideal of "eating and breathing of botany." Bessey's advice was to "Let your brain always contain much meristem, and little permanent tissue and have a bias in favor of new ideas" (Overfield, 1993, p. 158). He encouraged students to work on their own projects and offered free access to his own laboratory, the herbarium, and library 6 days a week and occasional evenings. One outcome was that the official "Flora of Nebraska" for the botanical survey was the independently organized ongoing product of *Sem Bot* members. As the number of student members grew, with each working on his own independent project, another function of *Sem Bot* was to provide an annual forum for student presentations, the model of undergraduate and graduate student research days on many campuses today. Notices of these final

Sem Bot seminars were included among the reports of regional scientific meetings announced in the *Botanical Gazette* (Anonymous, 1897b).

Botany and AAAS.

As part of the professionalization of botany, Bessey and his botanical peers were active in AAAS. In 1883, during the AAAS meeting in Minneapolis, they organized the Botanical Club, which met during the meeting and provided a forum for brief papers and reports that would not fit in the regular section F, Biology. In 1890, 28 of the 48 papers presented in section F were by botanists, and an additional 17 briefer papers, including one on physiology laboratory apparatus by J. C. Arthur, were presented (AAAS, 1890a, b). Arthur's paper appears to be the first presentation of a botanical paper with an education focus at a national meeting. Bessey suggested that the following year, others should bring sketches and/or instruments to share. Among the demonstrations presented in 1891 was a student reagent case brought by Dr. Beal (AAAS, 1891). In 1892 Bessey was elected chair of the new AAAS Botany Section, which would meet for the first time in Madison the following year. At Madison, 34 papers, one fifth of the papers presented at the entire meeting, were in the new section G, Botany. Most were related to the new botany, and several of them addressed pedagogy. Conway MacMillan, one of Bessey's former students who was then at Minnesota, presented "A preliminary statement concerning botanical laboratories and instruments in American universities and colleges." MacMillan noted that on the basis of survey results, three different approaches were being used in universities: "(1) those which do such work as that offered by Gray's "Lessons" and the "analysis" of a few flowers; (2) those which simply study types, after the Huxley and Martin method, and have little or no botanical tendency; (3) those with well-developed courses in all the various phases of botanical activity." As a result of the discussion that followed MacMillan's paper, a resolution was passed requesting the commissioner of education to publish a monograph on the subject of laboratories, to be prepared by Professor MacMillan.

Botany and The Committee of Ten.

In addition to the laboratories motion, a second motion was passed to appoint John M. Coulter, D. H. Campbell, and Nathaniel L. Britton to a committee with the charge of reporting at the next annual meeting of the section concerning some feasible way by which the section might use its influence in securing better botanical instruction in secondary schools. This charge was preempted by the National Council of Education, which appointed The Committee of Ten earlier that year. This committee was charged to make national recommendations for secondary school curricula, the best methods of instruction, and the requirements for entry into colleges. The chairman was Charles Eliot, president of Harvard and a former student of Asa Gray. The committee quickly organized nine "conferences," major discipline areas, among which was natural history. Ten members were selected for each conference, representing both colleges and secondary schools. Both Coulter and Campbell were chosen to represent botany. Rather than Britton, however, the Committee chose Bessey to be a third college botanist on the committee (Committee of Ten, 1894).

Among the recommendations of the committee was that botany and zoology should be taught for at least an hour a week, preferably in smaller blocks, from grades 1-8. This instruction should be primarily experiential and not use a textbook. At least a year of high school natural history should be three fifths laboratory based. The latter should be a minimum requirement for entrance to college. The primary objectives at the elementary level were to interest students in nature; to train them in observing, comparing, and communicating ("to develop in them a taste for original investigation"); and to acquire specific knowledge "gained by actual experience" (Committee, 1894, p. 142). A detailed plan of study was suggested so that by the end of 2 years, students would have a general idea of the plant as a whole, living being. By the end of 4 years, students should be asking "how" and "why" and know something about plant growth and reproduction as well as general uses and gross structure of organs. After 6 years, students should be self-reliant and independent with a general knowledge of the life history of the whole plant, and the last 2 years should introduce students to fungi, algae, and nonvascular plants. High school work should begin with at least a full year of biology consisting of 3 days of lab, 1 day of lecture, and 1 day for quizzing per week. A year and a half was preferable and this should include at least a semester of botany. Again, there should not be a textbook, per se, but only a laboratory manual and reference books. The course work should focus on a survey from blue-greens through flowering plants—basically the contents of Arthur et al. (1886) with additional algal examples.

The Botanical Society of America.

The most significant activity of the 1893 AAAS meeting for botany and botanical instruction was the circuitous formation of the Botanical Society of America, as described by Tippo (1958) and Smokovitis (2006). In short, despite a committee recommendation not to establish an independent American botanical society separate from either the botany section of AAAS or the associated Botanical Club, Dr. Charles Barnes convinced those present that the Botanical Club should approve "the formation of an American botanical society whose membership shall be restricted to those who have published worthy work and are actively engaged in botanical investigation. 2. That to this end the Botanical Club proceeded to elect ten men who beyond all question should belong to a society so restricted. 3. That these ten be directed to select fifteen additional members who in their judgment fall well within the limits suggested." Among the original ten were Bessey and Coulter (Coulter, 1893a, b).

