PLANT SCIENCE BULLETIN

FALL 2020 VOLUME 66 NUMBER 3

A PUBLICATION OF THE BOTANICAL SOCIETY OF AMERICA

What Have We Learned?

Lessons and Strategies from the Chaos

By Dr. Bryan Dewsbury

IN THIS ISSUE...

The Shapes of Botany, by BSA President Cynthia Jones...p. 174

Getting Started in Tropical Field Research, by Kadeem Gilbert...p. 243

Diversity and Inclusion in the Sciences, by Beth Ginondidoy Leonard .... p. 191

From the Editor

Greetings,

This final 2020 issue of *PSB* comes at what feels like an unprecedented moment. As I write this, the U.S. Presidential election is essentially over. However, due to pending recounts, litigation, and spreading disinformation, the transition of power is shaping up to be, at minimum, chaotic. At the same time, the world is still in the midst of the COVID-19 pandemic and the U.S. has just posted a record number of cases reported on a single day and a record number of hospitalizations. When I'm not teaching twice as much as usual to accommodate both my students who are meeting in person and my students who are in quarantine, I find myself "doom-scrolling" the latest news and opinions.

Since its first issue, *PSB* has been the place where members of the Society can confront current events and acknowledge current problems in science, academia and education. In this issue, we present an article by BSA President Cindi Jones that reflects on "The Shape of Botany" and demonstrates how we can learn from the past and act for the future. These themes are also highlighted in articles by Bryan Dewsbury and Beth *Ginondidoy* Leonard that specifically address issues of diversity and inclusion. How do we, as a community of scientists and educators, address the inequality and systematic oppression engrained in our institutions and promote equity and justice? In the student section, we check in on the ongoing impact of the pandemic on our student members.

I hope that you find the articles in this issue timely and motivating. I send warm wishes to all as 2020 draws to a close.

Sincerely,

Mackenzie

TABLE OF CONTENTS

Botany 2021

Boise July 17-21

Looking forward to meeting with these premier scientific societies!

SOCIETY NEWS

The Shapes of Botany

This article by BSA President Cynthia Jones is based on her BSA Incoming President Address at Botany 2020.

For most of my career, my research has focused on the evolution, development, and functional significance of leaf shape: physical, tangible forms in space. However, in this essay, I'm not going to address leaf shape, but instead leverage some of the other 14 definitions of shape (https://www.merriamwebster.com/dictionary/shape) to reflect on where I see the BSA today, on our "national aspirational capacity for botanical education" at the undergraduate level, and on teachable moments for botanists presented by the human emotional need for plants in a pandemic.

ACKNOWLEDGMENTS

I thank Marsh Sundberg for generously sharing his data files. I am also grateful to Charlie Henry for combing through 154 college catalogs on-line to document their course offerings in basic plant biology.

By Cynthia S. Jones
Department of Ecology and Evolutionary Biology
University of Connecticut, Storrs, CT 06269 USA

The BSA was formally established in 1893 to "unify and subserve the botanical interests of the country" (Diggle, 2013). A scroll through the Past Presidents on the BSA website shows that the Society elected its first President in 1894. Between 1984 and 1972, only 3 out of 78 presidents were women. Since 1972, the percentage of women serving in this role has gone up by an order of magnitude relative to the period preceding 1972 (Fig. 1). Why focus on 1972? In 1972, Title IX became law. Title IX stated that no person could be denied participation in, or reap benefits from, or be subjected to, discrimination in any educational program or activity receiving federal assistance on the basis of their sex. Shortly after, in 1973, the Supreme Court decision *Roe v. Wade* gave women rights associated with reproductive choice. Both of these events accompanied a new phase of the women's movement *and the BSA responded*. Clearly, intention and effort can change scientific societies, even if it takes 50 years!

Recent events have led to heightened reflection on the role of race and ethnicity in perpetuating inequities, and the BSA is owning its part in this situation. We intend to create a more equitable and welcoming Society. We will make every effort possible to fight discrimination against people who are black, indigenous, or persons of color. We acknowledge that we have a lot of work to do: optional responses to this year's membership form show what we all already know: over 50% reported as white (Fig. 2), and the actual

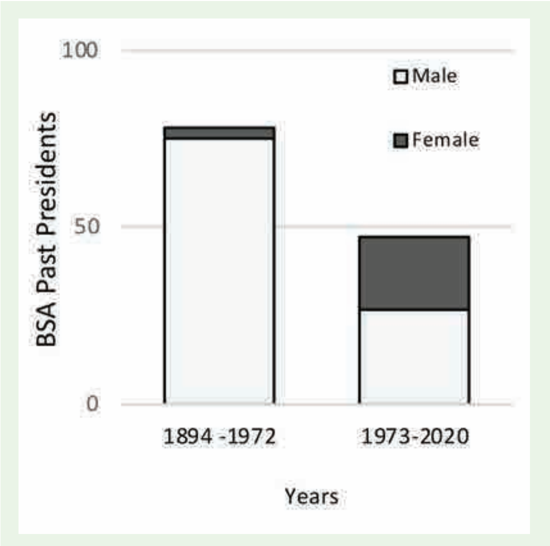


Figure 1. *Past Presidents of the BSA. Prior to 1972, 4% were female; since then, 43% have been female.*

percentage is likely higher as some if not most of the 30% who declined to report may be white. We will strive harder to become more diverse, such that we become a scientific society where the contributions of BIPOC members are welcomed, recognized, and celebrated.

What actions is the BSA taking? This Fall, the BSA is embarking on a new strategic plan that will define the Society's priorities for the next five years. Diversity, Equity and Inclusion (DEI) will be one of four pillars of this plan. In the shorter term, BSA staff and the BSA Board of Directors and the Committee on Committees will undergo training in Diversity, Equity and Inclusion. At Botany 2020 Virtual, we hosted our first BIPOC Mixer for members and their allies, and we also hosted an open forum on diversity. The Executive Director is working with the BSA Committee on Diversity, Equity and Inclusion on new tracking metrics that will allow us to tell if our initiatives are working, and beginning this Fall we will revamp the

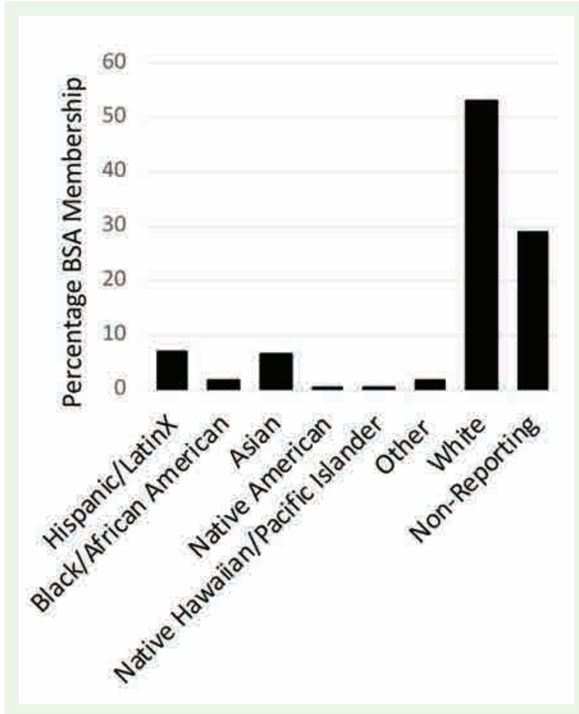


Figure 2. *Percentage of members reporting race and ethnicity data based on BSA 2020 membership renewal.*

process of selecting candidates for leadership positions and membership on committees with the goal of making these processes as equitable, accessible, and transparent as possible. Finally, the BSA will support initiatives, such as Black Botanists Week, that are independent of the BSA but that support and encourage BIPOC researchers, educators, and others who are passionate about plants.

Changing themes of this essay, I want to relate a story. In the late 1990s, I had a student in a course who seemed unhappy. The second week, I mentioned that I had noticed her demeanor. She responded that she didn't really "like" plants, but that she was a senior and she needed the course to fill a graduation requirement. We talked about strategies for approaching the course and in the end she did well. As she turned in her final exam, she said, "I don't know if I should thank you or not." I was surprised and responded that I had been under the impression she liked the course. She replied, "Well, yeah, but life was less complicated when I looked at the side of the road and just saw a lot of green." Now, "I see individual plants… it makes my brain work too hard."

This conversation was my first realization that when many people, including students, view a scene with vegetation such as Fig. 3A, they are seeing something more like in Fig. 3B: a smear of green. It is worth noting that seeing a smear of green isn't bad. Color phycologists will tell you that most people report feeling calm and restored after seeing green (Elliot and Maier, 2014). In fact, one of the first publications describing the "moral associations" of humans to color was by Johann Wolfgang von Goethe, translated into English by C. L. Eastlake in 1840 (Goethe, 1810). In his treatise *Theory of Colours*, Goethe wrote of green that "the eye experiences a distinctly grateful impression from this colour" (p. 316). But as botanists, we don't see a smear of green: we see diversity (Fig. 3C). We see shapes, colors, interactions, and species. We study how diversity evolved, how it is maintained, and how diversity will respond to climate change. We know that plant diversity forms the cornerstone of ecosystem stability and resilience (e.g., Tilman et al., 2014; Anderegg et al., 2018).

Given the importance of plant species diversity in terms of ecosystem responses to climate change, I wondered whether the concept of diversity had yet infiltrated how botany is presented in what I think of as mainstream information. The answer is "not really." Googling "botany" brought up five sites at the top of the page. The first is a definition of botany. The second is Wikipedia,

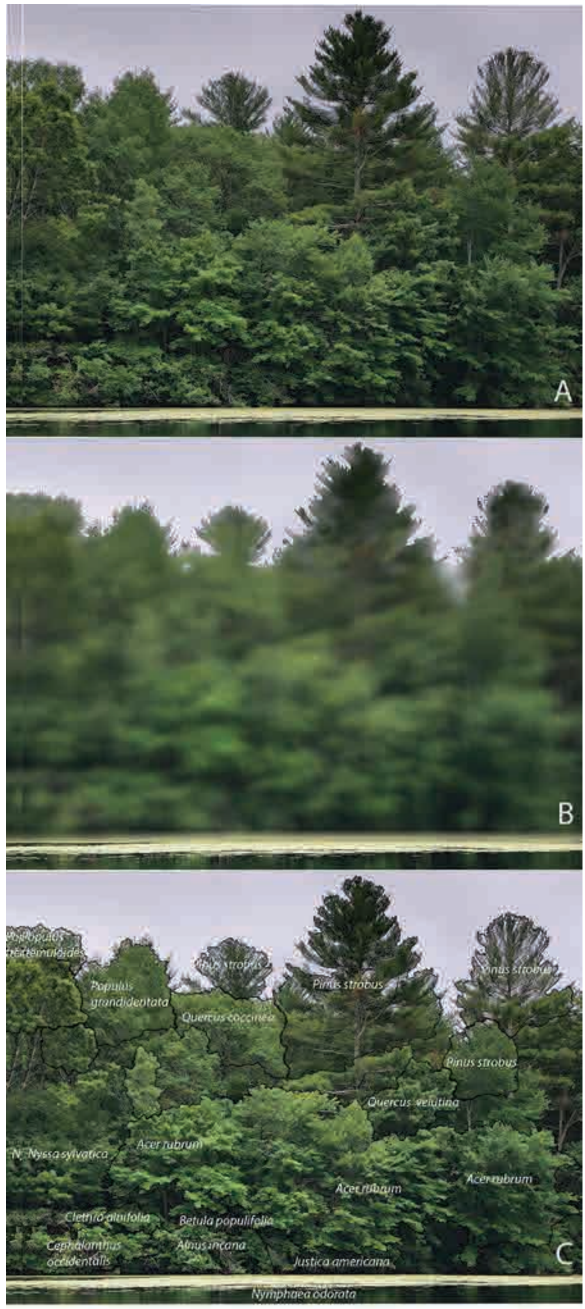


Figure 3. *A, New England forest on the edge of Echo Lake, Mansfield Center, CT. Photo taken by the author. B, The author's impression of what students see. C, What botanists see.*

which mentions biodiversity in the last line at the end of the fourth paragraph. An entry in Britannica follows that does not mention diversity. Fourth is the BSA site that mentions major groups of plants. The fifth site describes careers in environmental science (https://www.environmentalscience.org/). The introduction to Botany at this latter site makes no mention of diversity, but does include a statement I questioned: “Many of the top universities have botany degrees, but there has been a decline in recent years of students taking botany in favour of other environmental and natural sciences.” Is this true? Do many of the top universities have botany degrees? Has there been a decline in recent years in students taking botany?

While not addressing these questions directly, surveys of course catalogs of institutions of higher learning provide some insights. Marsh Sundberg (2004) published one such survey that provides baseline data. In 2008, Sundberg revisited the same course catalogs and updated the information for a talk he presented at Botany 2008 (http://2008.botanyconference.org/engine/search/index.php?func=detail&aid=194). Using the Sundberg 2008 data set as a starting place, we revisited course catalogs of the same 154 institutions. We searched for Botany Departments or any department with Botany in its name. I assumed the number of departments with “Botany” in the name would be correlated with the numbers of departments that award degrees in botany, with the caveat that some institutions that had removed Botany from the name of their department could retain a botany degree.

Even in 2004, with a few exceptions, only Research Universities had Botany departments. Of those surveyed in 2004,

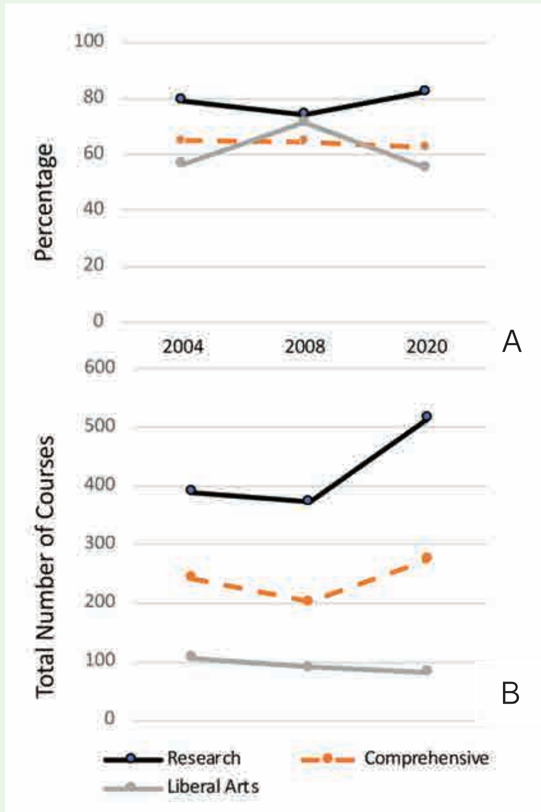


Figure 4. *Data based on course catalogs from 154 institutions of higher education. A, Percentage of institutions offering freshman level courses. B, Total number of courses beyond freshman level offered in each category. Numbers of institutions included in the study: in 2004, 58 research institutions, 60 comprehensive institutions, and 55 liberal arts colleges; in 2020, 57 research institutions, 48 comprehensive institutions, and 49 liberal arts colleges.*

41% had departments with Botany in the name. By 2020, that number had dropped to 12%, indicating that in fact “most of the top universities” no longer offer botany degrees.

The second issue raised on the “Environmental Science Introduction to Botany” website was that there has been a decline in the number of students enrolling in botany courses. I did

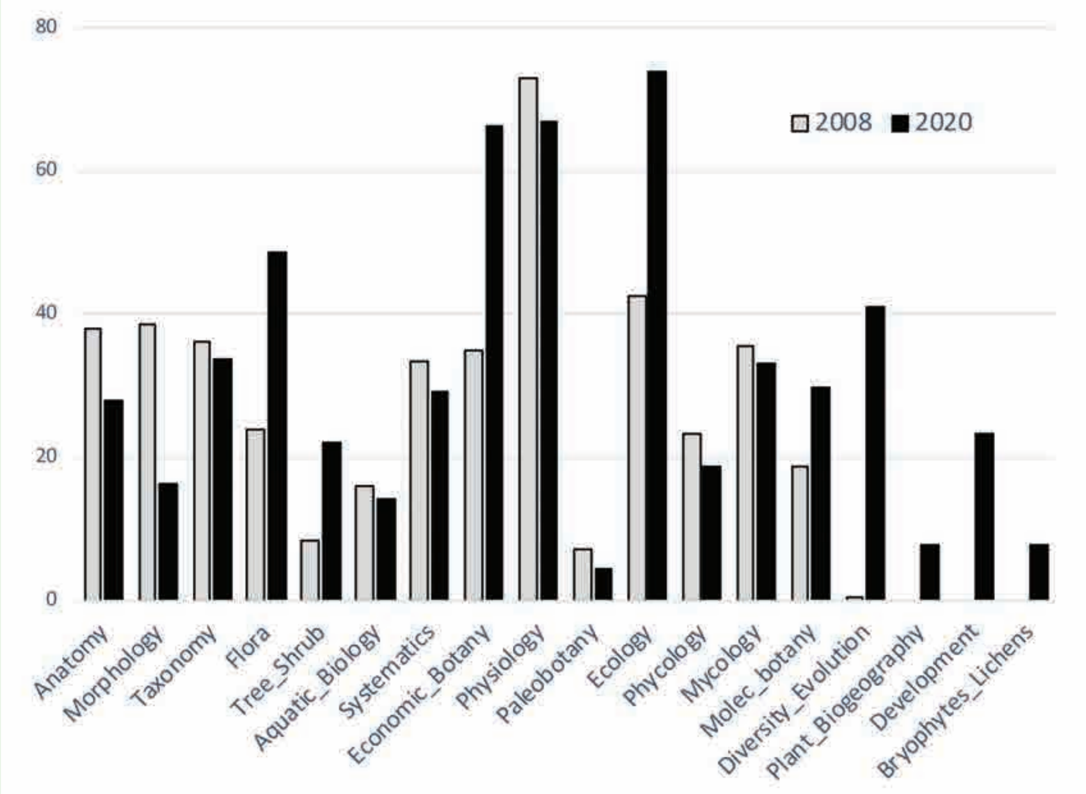


Figure 5. *Percentage of institutions offering courses in various botanical disciplines and areas of student. Grey = 2008, black = 2020.*

not investigate enrollment numbers, but we were able to record courses offered in course catalogs. More generally, I was interested in whether the decline in "Botany" departments translated to a decline in botanical education at the collegiate level. Assuming that institutions of higher learning update their catalogs periodically and drop (most) courses no longer offered, and assuming that these institutions do not continue to support courses with low enrollments, we looked at the percent of these 154 schools offering courses that were primarily focused on basic plant biology as a proxy for enrollments. We found that at the freshman level, there has been very little change in the number of the introductory courses focused on botanical instruction (Fig. 4A). The very good news is that there also has been no decline in the numbers of courses offered above the freshman level (Fig. 4B). In other words, our "national aspirational capacity" for instruction in the fundamental biology of plants appears to be as strong today as it was 16 years ago, despite the dramatic decrease in the number of botany departments! Considering different types of courses, the general distribution is roughly the same (Fig. 5), although new courses (e.g., Plant Development or Evolution and Diversity) have been added as others (e.g., Morphology) have declined.