Botany had reached that stage of scientific maturity that it could now sustain a national society, and its membership included some of the most influential scientists in the country. At the same time, its leaders recognized the importance of strengthening botanical education from the elementary and secondary schools through university and graduate work. Many of these leading scientists were also leaders in the botanical education movement, and they were committed to an integration of basic science and applied science with a place for both at the same table. This will be the focus of the next paper in this series.

Conclusion

By the turn of the 20th century, Charles Bessey and the other new botanists appeared to have established a de facto consensus about the role of botany as a professional discipline of natural history and that botanical instruction should begin in the elementary schools and be continued through high school and into college. Furthermore, a survey of a dozen botany textbooks of the time demonstrated near congruence of emphasis on ecology, physiology, gross morphology (structure and modifications of seed plants), general morphology (survey of the plant kingdom), and special morphology (related to angiosperm taxonomy), with the first three forming the backbone of a course. Most of these books adopted the approach of beginning with the algae and fungi and moving to the flowering plants (Trafton, 1902). It is interesting that at least one aspect of The Committee of Ten's recommendations continues to have a significant impact on kindergarten through 12th-grade education today (Vázquez, 2006). Biology continues to precede chemistry and physics in most high school and college curricula.

Despite the appearance of consensus, however, there continued to be dissension in the ranks. The biology movement, referred to above, continued to gain support, particularly from administrators, at both the school and college levels. In addition, the nature study movement began to usurp botany in the schools (Jackman, 1894; Kohlstedt, 2005). Although Coulter at the University of Chicago and Bailey at Cornell University were among the founders and strongest supporters of the nature study movement, inadequate teacher preparation and a plethora of publications weakened the effort. "Many of these have been little more than compilations of fantastic stories about natural objects, made by persons with excellent imaginations and a little inaccurate information upon several scientific subjects. As a result nature study is looked upon, in some localities, as a rather frivolous pastime, which is not of any very great importance in the real business of education" (Caldwell, 1899, pp. 143-144). Finally, although the new botany emphasized the importance of both applied and fundamental botanical studies, they would soon drift apart, in part because of the attitude quoted above by Farlow 2 decades earlier (Farlow, 1876, p. 288).

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Books Reviewed

Economic Botany

Dates: Production, Processing, Food, and Medicinal Values

A. Manickavasagan, M. Mohamed Essa, and E. Sukumar
2012. ISBN-13: 978-1-439-84945-3
Cloth, US$149.95. 442 pp.
CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA

The date palm (*Phoenix dactylifera* L.) is cultivated and eaten worldwide in varying amounts: in the United States, consumption might be quantifiable in units of fruit, whereas in some regions, intake typically may be measurable in pounds per person. Date is a major agricultural fruit crop in most countries in the West Asia and North Africa (WANA) region. Since antiquity, dates emerged linked with the histories of Mesopotamia, Egypt, and North Africa. However, according to the Food and Agriculture Organization of the United Nations, the future of date palms is uncertain. Serious problems hamper their cultivation: low yields, damaging insects, and a lack of research.

During the past half century, date palm groves have been subject to degradation due to increased human activity. El-Juhany (2010) states that over the past decade, productivity of date palm trees has declined in traditional growing areas. As much as 30% of yield can be lost to pests and disease. In the Gulf countries and Egypt, the red palm weevil has recently become a major date palm pest, while Bayoud disease caused by a parasitic fungus is a common threat to date palms in North Africa. Technical and socio-economic factors have contributed to decline in date palm quality. Limitations in date processing and marketing have affected economic revenue. Rehabilitation of date palm trees in the Middle East is crucial, and needs collaborative efforts and a dedicated budget. For all these reasons, the recent release from CRC Press's innovative series, Medicinal and Aromatic Plants–Industrial Crops, of its fiftieth volume, with the publication of *Dates: Production, Processing, Food, and Medicinal Values*, is especially timely. Featuring the sweet fruit and fiber crop's botany, chemistry, production, processing, food, and medicinal usage, it represents a comprehensive survey of fundamental facts about date cultivation.

Divided into four sections, the book begins by examining cultural practices and their inferences for date quality. The contributors discuss tissue culture studies, farm water management, mechanization, approaches in pollination and harvesting operations, and marketing aspects. The second section focuses on postharvest operations such as drying and explores alternatives for methyl bromide fumigation and value-added products. It also reviews biofuel manufacture from byproducts and discusses the issue of waste generated from industry.

Section 3 highlights the physical, chemical, and structural characteristics of dates. It reviews fermentative products that use dates as substrate, discusses the fruits as a substitute for added sugar in food, and explores date palm feeding to livestock. The final section discusses nutritional use and reviews the potential of dates in traditional and alternative medicine.

Authors affiliated with institutions from the following countries contributed to this volume: Australia, Egypt, Iran, India, Japan, Nigeria, Oman, Pakistan, Qatar, Saudi Arabia, United Arab Emirates, and the United States. Surprisingly, this book includes no authors working in many WANA date-growing countries, e.g., none at all from North Africa, not even from Tunisia, despite the fact that there are six experts listed in the Date Palm database active in date palm research involving biotechnology with a laboratory devoted to date tissue culture, nor from Morocco, with three experts listed in the Date Palm database active in date palm research, nor Algeria.

Sadly, despite the fact that the earliest known evidence of date palm cultivation was recorded from 4000 BC in Ur, lower Mesopotamia (now Iraq), and two Iraqi experts are listed as active in date palm research in the Date Palm database, this volume contains not a single study from Iraq. It would seem reasonable to assume that in Iraq—the crop's birthplace—war and neglect have taken their toll. Iraq's date industry, which once peaked at 30 million cultivated trees in the 1960s, has dwindled to 13 million. No author from Sudan appears in this book nor is indicated as active in date palm research in the Date Palm database, despite Sudan's diverse date cultivars (Elshibli and Korpelainen, 2008, 2009) and dedicated research centers at Wad Medani and Shambat, reflecting perhaps how extensively civil unrest and misdirected governmental priorities have taken a toll on agricultural researchers who must out-migrate from their countries of origin to work elsewhere. No author represents Yemen either, despite its substantial date cultivation in Wadi Hadhramaut.

It is commendable that CRC Press allowed eight pages of color illustrations, which enrich any volume of this kind. Economic botanists will particularly welcome Chapter 24, "Dates: A Fruit from Heaven" by Qasim and Naqvi, since the authors provided graceful ethnobotanical images illustrating Adam and Eve with a date palm between them, and another of the sacred date palm from the Sumerian or Babylonian era; two Roman-era coins picturing date palms are also featured. The book's attractive, colorful cover displays the fruiting panicles of three date varieties.

This reviewer observes a few grammatical errors missed by the volume's editors and the publisher's copy editor, and regrets the absence of much splendid ethnobotanical data, detail in which the subject of dates is so rich. One small example is the famous Hadhrami Yemeni asid, a highly valued aphrodisiac for which sesame oil is an essential ingredient (Bedigian, 2004: 345).

Included among date foods is Chapter 21, "Fermentative Products Using Dates as a Substrate," by Sivakumar, who mentions alcohol briefly (on two pages), but omits any mention of aragi, a powerful crude distilled alcoholic beverage made of fermented dates, widely available openly, in this writer's experience, in bygone days (e.g., 40 years ago) in Sudan. It is prepared secretly nowadays by thousands of women in the squalid camps and impoverished neighborhoods of those internally displaced persons who fled years of war across southern, western, and eastern Sudan. The recipe is simple: put dates and baking powder in water; cover with a plastic bag to protect against the perpetual dust; bury underground for two to five days, depending on the season; heat over a fire and drip the piping hot liquid through a sieve; dilute with water. To the people of Sudan residing in neighboring Egypt, however, aragi is more than a simple beverage; it is "a cultural artifact whose value lies in its material and empirical embeddedness in social practice" (Curley, 2009). Curley investigated the symbolic role that aragi plays in the establishment of identity among displaced Sudanese living in Cairo: "For Sudanese migrants in Egypt, aragi acts as a signifier, both linguistic and cultural, of their identity." Migrants establish selfhood through various practices involving aragi, within social, spatial, and material spheres. "In Egypt, Sudanese identity and aragi (as a cultural object) are ethnographically observed to be contextually and semiotically bound through their mutual signification in the word 'aragi.'"

It's unfortunate that this detailed work about dates neglected substantial cultural aspects and skipped considerable regional expertise.

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

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Out of Nature: Why Drugs from Plants Matter to the Future of Humanity

Kara Rogers
2012. ISBN-13: 978-0-8165-2969-8
Paperback, US$19.95. x + 204 pp.
University of Arizona Press, Tucson, Arizona, USA

The author is the senior editor of biomedical sciences at Encyclopaedia Brittannica, Inc., with a BS in Biology and a PhD in pharmacology and toxicology. However, this is not an academic treatise, with literature citations after every other sentence. There is, though, an extensive bibliography, not tied to the text, which is sort of a "suggested reading" segment—if your interests run to things like "Induction of pilocarpine formation in jaborandi leaves by salicylic acid and methyljasmonate." There are nine pages of these citations, arranged alphabetically by author, not organized by chapter.

The running narrative is, of course, plant chemistry, although not a single chemical formula adorns its pages (or, some would say, mars its pages). I judge that the work's intended audience is the college-educated public but not academic specialists, and it deserves to be read by that public because it is throughout an impassioned plea for conservation and preservation. The author makes the case that only 1% of the world's plant species have been tested for possible pharmacologic uses, while species are being driven to extinction, some famously, some silently.

In discussing plants, the author allows herself some linguistic shortcuts. For example, she speaks of collecting fruits of *Taxus brevifolia*, a gymnosperm, for studies on taxol. (The taxol story is given in great detail.) There are numerous other simplifications that come perilously close to saying, for example, "Plants have spines in order to ward off herbivores." She has no difficulty in stating that in dioecious plant species, there are male and female [sporophytes], just as in human beings. There is even a discussion as to whether or not plants have souls—in the context of certain religions. It is asserted that the leaves of plants are covered with stomata, despite the fact that the stomata in gymnosperms are typically in bands, including the Pacific yew noted above. It is also asserted that there are 380,000 described species of plants, and they all share the ability to photosynthesize, even where mention of non-photosynthetic flowering plants like *Conopholis, Epifagus*, and *Monotropa* would strengthen the argument for the amazing diversity of plants.