Botany classes are especially important because our labs satisfy many criteria for creating excellent learning opportunities (e.g., Nilson, 2010). They are multimodal, active,

Figure 6. *Botany labs provide engaged learning opportunities.*

and engage multiple senses and incorporate many of the skills necessary for STEM education, such as graphing, data analysis, and observation-based hypothesis testing (Fig. 6). Our labs also present plant diversity in ways that images and lectures cannot accomplish. Often not appreciated, our labs have the potential for unusually high levels of student engagement because they include living material, as compared to most modern animal-oriented courses.

Providing living material comes with a fairly high cost, especially if the material is provided by greenhouses. Greenhouses are expensive to build and to maintain, and we periodically hear examples of universities that make the decision not to continue to support them, especially if the greenhouses are not tied to research. Data always help make the case to administrators that greenhouses are critical to basic plant biology education, but I've never seen any multi-institutional data on greenhouse use or support. (Please contact me if you know of any!) To address this data gap, I published a survey in the February 2020 issue of the BSA's monthly e-mail newsletter. I also submitted the survey to the Association of Research and Educational Greenhouse Curators. In total, about 100 valid surveys were returned. Although that is a fairly low return rate, each of the valid responses was from a different institution. Seventy-three percent of responses were from institutions in the U.S. or a U.S. protectorate. Eighty percent of responses were from public institutions, and half of those had more than 20,000 undergraduates. Only 10% were from respondents who described their institutions as "primarily applied," as opposed to "primarily basic" or "combined." The survey results were similar so all institutions were combined. Ninety-seven percent of respondents teach courses in basic plant biology, and of those, 95% viewed the use of living plants for teaching as extremely important or very important.

Eighty-eight percent of the respondents indicated that they have greenhouses that are used for teaching, outreach, or undergraduate research. The modal number of plant species used primarily in teaching was between 50 and 200 species (Fig. 7A), although a fair number of institutions use more than 200 species per year. Most respondents indicated that between 100 and 500 undergraduate students are taught per year, although in some institutions the number is much higher (Fig. 7B).

Also relevant to the question of institutional support for greenhouses is, who paid for their construction? Greenhouse sizes are generally between 1000 and 10,000 square feet (Fig. 7C), Construction was funded most commonly by the educational institution, or by some

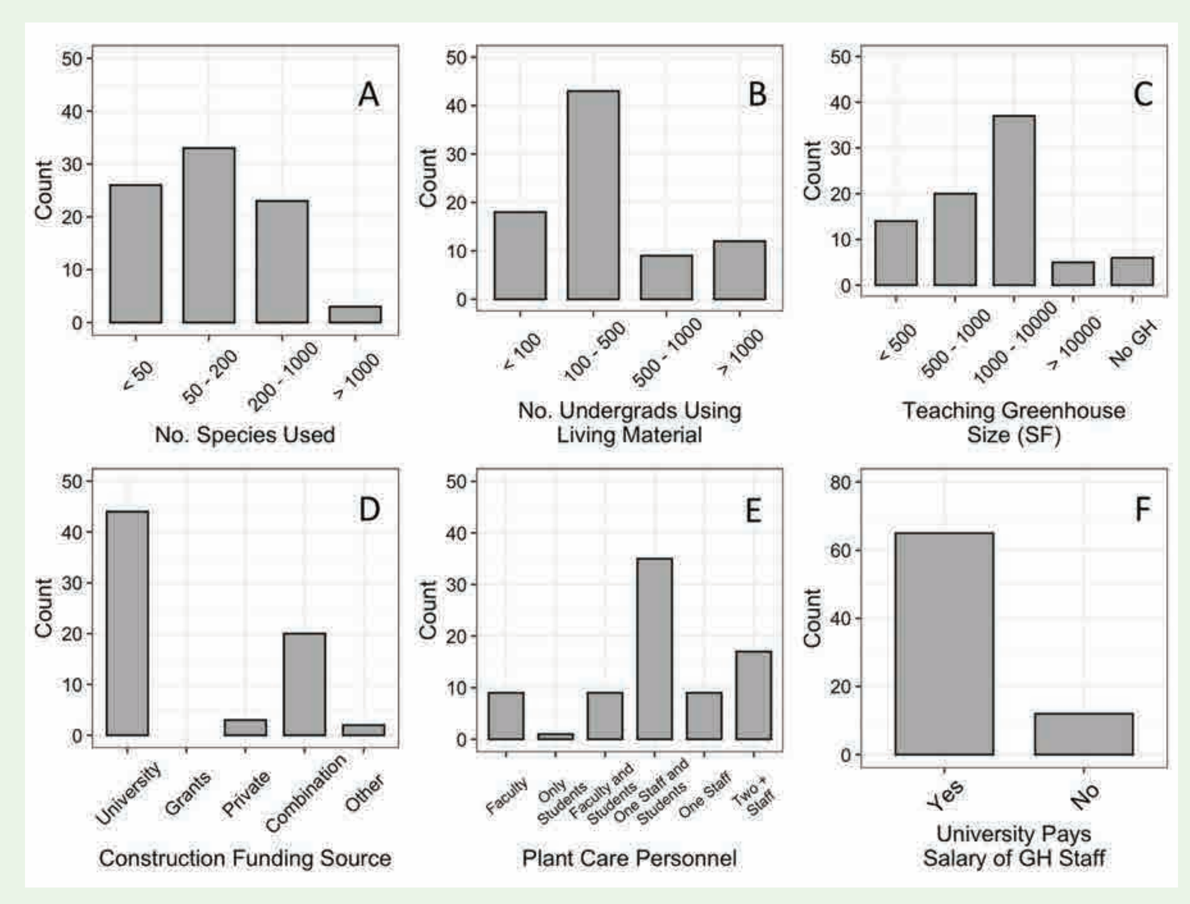


Figure 7. *Results from Survey of Greenhouse Use and Support. A, Numbers of plant species from greenhouses and outdoor space used for teaching. B, Number of undergrads using living materials. C, Size of greenhouses used for undergraduate teaching or research. D, Categories of funding sources for greenhouse construction. E, Categories of plant care personnel. F, Source of salary for plant care personnel.*

combination of funding sources (Fig. 7D). Most respondents indicated that greenhouses are staffed by a paid staff member, as well as students, and of those institutions with paid staff, most are funded by the institution (Fig. 7E, F). This represents significant financial investment in greenhouses that support undergraduate teaching and research.

Perhaps the most interesting finding of the study was that 61% of teaching and 48% of research greenhouses are more than 20 years old, with a significant proportion of those older than 30 years (Fig. 8). Traditional greenhouses have a life span of about 30 years, so if these data are nationally representative, more than 50% of greenhouses used for teaching should be replaced in the next 20 years. Given the current cost of constructing greenhouses and declining state support for public institutions of higher learning, the current age of more than half of the greenhouses used nationally for teaching ***presents a serious threat to our ability to continue to provide immersive learning experiences in basic plant biology***, a threat I perceive as especially dire given the critical role of plants in mediating Earth's response to climate change.

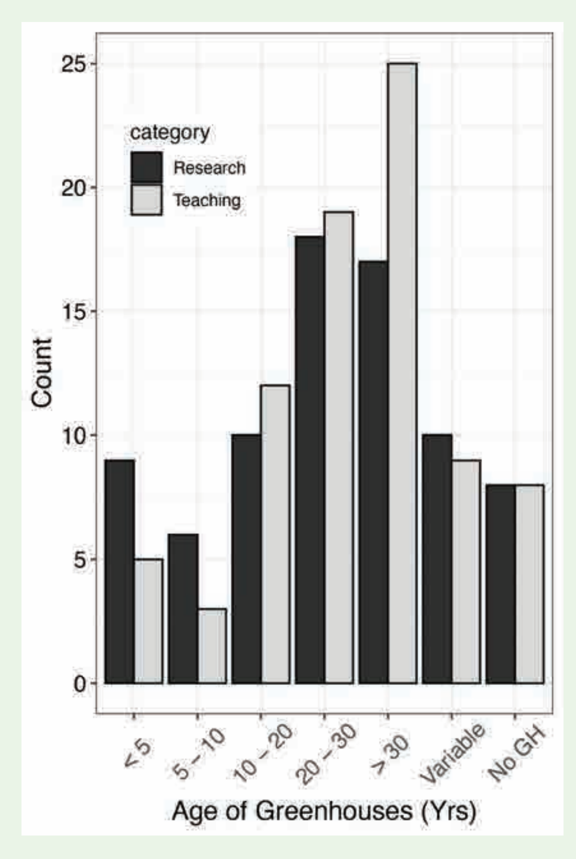


Figure 8. *Ages of greenhouses used for undergraduate teaching and research (grey) and research only (black).*

Perhaps the single most important thing we can do now is to recognize this looming threat and form a collective voice. In addition to making our federal agencies aware of this potential national decline in our ability to provide high-quality education in basic botanical education, there are several possible actions those of us currently facing greenhouse replacements are familiar with: inviting governmental representatives to view the greenhouses and how they are used, educating administrations on the critical role of plant biology relative to sustainability and climate change, aligning our greenhouses with the strategic plans of the universities, and identifying opportunities to involve the greenhouses in campus-wide initiatives.

In addition to these approaches, we also can and should emphasize to administrators the important role of plants and greenhouses as well as spending time in nature for the mental health of students. Numerous studies are showing that spending time in nature is beneficial to health (Lai et al., 2019; Robbins, 2020). The idea that academic greenhouses could contribute toward improving mental health was first brought to my attention when I learned of a program called NatureRx@ Cornell. A group of Cornell faculty and administrators recognized that today's college-age students experience stress, depression, anxiety, and other mental health issues at unprecedented levels. At the same time, this group was aware of recent research showing that there are many positive mental and physical health outcomes associated with spending time in nature. Relative to college-aged students, time in nature reduces stress, anxiety, depression, and aggressive feelings, as well as leading to increased happiness and life satisfaction and increased social connection, especially if nature is experienced with a friend. College students may be especially interested in studies showing that spending time in nature improves concentration, recall, and immune function. NatureRx@ Cornell is a program in which mental health providers write prescriptions for students to spend time in natural areas on or near campus and is described in detail in a book by Dan Rakow and Greg Eells, two of the founders of NatureRx@Cornell (Rakow and Eells, 2019). (For a list of steps to start a NatureRx program at your institution, see Box 1.)

For general background on the history of ideas and scientific literature demonstrating the mental health benefits of spending time in nature, I recommend The Nature Fix (Williams, 2017). This well-researched book

BOX 1
Steps for starting a NatureRx Program at your institution
(from Rakow and Eells, 2017; used with permission)

1. Organize a committed group.
2. Secure the support of the Administration.
3. Inventory green spaces on campus.
4. Engage the students.
5. Partner with campus health services.
6. Develop an app or website.
7. Impact the academic program.
8. Develop an approach to evaluation.
9. Identify and overcome the challenges.
10. Model the behavior.

reviews the hypotheses behind why spending time in nature makes us feel better, but to date, the actual mechanisms remain unclear (Lai et al., 2019). Two of the first researchers in this field, Rachel and Stephen Kaplan (1989), proposed, what is now known as Attention Restoration Therapy. This hypothesis states that prolonged use of directed attention, which by definition is voluntary (e.g., many jobs, academic study), causes mental fatigue and stress. Even brief periods in the natural world provide a level of involuntary fascination that allows directed focus to rest and recover. Ulrich et al. (1991) subsequently proposed the Stress Reduction Theory, arguing that nature lowers stress immediately, and lowering of stress then allows recovery. Research from Japan has shown that phytoncides, volatile organic compounds produced by some plants (e.g., pines, oaks, onions), reduce sympathetic nerve activity, and therefore blood pressure, and boost immune activity when taken in through our nasal passages (Li et al., 2009). Many psychologists also subscribe to the idea of "Biophilia" originally proposed by Eric Fromm and later reiterated in a slightly different form by E. O. Wilson (1984), which is the idea that humans have an "innate" (i.e., genetically predisposed) emotional affiliation with other living organisms.

In addition to the simple fact that being around plants is beneficial, and by extension that being in a greenhouse is beneficial, there is need for more research on the link between botanical education and mental health effects. We already know from decades of research that educating children outdoors increases academic performance in a range of areas. What we do not know is how the mental health benefits of being in nature interact with the stress associated with memorizing a fact. Are the positive effects of phytoncides achieved if attention is directed, for example, to learning a species name? Is it possible that simply because our botany labs use living materials, compared to labs based on non-living material, our students are more engaged, successful, happier, or creative?

This connection between mental health and plants extends beyond the classroom. If there is any silver lining in this horrible pandemic, it is that people are turning to plants for comfort! Seed companies sold out this year (e.g., Pierre-Louis, 2020), gardening supply stores are seeing high volumes, people are sharing photos of their house plants, and local parks have closed early in the day because they are so crowded. How can we turn this rekindled connection to plants into curiosity about them? Even during this pandemic, there are many possibilities and we should share ideas. We can volunteer to lead fall "flower walks" for the public, or within universities consider activities that link botany to mental health and offer socially distanced tours of the greenhouses or natural areas near campus to small groups, or as instructors, conduct as many labs outside as possible. A recent study conducted at UC Santa Cruz (Beltran et al., 2020) demonstrated that students from four demographic categories (underrepresented minority students, first-generation, students from families with low income, and gender) benefit from participation in field courses. Over five years, this participation was linked to higher gains in self-efficacy, higher retention in ecology and evolutionary biology majors, and higher rates of graduation as compared to lecture-based courses. In other words, students who choose these courses benefitted significantly beyond the knowledge gained from course content.

The main points of this essay can be summarized by two quotes from Goethe, both from *Theory of Colours*. In the preface to the book, he wrote, "*Every act of seeing leads to consideration, consideration to reflection, reflection to combination, and thus it may be said that in every attentive look to nature, we already theorize*" (p. xx). To me, this quote encapsulates the essence of teaching. The second quote speaks to the second part of this essay: "*And thus as we descend the scale of being, Nature speaks to other senses – to known, misunderstood, and unknown senses: so speaks she with herself and to us in a thousand modes*" (p. xviii). This year, more than a quarter of members in the BSA are students. This is a remarkable achievement and is essential for the future of the Society. The Society is in good shape and we have a very bright future. With intention, we can change. We can become a more diverse Society that supports botanical endeavors from multiple perspectives.

LITERATURE CITED

Anderegg, W. R. L., A. G. Konings, A. T. Trugman, K. Yu, D. R. Bowling, R. Gabbitas, D. S. Karp, et al. 2018. Hydraulic diversity of forests regulates ecosystem resilience during drought. *Nature* 561: 538-541.

Beltran, R. S., E. Marnocha, A. Race, D. A. Croll, G. H. Dayton, and E. S. Zavaleta. 2020. Field courses narrow demographic achievement gaps in ecology and evolutionary biology. *Ecology and Evolution* 10: 5184-5196.

Diggle, P. 2013. Learned societies - Past, present and future? *Plant Science Bulletin* 59: 150-157.

Elliot, A. J., and M. A. Maier. 2014. Color psychology: effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology* 65: 95-120.

Goethe, J. W. v. 1810. *Goethe's Theory of Colors*: Translated from the German, with Notes by Charles Lock Eastlake, R.A., F.R.S, Retrieved 20 September 2020 via Internet archive. John Murray, London, England U.K.

Kaplan, R., and S. Kaplan. 1989. *The Experience of Nature: A psychological perspective.* Cambridge University Press, New York, NY.

Lai, H., E. J. Flies, P. Weinstein, and A. Woodward. 2019. The impact of green space and biodiversity on health. *Frontiers in Ecology and the Environment* 17: 383-390.

Li, Q., Y. Wakayama, R. Inagaki, M. Katsumata, Y. Hirata, T. Shimizu, T. Kawata, et al. 2009. Effect of phytoncide from trees on human natural killer cell function. *International Journal of Immunopathology and Pharmacology* 22: 951-959.

Nilson, L. B. 2010. *Teaching at its best: A research-based resource for college instructors*, ed 3, pp. 3-15. Jossey-Bass, Wiley Imprint.

Pierre-Louis, K. 2020. Panic buying comes for the seeds. *The New York Times*, New York, New York, USA.

Rakow, D. A., and G. T. Eells. 2019. *NatureRx: Improving College-Student Mental Health.* Cornell University Press, Ithaca, New York.

Robbins, J. 2020. Ecophychology: How immersion in nature benefits your health, YaleEnvironment360. Yale School of the Environment, New Haven, CT.

Sundberg, M. D. 2004. Where is botany going? *Plant Science Bulletin* 50: 2-6.

Tilman, D., R. Isbell, and J. M. Cowles. 2014. Biodiversity and ecosystem functioning. *Annual Review of Ecology and Systematics* 45: 471-493.

Ulrich, R. S., R. F. Simons, B. D. Losito, E. Fiorito, M. A. Miles and M. Zelson. 1991. Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology* 11: 201-230.

Williams, F. 2017. *The Nature Fix*. W. W. Norton & Company, New York, NY.

Wilson, E. O. 1984. *Biophilia*. Harvard University Press, Cambridge, MA.

Advocate for Botany and Science!

The joint BSA Public Policy and ASPT Environmental and Public Policy Committees strive to connect membership to relevant public policy resources, actions and activities.

Join the BSA Slack #public_policy channel to learn about late-breaking public policy issues and ways that you can get involved to advocate for plants and science! Get started at https://cms.botany.org/home/membership/bsa-slack.html.

In this issue, we showcase the work of a member involved in a local policy topic that may be of interest to many within the societies. Dr. Naomi Fraga's work also provides an excellent example of the ways in which the scientific community can affect meaningful change for biodiversity conservation.