The winding, agonizingly slow, and hugely expensive path from a plant in the wild to a therapeutic drug at the pharmacy is given special attention. The roles of academic scientists and their counterparts in the pharmaceutical industry are also treated in detail. These tales are the main strength of the book. The point is made repeatedly that it all depends ultimately on maintaining biodiversity and intact ecosystems. But the dangers to these systems are very largely due to burgeoning human populations, which are in turn greatly aided by pharmaceuticals that treat and prevent "premature" deaths. This built-in contradiction is not even hinted at. Indeed, the most effective contraceptive drugs, whose origins were originally from plants, are not mentioned in this work. It is a conundrum: a paradoxical, insoluble, or difficult problem; a dilemma. If there is a solution, it lies not in the chemistry laboratory but in changing attitudes in the human animal. One suspects the author wisely decided that would have to be the subject of a whole other book.

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Sesame: The Genus Sesamum

Dorothea Bedigian, ed.
2010. ISBN-13: 978-0-8493-3538-9
Hardcover, US$135.95. xxiii + 532 pp.
CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA

The editor of this volume is a long-time student of the genus. She is the author of six chapters of this work, with the other 20 chapters authored by an array of experts on various facets of these plants, in particular chemistry and various contributions on its local culture in places such as Turkey, China, and Ethiopia. The cultivated crop is *Sesamum indicum* L., Pedaliaceae. She makes clear that the name is a *nomen conservandum,* but she does not stress that *Sesamum orientale* L., its competing heterotypic synonym, is a *nomen rejiciendum;* the rejected name was once fairly widespread in the literature, and continues to be used to a minor extent.

There is some doubt as to how many species there are in the genus, perhaps 25 or more. Apparently, no one has ever monographed the genus, although Professor Bedigian makes repeated reference to a "forthcoming taxonomic revision," from her hand. There are no keys. As a result, her discussion of the four sections of the genus, and of some of the species within each section, is difficult to follow. There are statements about which binomials ought to be reduced to synonymy, but these are not supported by any reference to type specimens, competing dates of publication, or other formal taxonomic apparatus. The beautiful cover illustration in color, unidentified after the title page by the publisher, is Fig. 2.1 (p. 34) in the text.

The primary use of the plant is sesame oil, which is extracted from the seeds. It is widely used in cooking, and is said to be notable for its stability at room temperature (but two experienced cooks whom I consulted said that it so quickly becomes rancid that they stopped using it). It is pricey, because the seeds are collected by hand. The fruits do not mature all at once and dehisce readily. As a result, farmers cut off or uproot the plants and stack them vertically, to wait for the majority of the fruits to mature. At present, 99% of the world's sesame seed is harvested by hand. Races with indehiscent fruits have been discovered, but apparently these have not made their way into modern agriculture.

The crop has been cultivated from some 5000 years. Accordingly, there is an extensive body of folklore, which is touched on in many places in the book. The phrase "Open, sesame," is said to refer to dehiscence of the capsule of this "magical" plant. As one would expect, sesame oil is widely employed in folk medicine to treat toothaches, headaches, insomnia, anxiety, and burns. There are health food claims for its effects in lowering bad cholesterol, not to mention protecting against colon cancer, high blood pressure, and an array of other ills.

This volume includes a full chapter on "Sesame Seed Food Allergy," written by Suzanne Teuber, M.D., a professor of rheumatology, allergy, and clinical immunology at the University of California–Davis. The chapter is a primer on food allergies in general, and will be read with interest by those afflicted; she points out that people allergic to peanuts and various tree nuts may also be allergic to sesame seeds. It appears that sesame seeds are ubiquitous in the food supply—McDonald's hamburger buns are mentioned several times.

Chapter 25, "Current Market Trends," by Professor Bedigian, may be the chapter of greatest interest to some readers, because she has amassed an extraordinary array of information on the subject, including insights and anecdotes that are surely unavailable anywhere else. Both food and skin care uses are surveyed extensively, but also included is the tidbit that sesame is planted as a food plant for quail, doves, and pheasant in the southeastern United States. The plant is a minor component of the weed flora in some parts of the United States.

This work will long stand as the standard reference on the subject, and one can only wish Professor Bedigian every success in seeing to completion her taxonomic revision of the genus.

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EDUCATION

Joseph Hooker: Botanical Trailblazer

Pat Griggs
2012. ISBN-13: 978-1-84246-469-4
Paperback, US$17.00. 64 pp.
Kew Publishing, Royal Botanic Gardens, Kew. Distributed by University of Chicago Press, Chicago, Illinois, USA

This slim, exquisitely illustrated volume seems to satisfy a noble goal, to popularize botany. Appealing to a wide audience—readers interested in biography, botanical illustration, botanical and herbarium history, or adventurous colonial-era travel and exploration—this would seem to be an elegant souvenir of a visit to the world-renowned Royal Botanic Gardens, Kew.

The subject, Joseph Hooker (1817–1911), is substantial. He turned his humble employment, requiring world travels (i.e., achieved without a wealthy sponsor), into plant collecting expeditions, first to Antarctica and later to India and the Himalayas. A pioneering practicing botanist—even before the term "scientist" was coined, as the book's Introduction by Jim Endersby points out—his "early travels left him with a lifelong fascination with the geographical distribution of plants" [p. 10]. Hooker identified, described, or introduced over 12,000 plant species. His publications assured his reputation among his peers and as a 40-year-long confidante of Charles Darwin, ensured his pedigree.

Joseph Hooker became Assistant Director of the Royal Botanic Gardens, Kew, in 1855; in 1865, Hooker followed his father Sir William Hooker as the director of Kew. He completed an expedition to the western United States with America's foremost botanist, Asa Gray, in 1877, bringing back 1000 new specimens. Botanists involved with writing regional floras or genus revisions will celebrate Hooker's persistent goal: increasing Kew's collections is pervasive, throughout this book. Some of Hooker's other travels included journeys to Morocco, Palestine, and Syria. Sir William Hooker established Kew's Economic Botany collection, comprising 85,000 items; his son Joseph collected many during those collecting trips.

Author Pat Griggs, Kew's science writer, prepared the book in conjunction with an exhibition about Joseph Hooker at the Shirley Sherwood Gallery at the Royal Botanic Gardens, Kew. She writes that young Joseph Hooker used to sit in on his father's lectures and tag along on field trips. All he wanted to do with his life was to study plants. However, recognizing that professionals in the other sciences did not think much of botany, Joseph became a doctor and used this title (and his father's contacts) to secure a place on an expedition to the Antarctic. Hooker requested an appointment as the ship's botanist, and the expedition commander granted Hooker this "meaningless title."

This book lavishly illustrates the critical role that drawing has played in our understanding of plants and nature. Griggs does readers a service, presenting Hooker's pencil sketches alongside his watercolor paintings and the paintings by Hooker's talented collaborator, Walter Hood Fitch. Fitch, a botanical artist and lithographer, was also the illustrator for *Curtis's Botanical Magazine*. The paintings and lithographs Fitch created for Hooker were based on Hooker's field drawings. Excerpts from Joseph Hooker's field journal and personal letters are also included in the book, and they offer a limited glimpse at the extensive notes and copious illustrations he must have created during his lifetime.

Hooker's own plant studies, in pencil sketches and watercolors, are dynamic, with dissected plant parts that lead one to contemplate how each species is constructed. A list of references includes links to websites where readers can view digitized copies of Hooker's books and field notes dating from 1849–1878. Along with the historical text and botanical images in the book, Griggs provides an informative timeline of significant events in Joseph Hooker's life. Prediction: peruse this tribute to Joseph Hooker, and you'll get "hooked" on plants!

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Systematics

Aquatic Plants of Pennsylvania: A Complete Reference Guide

Timothy A. Block and Ann Fowler Rhoads
2011. ISBN-13: 978-0-8122-4306-2
Hardcover, US$59.95. 320 pp.
University of Pennsylvania Press, Philadelphia, Pennsylvania, USA

Aquatic Plants of Pennsylvania: A Complete Reference Guide lives up to the status and caliber of the other botanical reference books for Pennsylvania written by the same authors, *The Plants of Pennsylvania: An Illustrated Manual* and *The Trees of Pennsylvania: A Complete Reference Guide.* In a similar format as these two previous reference materials, *Aquatic Plants of Pennsylvania: A Complete Reference Guide* provides the most accurate, up-to-date botanical information on aquatic plants in a reader-friendly, easy-to-use layout.

The book starts with a brief, informative introduction to aquatic plants and aquatic habitats in Pennsylvania, a region that includes such diverse components as glacial lakes, extensive wetlands, rivers, and the Delaware River estuary. A simple drawing of the phylogenetic relationships of aquatic plants is included, in which mosses, horsetails, and ferns are not pictured despite their isolated and relatively old branches on the green tree of life.

The dichotomous keys used to identify aquatic plants are organized by growth habit and are easy enough for an amateur to use. The rest of the book is composed of detailed botanical descriptions that are both scientifically correct and easy to understand. We used this book to successfully key out aquatic plants in a Rutgers University college course last fall without any major problems. We found one mistake in the key, though, since *Cabomba* is keyed out under “leaves limp when lifted out of the water” and “leaves not crowded towards branch apices.” The species descriptions are detailed and adapted to a general public interested in nature more than expert botanists. Species are listed as either “native” or “introduced”; however, this refers to Pennsylvania only, since U.S. native species such as *Cabomba caroliniana* are listed as “introduced.”

Color photographs, line drawings, and distribution maps of every species make this guide useful for both experts and amateurs alike. Unfortunately, the weakest part of the book is the illustrations—pen-and-ink drawings by Anna Anisko. There is often space for much larger illustrations with magnified details (flowers, fruits, leaf margins, etc.), but instead there are large empty white spaces with a smaller-than-necessary simple drawing on it. For example, the drawings of charophyte algae could have been enlarged substantially. Important characters are not highlighted with precise illustrations and the quality of the drawings varies considerably, with some species having excellent, high-resolution drawings, and others much less so.

Each species is accompanied by a distribution map showing major rivers, county borders, and the southern edge of the latest Wisconsin glaciation. Georeferenced specimen data are mapped onto these base maps and provide excellent spatial data. The color photos are mostly of excellent quality, but some common species are missing photos, such as watercress (which instead has half a white page, did the photo get lost?).

Although distribution maps and illustrations are useful for identification, the book is not as compact as it could be due to these inclusions (194 species are covered in 308 pages). In fact, the book could have been made more as a field guide with less “white space,” a more compact formatting, and better illustration layouts. However, the book is still functional and condensed enough to be used in the field and contains excellent information. Whether you are new to botany or an expert in the field, an amateur naturalist or a professional biologist, a horticulturist or a natural resources manager, this book is an essential and useful addition for anyone dealing with aquatic plants in the mid-Atlantic region of North America.