By BSA PPC Co-Chairs **Krissa Skogen** *(Chicago Botanic Garden) and* **Tanisha Williams** *(Bucknell University) and ASPT PPC Chair* **Naomi Fraga** *(California Botanic Garden)*

JOIN #TEAMBUCKWHEAT

By Naomi Fraga

Eriogonum tiehmii Reveal (Tiehm's buckwheat, Polygonaceae) is endemic to the Silver Peak Range in Esmeralda County, Nevada, about halfway between Reno and Las Vegas. This species is at risk of extinction because its entire global population is located within the boundary of a proposed industrial lithium and boron mine. If approved, the mine would extirpate more than 60% of all the known plants (~28,000 of 44,000 plants known) and up to 30% of the total occupied habitat. Further, in a devastating turn of events, it was discovered in September 2020 that up to 40% of the global population of *E. tiehmii* was damaged or destroyed as the project awaits environmental review. This newly documented threat is currently undergoing investigation, but illustrates the extreme vulnerability of *E. tiehmii*.

As a part of the coordinated effort to support conservation of *E. tiehmii*, I along with the Center for Biological Diversity launched a plant conservation campaign on social media to urge the botanical community to "join #Teambuckwheat to save Tiehm's buckwheat." In July 2020, over 80 #TeamBuckWheat supporters showed up to the 3.5-hour workshop, and over 100 scientists signed a letter advocating for the addition of Tiehm's buckwheat to the Nevada list of endangered flora. We now have the opportunity to broaden our network and leverage support from the botanical community via the BSA Slack #public_policy channel. If you'd like to learn more about conservation efforts such as this, please join our network. We will share current information related to conservation issues, and especially those that will benefit from a call to action.

ASSESSING GRAZING IMPACTS ON REMOTE MONTANE MEADOWS IN THE SOUTHERN SIERRA NEVADA, TULARE COUNTY, CALIFORNIA

By Nina House

I am a Master's student in Botany at the California Botanic Garden and Claremont Graduate University, currently undertaking a floristic study of the Manter and Salmon Creek watersheds in the southern Sierra Nevada, Tulare County, CA. The primary goal of my study is to conduct a systematic inventory of the vascular plant diversity of the region, but I am also collecting data on disturbances and threats to plant diversity. One notable disturbance in the study area is cattle grazing in montane meadows. I am interested in studying and communicating the impacts of cattle grazing, since my research interests extend to plant conservation, land management, and disturbance regimes. My hope is that this project will provide tangible data that can help improve management practices.

Montane meadows are an incredibly species-rich ecosystem (Jones et al., 2019). Although they make up only 10% of the land area within the Sierra Nevada, they are an essential component for the health of wildlife and humans (Ratliff, 1985). Montane meadows play a critical role in water storage and cleanliness, acting as the kidneys of a watershed as they filter out sediments and debris from water flowing downhill (Blank et al., 1995). Additionally, 50% of California's domestic water comes from Sierra Nevada watersheds, demonstrating the distinct role that meadows play in water quality for millions of people across the state (McIlroy and Allen-Diaz, 2012). However, when not managed sustainably, grazing by cattle can lead to altered species composition, trampled soil and plants, altered hydrology, and the spread of non-native species (McIlroy and Allen-Diaz, 2012). Further, when combined with other threats and disturbances within the region, including altered fire regimes, drought, climate change, and increasing recreation, these vital habitats may be significantly altered.

It is often difficult to assess the exact consequences of grazing, since impacts can vary depending on the timing, duration, and intensity of use (McIlroy and Allen-Diaz, 2012). Knowing the types of data to collect and who to approach with concerns can make all the difference in improving management of grazing in montane meadows. Laura Cunningham, California Director of the Western Watershed Project, has been working to document the impacts of cattle grazing in montane meadow systems in the southern Sierra Nevada (Figure 1). Through the help of the Botanical Advocacy and Leadership Grant, funded jointly by both the Botanical Society of America and the American Society of Plant Taxonomists, I have had the privilege of inviting Laura to my study site so I can learn more about how to document these disturbances in a way that can inform future forest management.

During one trip in July 2020, Laura and I visited three montane meadows located within my study site. Manter Meadow occurs within the Domeland Wilderness and represents a relatively undisturbed montane meadow that has seen little in the way of recent cattle grazing (Figure 2). We also visited two meadows outside of designated wilderness, Big Meadow and Horse Meadow, that reside in active grazing allotments (Figure 3). Laura demonstrated how to document a variety of meadow health indicators, including: stream bank height, stability, water color, sediment deposition in streams, trampling, presence of tufted hair grass (*Deschampsia cespitosa*, Poaceae), percentage of bare ground, vegetation height, and location of fencing. Our initial observations indicated that there is a difference in the ecosystem health of the heavily grazed vs. minimally grazed meadows in my study site. In Manter Meadow, stream banks were high and were stabilized by tall vegetation. We observed clear water along streams and small rocks that were unburied by sediment. These kinds of habitat characteristics provide trout with a secure place to lay their eggs. There was little bare ground, and *D. cespitosa*, an indicator species for meadow health, was seen throughout the meadow. In contrast, Big Meadow and Horse Meadow displayed several impacts from grazing, including trampled and collapsing

Figure 1. *Laura Cunningham, California Director of Western Watershed Project, and I worked together to document grazing impacts in three meadows in my study site. Here she can be seen measuring the height of vegetation in the heavily grazed Big Meadow.*

Figure 2. *Many montane meadows throughout the Sierra Nevada, such as Big Meadow (pictured), see active cattle grazing from June through September each year.*

Figure 3. *Manter Meadow represents a montane meadow that has seen little in the way of recent grazing.*

springs and stream banks, brown water, and a deep sediment layer. These characteristics are known to negatively impact populations of fish and aquatic invertebrate that make their homes in and downstream from montane meadows (Herbst et al., 2012). *Deschampsia cespitosa*, while present, was often absent of reproductive features due to being grazed by cattle. Finally, large patches of bare ground were present in both grazed meadows, and in Horse Meadow the bare patches were particularly sizable.

Laura and I are now collaborating on a report to the Sequoia National Forest that will include our observations and recommendations for grazing management. These recommendations include additional fencing around springs and streams in both Big Meadow and Horse Meadow to enhance water quality and prevent the collapse of stream banks. Additionally, in Horse Meadow, we recommend reducing cattle density and, in both Big and Horse Meadows, periodic off-years would allow for the rejuvenation of meadow vegetation. In addition to our report, we also hope to interact directly with forest service staff to discuss our findings and suggestions.

I would like to thank the American Society of Plant Taxonomists and the Botanical Society of America for providing the Botanical Advocacy Leadership Award. Through this award I will be able to provide scientific information that may lead to management changes in important ecosystems. With the reports and publications that result from this work, I hope I can inform future policy. I would also like to thank my Master's thesis advisor, Dr. Naomi Fraga, who has assisted with the synthesis and implementation of this project. I am grateful to Laura Cunningham for taking the time to work with me and share her knowledge of meadow management. Her work evaluating grazing impacts on meadow health is timely and much needed! Finally, I would like to thank the California

Figure 4. *The Salmon Creek (pictured) is currently under review for designation as a Wild and Scenic River. Running through both Horse Meadow (pictured) and Big Meadow, it receives heavy impacts from grazing, as can be seen here in the way of collapsing banks.*

Botanic Garden for their continued financial, educational, and moral support as I work to complete my floristic inventory of the Manter and Salmon Creek watersheds (Figure 4). My hope is that through greater knowledge of our flora and the impacts of cattle grazing, we will spark change in forest management and work to conserve and protect montane meadows throughout the Sierra Nevada mountain range.

LITERATURE CITED

Blank, R. R., T. J. Svejcar, and G. M. Riegel. 1995. Soil genesis and morphology of a montane meadow in the northern Sierra Nevada range. *Soil Science* 160: 136-152.

Herbst, D. B., M. T. Bogan, S. K. Roll, and H. D. Safford. 2012. Effects of livestock exclusion on in-stream habitat and benthic invertebrate assemblages in montane streams: Stream recovery and livestock grazing exclusion. *Freshwater Biology* 57: 204–217.

Jones, J. A., R. Hutchinson, A. Moldenke, V. Pfeiffer, E. Helderop, E. Thomas, J. Griffin, and A. Reinholtz 2019. Landscape patterns and diversity of meadow plants and flower-visitors in a mountain landscape. *Landscape Ecology* 18.

McIlroy, S. K., and B. H. Allen-Diaz. 2012. Plant community distribution along water table and grazing gradients in montane meadows of the Sierra Nevada Range (California, USA). *Wetlands Ecology and Management* 20: 287–296.

Ratliff, R. D. 1985. *Meadows in the Sierra Nevada of California: State of knowledge* (No. PSW-GTR-84; p. PSW-GTR-84). https://doi.org/10.2737/PSW-GTR-84.

SPECIAL FEATURES

Diversity and Inclusion in the Sciences: Relationships and Reciprocity

I was honored to present during the Botany 2020 session "Enhancing scientist diversity in plant biology." I am Deg Xit'an (Dene'/Athabascan), a member of the Shageluk Tribe of interior Alaska, and research professor of Indigenous Studies at Alaska Pacific University. Alaska Pacific University (APU) is a small private institution located in Anchorage, Alaska and is currently pursuing tribal university status. I recently transferred from the University of Alaska Anchorage, where I served as professor of Alaska Native Studies from 2016 to 2020 to APU. APU's board of trustees recently appointed a Yup'ik woman—Valerie Davidson,[1] an attorney/health fields scholar—as president, a first for that institution.