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The Cape Orchids

William R. Liltved and Steven D. Johnson
2012. ISBN-13: 978-0-9870197-0-7 (Standard edition); ISBN-13: 978-0-9870197-3-8 (Collectors' edition)
Standard edition: US$380.00 (€305.00, £240.00). Inquiries to capeorchids@gmail.com
Hardcover, 2 vols., xix + 1022 pp.
Sandstone Editions, Cape Town, South Africa

The Cape Floristic Region (CFR) comprises 90,000 km^2 and includes about 9100 plant species, 70–80% of which are endemic, making it just about the hottest of biodiversity hotspots. Orchidaceae comprise the 10th largest plant family in the CFR with 24 genera and 241 species, two thirds of which are endemic. All have been treated in previous modern floras (e.g., Stewart et al., 1982; Linder and Kurzweil, 1999) from the angle of systematics with artificial keys to the taxa. *The Cape Orchids* focuses instead on natural history—what the authors call a holistic approach—to understand that unique orchid flora. Bound in two volumes with a full-color slipcase, this title represents over 20 years of fieldwork and photography, supplemented by invited essays from 23 contributors. It includes more than 2000 color photographs and reproductions of both historical and modern paintings of the species printed on 128 gsm (about 80 lb.) matte art paper. As a result, the set is heavy, weighing 6 kg, hardly a convenient field guide that can be tossed into a stuffed backpack at the last minute.

However, neither is it meant to be consigned to the coffee table. This is a masterwork that provides such an overwhelming amount of data that it can only be considered encyclopedic. The Introduction thoroughly covers the biomes and vegetation of the CFR as well as its geology, fossil plants and past climates, ethnobotany, habitat loss, and conservation status of South African orchids. That fascinating commentary is followed by authoritative chapters on the history of botanical exploration in the CFR from 1652 to the present with emphasis on the life and work of Harry Bolus (1834–1911), orchid morphology, fire ecology, pollination and natural hybridization, and cultivation and artificial hybridization.

Most of the two-volume set is devoted to species accounts, first the terrestrials and then the relatively few epiphytes. The systematic account of tribe Diseae in *The Cape Orchids* is in general accord with that of Kurzweil and Linder (2001) in volume 2 of *Genera Orchidacearum*, although some updating has been necessary in light of more recent molecular studies by Bellstedt et al. (2001), Van der Niet et al. (2005), Bytebier et al. (2008), and Waterman et al. (2009). For each species, the authors include derivation of the specific epithet, common names, description, flowering period, history and relationships, distribution, field notes and biology, and references. Illustrating the habitats and key characters are high-definition photographs (principally by the authors and Austrian orchid photographer Herbert Stärker); historical watercolors from *Edwards's Botanical Register, Curtis's Botanical Magazine,* and Bolus's *Orchids of South Africa* (among others); and modern watercolors by Fay Anderson, which are often juxtaposed with photographs to reveal features not otherwise shown. A fire in Ms. Anderson's home in 1996 destroyed many of her paintings, but some could be salvaged and repainted for publication here.

Many species accounts are supplemented with well-written, short essays on the collector or eponym of the species. One of the most interesting in this respect is *Holothrix burchellii* (Lindl.) Rchb.f., commemorating William John Burchell, who was trained as an apprentice at the Royal Botanic Gardens, Kew, and became a Fellow of the Linnean Society at the age of 21. He traveled throughout the Cape from November 1810 to October 1812 and described and illustrated his fieldwork in *Travels in the Interior of Southern Africa.* Burchell returned to England with over 40,000 plant specimens and 120 skins of 95 quadrupeds and 265 bird taxa. He described the white rhinoceros (*Ceratotherium simum* Burchell) and discovered Burchell's zebra (*Equus burchellii* Gray) as well as the orchid genus *Pachites*. Disabled and depressed, Burchell committed suicide at the age of 81. Essays on other well-known eponyms include Swedish botanists Carl Peter Thunberg and Olaf Peter Swartz, British astronomer Sir John Herschel, and British botanists John Lindley and Francis Masson. Masson's specimen of the cycad *Encephalartos altensteinii* Lehm. (collected as *E. longifolius* (Jacq.) Lehm. in the Eastern Cape in the 1770s) is still thriving in the Palm House at the Royal Botanic Gardens, Kew, making it one of the oldest pot-plants in the world.

Volume 2 begins with a 350-page account of the 180 species of *Disa*, arranged in 18 sections (17 occurring in the CFR), and ends with coverage of the five genera of epiphytes found there—*Polystachya, Angraecum, Cyrtorchis, Mystacidium*, and *Tridactyle*. The work closes with recent Cape orchid photographs, references to Cape orchids in Bolus's published works, a glossary of botanical terms, vignettes of the authors and contributors, glossary, and index.

A trivial criticism is that a given species account is difficult to find without consulting the index, and so the reader is forced to juggle the volumes for those taxa treated in volume 1. A quick locator list of the taxa by page number on the endpapers of each volume with corresponding page numbers would have been useful. In the Table of Contents, those few genera outside of tribe Diseae are listed without any systematic context; inclusion of at least their subfamily name in parentheses could have added significant systematic information (complementing Table 1 on page 15) with little loss of space.

The wealth of data and treasury of superb illustrations make this one of the best regional monographs (regardless of plant family) in recent memory. I recommend *The Cape Orchids* to botanists in all disciplines and to institutional libraries, as it is a valuable work that will not soon become obsolete—barring extinctions, of course.

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–Alec Pridgeon, Sainsbury Orchid Fellow, Royal Botanic Gardens, Kew, Richmond, Surrey, United Kingdom

The Jepson Manual: Vascular Plants of California, 2nd ed.

Bruce G. Baldwin, Douglas H. Goldman, David J. Keil, Robert Patterson, Thomas J. Rosatti, and Dieter H. Wilken (eds.)
2012. ISBN-13: 978-0-520-25312-4
Hardcover, US$125.00. 1568 pp.
University of California Press, Berkeley, California, USA

The first *Manual of the Flowering Plants of California* (including ferns) was published by Willis Linn Jepson, professor at University of California, Berkeley, in 1925. This was an extremely important, but also somewhat overdue accomplishment because seven editions of Asa Gray's *Manual of Botany* (covering the central and northeastern United States) and two editions of Britton and Brown's *An Illustrated Flora of the Northern United States and Canada* had been already published at that time (Moore et al., 2010). After 1925, the first edition of Philip A. Munz's *A California Flora* was published in 1959, and *A California Flora and Supplement* was published in 1968. Later, in 1993, the Jepson Herbarium at UC Berkeley, under the leadership of James C. Hickman, produced *The Jepson Manual: Higher Plants of California* (TJM1), effectively starting a tradition similar to *Gray's Manual of Botany*. This year we got the second edition of *The Jepson Manual* (TJM2), resulting from revisions and new treatments accomplished by 332 authors and/or editors, produced again by the Jepson Herbarium, but this time under the leadership of Bruce Baldwin.

First, it is interesting to compare numbers of families, genera, and species (total, native, endemic, and alien) included in the three "Jepson Manuals" (1925, 1993, 2012) and in the summary based on Munz's "Floras" (Raven, 1977) (Table 1).

or *en passant* in the text. Some species classified as native (Latin names in bold italic) are most likely alien (*Galium tricornutum, Landoltia punctata, Phalaris arundinacea, Typha angustifolia*). Still, the resulting numbers may indicate recent reduction of the rate of alien plants naturalization in California—a trend anticipated by Rejmánek and Randall (1994, Fig. 1).

Table 1. Comparison of numbers of families, genera, and species published in the Jepson Manuals and in Munz's Floras.

	1925	1977	1993	2012
Families	140	—	173	185
Genera	927	—	1222	1314
Species	4019	5711	5862	5967
Native species	3727	5057	4844	4976
Endemic species	1416	1525	1169	1315
Alien species	292	654	1023	991

Obviously, the total numbers of families, genera, and species have been increasing almost linearly over the past 90 years. This is partly because of discoveries of native species new to California or even to science, partly because of naturalization of non-native species, and to some extent also because of changes in taxonomy, namely splitting of families and genera into monophyletic units (see below). However, the number of endemic species has been jumping up and down substantially depending on taxonomic delineation of species and improving knowledge of their distribution.

To define the exact number of naturalized (permanently established) species is always difficult (Rejmánek, 2007). The authors of TJM2 tried to be more conservative and wanted to include only alien species conclusively naturalized in California. That explains a small drop in the number of alien species compared with TJM1. I can suggest only a few possible corrections: a few species called "waifs" (this is a rather endemic term; "casual" is the term more commonly used, see Pyšek et al., 2004) are included (*Agrostema githago, Cucurbita pepo, Emex australis, Geranium solanderi, Lasiospermum bipinnatum, Triticum vulgare*), while some naturalized species (*Cuscuta japonica, Danthonia decumbens, Fraxinus uhdei, Geranium yeoi, Melianthus major, Pinus pinea* [Santa Cruz Island], *Rhamnus alaternus, Rhus lancea, Rytidosperma caespitosum, Solanum mauritianum, Veronica hederifolia)* are not mentioned at all or just in keys

In TJM2, the chapter on geologic, climatic, and vegetation history of California was completely rewritten by Constance Millar. The geographic subdivision section was revised and more accurate color maps were provided. There are 272 full plates (compared with 242 in the 1993 edition) illustrating about 80% of native and naturalized species. Genera are somewhat unevenly illustrated (8 of 8 Polystichum species, 18 of 18 Pinus, but only 3 of 12 of Botrychium, 3 of 13 of Eryngium, and 11 of 38 of Lomatium). However, in large and difficult genera (Astragalus, Carex, Eriogonum, Juncus, Lupinus, Mimulus [now in Phrymaceae], Salix), almost all species are illustrated!

As with the TJM1, the index is not all-inclusive because the book is arranged alphabetically by family and species within each of the eight major clades. In addition, in order to make the volume as short as possible, only synonyms in use since TJM1 are included and can be found in the index and the text; thus species that were moved to different genera in TJM2 can be found by looking in the index. However, if you have only TJM2, you will not be able to figure out what happened to one of the first species collected in California—*Zauschneria californica* C. Presl, which was moved to the genus Epilobium in TJM1. In this situation, you have to go to the online Index to California Plant Names; the website URL is provided inside the front cover. Despite all the editors' attempts at space-saving, TJM2 is 168 pages longer than TJM1. Well, still portable.