My academic background includes linguistics, education, and cross-cultural and Alaska Native/Indigenous studies. In terms of the natural sciences, my undergraduate courses were limited to "natural history of Alaska" and "human osteology." However, as a member of the Deg Xit'an (Dene'/Athabascan) nation, my personal experiences include place- and land-based education, since Alaska Native peoples have thousands of years of knowledge[s] around place and land. As my thinking around science progressed, I began to think of Alaska Native and Indigenous ways of knowing as science(s), rather than "just" ways of knowing. This essay focuses on Alaska Native and Indigenous perspectives, although the processes of diversity and inclusion obviously need to be engaged more broadly.

By Beth *Ginondidoy* Leonard
Research Professor of
Indigenous Studies
Institute of Culture
and Environment
Alaska Pacific University

THE ALASKAN CONTEXT AND PERSONAL HISTORY

Research on Alaska Natives is often combined with American Indians, and researchers tend to gloss over the unique and diverse contexts of Alaska Native nations (Figure 1). For example, Alaska Natives make up almost 20% of Alaska's population,[2] there are at least eight

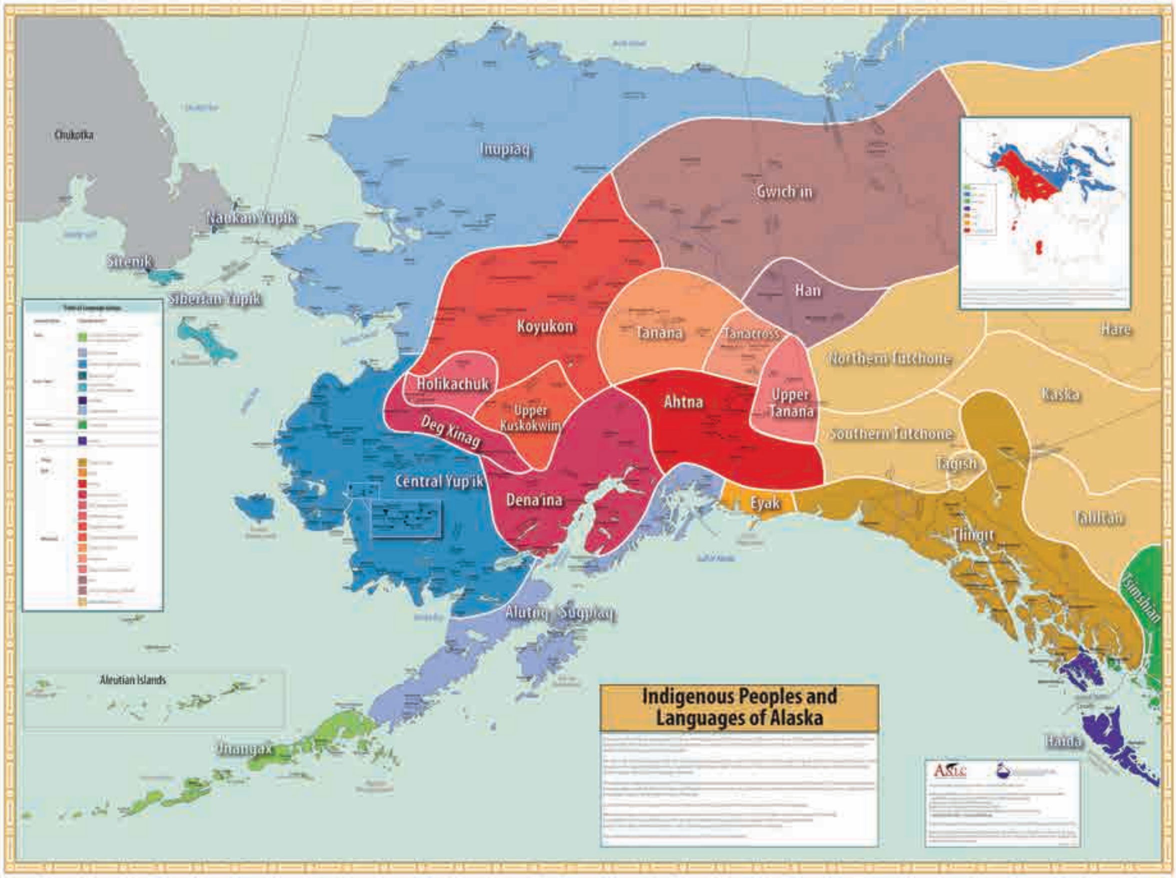


Figure 1. Indigenous peoples and languages of Alaska map. (From Krauss, M., G. Holton, J. Kerr, and C. T. West. 2011. Indigenous Peoples and Languages of Alaska. Fairbanks and Anchorage: Alaska Native Language Center and UAA Institute of Social and Economic Research. Website: https://www.uaf.edu/anla/map.)

distinct cultural groups, 229 federally recognized tribes, 20 official Indigenous languages,[3] 12 Alaska Native Claims Settlement Act (ANCSA) regional corporations,[4] and over 200 ANCSA village corporations. Alaska Native students are 24% of the K-12 population, a significant percentage when considering the diversification of STEM fields. Native peoples have thousands of years of knowledges/ sciences and relationships with specific lands or regions around Alaska, and archaeological evidence suggests that Athabascan peoples have been living in interior Alaska for at least 12,000 years.

Deg Xinag (literally, "language from around here") is the westernmost Dene'/Athabascan language, a region that stretches from Holy Cross, Alaska to Hudson Bay in Canada. I grew up in the *Deg Xit'an* ("people/beings from around here") communities of Shageluk and Anvik in the 1960s and 1970s and because of socio-historical circumstances did not learn my heritage language. As a second language learner of *Deg Xinag,* however—a process that began in my early 30s—I found that the language provided a doorway into the scientific worldview of the *Deg Xit'an* peoples whose terms for plants reflect complex relationships between and among humans and non-humans. Place names may also reflect the "beings" of an area; for example, my father grew up in *Didlang Tochagg*, or Spruce Slough. The spruce tree, or *didlang*, was/is one of the most useful plants to the Deg Xit'an people, providing, for example, medicine in the form of new shoots in the spring that could be collected and made into tea to treat colds; pitch, which was used for bandaging cuts and waterproofing canoes; and wood for burning, or the construction of items such as sled runners or household items. Although the term *didlang* does not have a known literal meaning, its relationship with the people of my area reflects Potawatomi scholar Robin Wall Kimmerer's observations: "In some Native languages the term for plants translates to 'those who take care of us'" (Kimmerer, 2013, p. 278). Spruce also burns at a higher temperature than other woods and is softer than birch, making it easier to work with. In terms of "plants-based" knowledge, the people of my area and other areas of Alaska maintain a reciprocal "gift" relationship with plant beings:

> "…in the gift economy, the gifts are not free. The essence of the gift is that it creates a set of relationships. The currency of the gift economy is, at its root, reciprocity…in a gift economy property has a 'bundle of responsibilities' attached." (Kimmerer, 2013, p. 28)

Indigenous peoples, before gathering plants or berries, for example, may often sing a song, or offer a prayer or gifts. Considering the current research on plants that suggests that the plant can alter its chemical structure when responding to a threat, I have often wondered if the songs or prayers or gifts also cause the plant to alter its chemistry to be perhaps more beneficial to humans when consumed as medicine and/or food. In her discussion of Indigenous knowledges, Mi'kmaq scholar Marie Battiste (2002) references the significance of protocols and time in ceremonial practices: "Indigenous knowledge is also inherently tied to land, not to land in general but to particular landscapes, landforms, and biomes where ceremonies are properly held, stories properly recited, medicines properly gathered, and transfers of knowledge properly authenticated" (p. 13).

Bang et al. (2018) also respond to Western science's beliefs around the sentience and agency, and how this has constrained scientific inquiry:

> "…from a Western perspective, plants have little agency. This logic has arguably held back emerging research on plant abilities and intelligence, as Western scientists now understand that some plants can recognize and selectively favor kin and that many plants can signal the presence of threats."

For many Alaska Native and Indigenous peoples, the Western hierarchy of humans as the pinnacle of intelligence and achievement is a foreign concept because the often-superior sensory abilities of non-humans such as plants and animals are recognized and celebrated. For example, in his discussion of Yupiaq realms of being, Oscar Kawagley's (1998, p. 4) tetrahedral metaphor places the human and natural realms on the same level. Other Indigenous scholars such as Tewa scholar Gregory Cajete (2016) highlight the abilities of plants and animals to "educate" humans on different topics such as appropriate medicines, etc. Peter John, a late Dene'/Athabascan chief from Minto, Alaska, also emphasized the importance of close relationships with the natural world: "If you look deeply enough, you'll see that animals can help us understand life as it is…animals understand you, but only if you know how to talk with them" (Krupa, 1996, p. 25).

INDIGENOUS EDUCATION: WAYS OF KNOWING, BEING, AND DOING

> "There is a shared body of understanding among many Indigenous people that education is really about helping an individual find his or her face, which means finding out who you are, where you came from, and your unique character…Indigenous education is, in its truest form, about learning relationships in context." (Cajete, 2000, p. 183)

Gregory Cajete offers both critique and solutions for education, including the concept of "learning relationships in context." Relationships and reciprocities are key to Indigenous engagement with human and non-human worlds, and in many areas of the world Indigenous "ways of knowing, being, and doing" have been maintained for thousands of years. As I began my language-learning journey, I also began to understand these relationships through examining literal translations of kinship, bird, and plant terms. For example, the term for "grandfather" is also closely related to the term for "raven." "blackbird," and "puffball mushroom," although this is not obvious through the separation of these terms under "kinship," "birds," and "plants" in the organization of topically based noun dictionaries (see chart below).

The Deg Xit'an organization of these "beings" through the Deg Xinag language conceptualizes a world of relationships and reciprocities among human and non-human realms—a world very different than the separated disciplinary world(s) presented to Indigenous students in academia. For the Deg Xit'an people, the entity Raven (sometimes referred to as "Crow") is significant as cosmological narratives document how he brought light and helped create different aspects of their environment. Raven's relationship with the puffball mushroom is likely further explained through stories; however, some of this information may have been lost with the passing of Elder storytellers.

> "Educate comes from Latin *educare*... which is derived from a specialized use of Latin *educere*...meaning 'to assist at the birth of a child'. This old meaning of the English word 'educate' is similar to our own Inupiat Eskimo word...which literally means 'to cause to become a person.'" (Okakok, 1989, p. 413)

For Alaska Native and other Indigenous peoples, goals of education might include Okakok's Inupiat translation "to cause

Deg Xinag	English	Literal translation
-tsiy	Grandfather	
Yixgitsiy	Raven	you guys/your (pl.) grandfather
Yixgitsiy Vozra'	Rusty Blackbird	Raven's nephew
Yixgitsiy Nołchidl	Puffball Mushroom	Raven's (sewing) bag

to become a person" and a Yup'ik goal of nourishing "a right mind to think with" (Barker, 1996). Part of "becoming a person/ human being" includes understanding relationships and reciprocities between and among human and non-human worlds. Similar concepts from the *Deg Xinag* language include the terms *dinayetr* (literally, "our breath/way of life, our belief system") that recognizes the responsibilities of humans to the natural world in maintaining life and balance as well as *getiy xiyo t'anh* (literally "s/he has a good mind/is able to plan ahead").

DIVERSITY IN THE SCIENCES: OPPORTUNITIES IN HIGHER EDUCATION

Garcia and Shirley (2012) frame education as a "sacred learning landscape," emphasizing the roles of institutions and teachers in nurturing critical consciousness and "origins of place" (pp. 77-78). Higher education institutions have numerous opportunities to offer authentic and interesting experiences for Indigenous students. In my experience, higher education offered a number of learning experiences and opportunities that were absent or erased in the K-12 system. For example, this was my first opportunity in a classroom setting to engage with my heritage language; a place where Deg Xinag was seen as interesting and important, rather than "primitive" and irrelevant in global contexts. It was also my first opportunity in a classroom setting to engage in any substantive way (beyond material culture) with my culture, other Alaska Native cultures, and authentic Alaska Native and Alaskan histories. Granted, institutions did and still do fixate on the "under-prepared" Alaska Native student or student-of-color, and often question the abilities of these students to finish programs and attain degrees. Institutions might consider re-orienting themselves in terms of "preparedness," i.e. universities are often "underprepared" to serve Indigenous students or students-of-color, and instead focus on educational pathways that utilize "funds of knowledge" (Gonzalez et al., 2005), decolonizing (Battiste, 2013), Indigenous and/or other educational methodologies that would enhance diversity and capacity-building in STEM fields.

Another key challenge within academic institutions is the creation and expansion of both physical and intellectual landscapes for Indigenous students and students-of-color. These students often encounter barriers as they seek to maintain their personal identities while expanding their knowledge in disciplinary fields. Institutions also suffer from a lack of Indigenous faculty and faculty-of-color. For example, Alaska Native students make up a significant percentage of students in the University of Alaska system (10%–20%), yet Alaska Native faculty numbers have never exceeded 5% (and are now closer to 3%), highlighting a significant parity issue. And there are very few, if any, Alaska Native faculty who teach and research in STEM fields in the University of Alaska system. Recently, the only two Alaska Native biology faculty teaching in the University of Alaska system relocated to universities in the eastern U.S. With relationships and reciprocity being key Alaska Native values and factors in student success, recruiting and retaining Indigenous faculty are significant challenges that can hinder that diversity and inclusion in the sciences—especially when considering recruitment of Alaska Native students into higher education. Indigenous higher education research indicates that formation of relationships (mentoring/networks) is necessary for

Indigenous student success (Pihama et al., 2019); for many Indigenous scholars, these relationships are more akin to a godmother/father relationship than a "traditional" academic mentor relationship (Leonard et al., 2020). Mentoring in an Indigenous way often goes well beyond preparation for academic writing, research, and "getting students through" their programs, to assisting with job searches, co-authoring publications and conference presentations, and continuing the relationship throughout the student's/faculty's career.

CONCLUSIONS

With current advances in science that seem to converge or negotiate parallel paths with Indigenous knowledges/sciences, and the number of groundbreaking publications by Indigenous scholars and scientists, one might ask, "Who *wouldn't* want to pursue a STEM field?" If used in science programs, *Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants* (Kimmerer, 2013), *Who's asking? Native science, Western science and science education* (Medin and Bang, 2013), *Native science: Natural laws of interdependence* (Cajete, 2016), and *Blackfoot physics: A journey into the Native American universe* (Peat, 2002) provide valuable new perspectives into the natural realms; these new perspectives and theories by established scholars are currently absent in STEM curricula. If science curricula could be renegotiated to explore its own philosophical ideologies and "other" ways of knowing, this approach could advance recruitment and retention of underrepresented students, but also "advance" scientific thought and knowledge in significant ways. Institutional changes are also necessary to recruit and retain Indigenous faculty and faculty-of-color to address parity issues. Reframing relationships in higher education and acknowledgement and action around reciprocities would extend possibilities for Indigenous students and students-of-color and might advance academia in unexpected and refreshing ways.

FOOTNOTES

[1]https://www.alaskapacific.edu/valerie-nurraraaluk-davidson-named-alaska-pacific-university-president/

[2]https://firstalaskans.org/census-information-center/overview/

[3]https://uaf.edu/anlc/languages.php

[4]https://ancsaregional.com/about-ancsa/

LITERATURE CITED

Bang, M., A. Marin and D. Medin. 2018. If Indigenous peoples stand with the sciences, will scientists stand with us? *Daedalus* 147: 148-159.

Barker, R. 1996. *A right mind to think with: A Yup'ik theory of human development.* Unpublished M.Ed. Project, University of Alaska Fairbanks, Fairbanks.

Battiste, M. 2013. *Decolonizing education: Nourishing the learning spirit*. Saskatoon, SK: Purich Publishing.

Battiste, M. 2002. Indigenous Knowledge and pedagogy in First Nations education: A literature review with recommendations. Prepared for the National Working Group on Education and the Minister of Indian Affairs. Indian and Northern Affairs Canada, Ottawa, Ontario.

Cajete, G. 2016. *Native science: Natural laws of interdependence*. Sante Fe, NM: Clear Light Publishers.

Cajete, G. 2000. Indigenous knowledge: The pueblo metaphor of indigenous education. In M. Battiste (Ed.), *Reclaiming indigenous voice and vision* (pp. 181-191). Vancouver, BC: UBC Press.

Garcia, J. and V. Shirley. 2012. Performing decolonization: Lessons learned from Indigenous youth, teachers and leaders' engagement with critical Indigenous pedagogy. *Journal of Curriculum Theorizing* 28: 76-91.

Gonzalez, N., L. Moll, and C. Amanti. 2005. *Funds of knowledge: Theorizing practices in households, communities and classrooms.* Mahwah, NJ: Lawrence Erlbaum Associates.

Kawagley, A. O. 1998. An alliance between humans and creatures. Sharing our Pathways 5: 4-5. Fairbanks: Alaska Native Knowledge Network. Retrieved from https://uaf.edu/ankn/publications/collective-works-of-angay/An-Alliance-Between-1819DE.pdf.

Kimmerer, R. W. 2013. *Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants*. Minneapolis, MN: Milkweed Editions.

Krupa, D. (Ed.) 1996. The gospel according to Peter John. Fairbanks: Alaska Native Knowledge Network.

Leonard, B., S. Nicholas, O. Skinner, and G. Tsinajine. 2020. *Innovations in Indigenous scholar mentorship: Relationships and responsibilities.* 2020 International Indigenous Research Conference, Ngā Pae o te Māramatanga.

Medin, D. L. and M. Bang. 2014. *Who's asking? Native science, Western science and science education*. Boston, MA: MIT Press.

Okakok, L. 1989. Serving the purpose of education. *Harvard Educational Review* 59: 405-422.

Peat, F. D. 2002. *Blackfoot physics: A journey into the Native American universe.* Grand Rapids, MI: Phanes Press.

Pihama, L., J. Lee-Morgan, L. T. Smith, S. J. Tiakiwai, and J. Seed-Pihama. 2019. MAI Te Kupenga: Supporting Māori and Indigenous doctoral scholars within higher education. *AlterNative* 15: 52-61.

What Have We Learned? Lessons and Strategies from the Chaos

Dr. Dewsbury was the Plenary Speaker at Botany 2020 and his talk examined what the social reality of inequity has taught us, and more importantly, how we can and must position ourselves to be agents of change.