Many taxonomic changes were made in TJM2. The authors followed mostly the APG II (Angiosperm Phylogeny Group, 2003) classification of vascular plant families, which emphasizes monophyletic taxonomy. Goodbye Aceraceae, Asclepiadaceae, Hydrophyllaceae, Lemnaceae; nevertheless, Chenopodiaceae are still kept separate from Amaranthaceae. The relationships of all families, as currently understood, are shown on the back endpaper, along with the page numbers where they are treated. For convenience, within each of the eight major clades, families are presented alphabetically. Genera within families are also organized in alphabetic order. It seems that the prevailing tendency was to split many genera and even some families (for example, the Liliaceae of TJM1 has been split into 12 families, Caprifoliaceae into three, *Aster* has been broken up into seven genera, *Camissonia* into nine, *Cupressus* into three, *Gilia* into five, *Gnaphalium* into four, *Hemizonia* into three, *Madia* into six, *Mitella* into three, *Polygonum* into five, *Potentilla* into four). This, however, does not seem to be true for the grasses, where rather drastic lumping was the rule. Some of these mergers may be justified (*Lolium* and *Vulpia* are merged into *Festuca*; Inda et al., 2008), but others are clearly erroneous (*Piptatherum miliaceum* is treated as *Stipa miliacea*!). The classification of some groups of grasses is also not in agreement with recently published volumes of the *Flora of North America*. Moreover, it is not even in agreement with most recent molecular studies of phylogeny in these groups (Romanchenko et al., 2010; Hamasha et al., 2012). Yes, our understanding of phylogeny in some groups of grasses is still not complete. However, putting many obviously different species into giant genera was premature. All local floras, databases, and herbaria in California will now follow this provisional taxonomy. In the future, all of that will have to be changed again. A more conservative approach would be less problematic.

Many resources currently available in California made the completion of this manual easier. Just look at the Jepson Flora Project (http:/ucjeps.berkeley.edu/jepsonflora) or at the Consortium of California Herbaria (http:/ucjeps.berkeley.edu/consortium) websites to gain an appreciation of this fact. However, we have to realize that this was a difficult time for the taxonomic reorganization of a manual covering so many species. Many major changes in phylogenetically-based taxonomy at the family level have been accepted since 1993, but the relationships between many genera are still not completely resolved. Obviously, the authors tried their best, and the result is another milestone in Californian botanical literature. Editors and authors should be congratulated on this demanding publication.

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–Marcel Rejmánek, University of California, Davis, California, USA

Peonies of the World: Polymorphism and Diversity

Hong De-Yuan
2011. ISBN-13: 978-1-84246-458-8
Hardback, US$113.40 (£70.00). xvi + 94 pp.
Kew Publishing, Royal Botanic Gardens, Kew, Richmond, Surrey, United Kingdom

This the second of a projected three-volume series titled *Peonies of the World*. Its predecessor volume is subtitled *Taxonomy and Phytogeography* (2010, $145.80 at http://www.kewbooks.org, but up to $300 elsewhere); its final volume will be subtitled *Phylogeny and Evolution*. It may be noted in passing that the parts that have appeared thus far are not furnished with volume numbers, although some booksellers have added them, for clarity.

The work begins with a very detailed "Key to Species," which is at the same time a key to all the recognized subgeneric categories as well. There are in all 33 species of the genus *Paeonia*, the sole genus of the Paeoniaceae, all north-temperate woody and herbaceous perennials. The names at the ends of the legs of the key are not accompanied by page numbers, which would have been helpful; the arrangement is of course not alphabetical. The keys appear to be very usable. The vast array of garden hybrids and horticultural races are necessarily not included in the keys, nor in the descriptive text. There are no nomenclatural innovations published here.

The work is lavishly illustrated with color photographs of the species in the wild, following a detailed description and range statement. There are 10 or more photographs for each species, showing habitat, habit, flowers (both front and back), fruits, and below-ground parts. The labels are quite ample. A welcome feature is that the author has preserved voucher specimens for every photograph, including full label data and herbaria of deposit.

The treatments all include place of publication of accepted names, but not for names cited in synonymy—one assumes these are given in the first volume of the series. Likewise, no type specimens are cited, though they doubtless were earlier. The work concludes with a thorough taxonomic index. There is no Literature Cited, because the only citations are those accompanying the accepted names.

Professor Hong was a co-author of the treatment for *Flora of China* (volume 6, 2001). In an introductory remark in that volume, it was observed that "*Paeonia* is a very complex genus and many of the species are not yet well defined. A consistent taxonomic treatment will require further studies throughout the world distribution of the genus in order to resolve questions about the limits of, and relationships between, the species." It appears that Professor Hong has done precisely that.

–Neil A. Harriman, Biology Department, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin, USA. harriman@uwosh.edu

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Plant Science Bulletin Featured Image

The PLANTS Grant Recipients

The PLANTS program (Preparing Leaders and Nurturing Tomorrow's Scientists: Increasing the diversity of plant scientists) recognizes outstanding undergraduates from throughout the US who attend the BOTANY meeting, receive mentoring from graduate students, postdocs and faculty, and participate in networking events including the Diversity Luncheon and career-oriented activities. The program covers the normal costs of travel, registration, and food and accommodation at the meetings. This grant is funded by the Botanical Society of America and the National Science Foundation. We will be accepting applicants for the 2013 PLANTS program early in the new year.

The 2012 PLANTS grant recipients are:

Dominique Alvis, University of Maryland-Baltimore - Advisor, Dr. Mauricio Bustos

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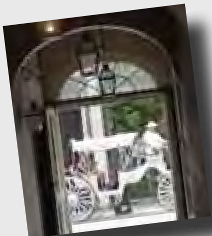

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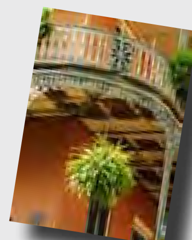

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