A CHAOTIC SPRING

Disasters wreak havoc on communities no so much through their inherent destructive powers, but by their ability to expose existing fissures in poorly constructed systems. Two unique disasters upended normal academic social functioning in the Spring of 2020 in very different but also connected ways. COVID-19 arrived to the shores of a skeptical United States, and quickly ground all operations requiring physical proximity, including institutions of higher education, to an abrupt halt. The chaos that ensued saw pedagogical models carefully crafted for the physical classroom struggling to adapt itself for remote learning. Though the virus itself can infect most people, even asymptomatically, its requirement for close contact for spreading meant that prevention required physical distancing. This simple reality allowed the virus to sort the population, each according to their privilege. Workers in the retail and service industries as well as the gig economy soldiered on, unable to "work remotely" or give up employment critical for keeping themselves economically solvent. In so doing, these workers continued to risk exposure to themselves and their families while those with means were safely ensconced behind closed doors and online meetings. Similarly, as faculty, staff, and students migrated to the online classroom, the ability to transition seamlessly depended on several factors that varied according to means. Many students returned to homes with internet that was either nonexistent or of inferior quality to that which existed on campuses. This, along with changes in the availability of ideal study environments, meant that the quality of the home environment (in turn impacted by economics) strongly predicted the ability of the student to continue to fully engage in the course. In many cases, students did not have the option to return home at all.

By Dr. Bryan Dewsbury
Assistant Professor,
Department of Biology-
University of Rhode Island,
Kingston, RI

In the midst of the pandemic, hundreds of thousands of protesters spurred by yet another senseless Black death, braved quarantine protocols to bring attention to the deaths of more Black lives at the hands of law enforcement. This was not the first time that activists have shone a light on the physical danger Black lives face in the United States, but on this occasion, the Black Lives Matter movement's message garnered much more widespread support (Dave et al., 2020). Activists and other academic advocates within the higher education space embraced this time with mixed emotions. On one hand, it is frustrating that much of the systemic changes suggested in response have been discussed and fully articulated by its proponents for decades, and that it took the cessation of many Black lives in public and graphic fashion in order for these proposals to be finally seriously discussed. On the other hand, the momentum that has been generated by the latest protests have brought a more diverse and expansive community to the table in favor of working towards more concrete equitable solutions.

If there is to be a message of hope from the darkness, institutions of higher education must position ourselves to look critically at this chaotic time and learn crucial lessons. In this process we might recognize that the chaos highlighted an existing system that was broken, particularly for those who depended on it the most. If we are to return to something different and improved, we must have a clear plan to address our historic shortcomings. I offer here a four-step process, undergirded by the paradigm of inclusive practices, as a mechanism for our community to collectively move forward. These are **(1) having a clear vision, (2) being prepared to learn, (3) identifying a specific achievable strategy, and (4) having a mechanism to assess the impact of your efforts**. My hope is that although the events of Spring revealed our collective failures, they also offer us an opportunity to re-envision the structure and delivery of education experiences in ways that are authentically inclusive. Elizabeth Moje (1996) said, "I don't teach subjects, I teach students." This simple but useful proclamation offers a powerful counter to the conventional mindsets of our current teaching practices. Pedagogy, even supposedly active ones, have long privileged the dissemination of content over the more socio-psychological goals of education. At best, it was assumed that the student cultivating a sense of meaning and purpose through the process was an existing by-product of classroom instruction, or at worst, that process was outsourced to the student affairs side of campus. Inclusive practices center the cultivation of relationships as the driver of pedagogical structures, in that what eventually occurs in the classroom is the result and the continuation of meaningful dialogue (Durakoğlu, 2013) between teacher and students. At its core, inclusive practices are not simply about "how to teach"; they are guiding principles for how members of civic society interact with each other. In so doing they offer us ways to think about and move forward from our chaotic Spring, and that begins with having a clear vision for equitable futures.

HAVE A VISION

Activists inside and outside academia might view our current moment with a wary eye because many of us have seen too many instances like these end with the whimper of performative platitudes. The pattern is always the same. Incident takes place that generates collective outrage, thoughts and prayers are bestowed, and perhaps on a campus there is the hiring of a diversity officer or creation of a diversity office in response. Once the cameras depart and the news cycle moves on to other things, accountability for the response measures often fail to match the level of furor that generated the initial response.

What exacerbates this issue is the tendency to place the entire responsibility for racial progress on the newly hired officer, an act of careless deference that likely contributes to the high turnover seen for this role (Hartley III and Godin, 2010). It appears then to the marginalized that institutional responses are more about quelling institutional and personal guilt as opposed to accepting responsibility for implementing policy and behavior change to augur different futures. In the midst of a plethora of position statements and institutional proclamations about their commitment to Black lives, it is critically important that stated visions are reflected in the core of the university operations. Hiring practices, promotion and tenure review policies, and pedagogical support structures are just some examples of areas where colleges and universities can demonstrate their commitment to a stated vision. In other words, until well-crafted visions and statements are supported by budget line items and policy changes, the cycle is at high risk to continue, because the institutional position on equity is communicated to community members in the ways these policies are enacted, funded, and assessed, not in public bombast.

Before embarking on major policy change, some aspirational questions are worth asking. What kind of social imaginary will unfold should equity work be successful on your campus? If I were to walk onto your campus in 20 years, what would the classrooms, the meetings, and the hallways feel and look like? These are not easy questions to answer. They are worthy of a retreat where the breadth of an appropriate vision is chartered and anchored by the desire to create a system that promotes equity. Without such a charge, institutions are left looking to their side at their neighbors, copycatting well-worn responses without disrupting the core functional elements of their operation. Ideally, the charting of this vision should reflect an ongoing dialogue between all stakeholders within the institution. Organizational change theory purports that neither fully top-down nor fully grassroots efforts are sufficient for bringing about meaningful change (Kezar, 2012). It is when all parties feel like they have legit agency in shaping the structure and future of the institution. That agency comes about as a recognition of the power and privilege that each member has, regardless of their professional station within the organization. Too often, conversations about institutional change get derailed by complaints about the *lack* of power the individual has. Professors are not as powerful as Deans, who are not as powerful as Presidents, who are not as powerful as Boards of Trustees, etc. We can choose to focus on this academic food chain, or we can cultivate the power we *do* have and use it for good in our context. For practitioners in the classroom, this means having an aspirational vision for our students and our practice. I make no requests here for specific pedagogical techniques but instead ask that you pose tough questions about the course(s) that you teach. Are you confident that you are cultivating the full potential of the students who matriculate through your classroom? Is your course elevating equity outcomes by examining critical social questions in the discipline? Or by cultivating meaningful dialogue between classroom members? Once that vision is crafted, at either level, then the difficult work of backward designing begins from that vision to identify the specifics of what needs to be done in order to meet that vision. It is here that equity work becomes particularly challenging, since it exposes our collective intellectual and experiential shortcomings in this area. However, our preparation and commitment to the learning process and its inherent supports will be crucial if success is to be achieved and sustained.

BEING PREPARED TO LEARN

The reality of the professoriate, particularly the STEM professoriate, is that most of us were trained, hired, and promoted over long periods of time with little careful attention to the scholarship of teaching, much less the enactment of inclusive practices. There seemed (and still seems) to be an implicit notion that expertise in an acutely refined content area constituted expertise in being able to craft a meaningful educational experience. Filtration pedagogical models, particularly in introductory STEM courses, perpetuated this myth with the "it's not me, it's you" mindset of science professors. As a first step, the learning process must recognize college teaching as a skill to be cultivated and not as a practice that is automatic. Secondly, to fully realize the power that inclusive teaching has to help create equitable futures, we must learn the history (and present) that informs the social context of the learning process. This means engaging literature that explains the broader context of American social structures as well as specifically trying to understand our own social positioning within it.

These are not easy lifts. The evidence from studies on K-12 curricula suggests that if you had a fairly conventional education experience in the United States, your knowledge of the experiences of the marginalized are likely at best inadequate and at worst partially incorrect (Brown and Brown, 2010). Even in institutions of higher education, students in non-humanities majors may only engage these topics in general education courses and if so, rarely in the context of their STEM discipline. But understanding these contexts are crucial if we are to permanently move away from deficit thinking toward empowerment and working on structural change. For example, institutions such as the one where I work enroll students from a diverse cadre of secondary institutions. Preparedness level for college-level introductory biology (a course that I teach) varies widely and typically correlates with school location. But what does that correlation actually mean? Even a cursory look at the variables of "preparedness" and "school location" indicate there is a lot to understand with each. This led to me embarking on a course of study that explored the relationship between neighborhood ethnic and economic structures (particularly property values), school quality at the K-12 level, and the relative choices that families have to meaningfully impact any of the above variables. I would not do this topic a disservice by attempting to summarize the issue here, except to say that federally sanctioned and unofficial redlining policies have been powerful forces helping social inertia in marginalized groups for almost a century. This means that by the time the student gets to my classroom, privileged or not, they have been impacted by social forces over which they had little control. So I, cognizant of that history, must enact a pedagogy centered on uplift, particularly for the historically marginalized, and help students identify skills that allow them to arrest and shape their own futures. The biology content is just a tool in service of the cultivation of those skills.

The learning process must be sustained, continuous, and legislated. One-off workshops and conversations are not enough to fully reorient praxis once fixated on delivery to embrace humanistic principles. This learning process would have to be supported with the appropriate time and feedback structures that are customary to how any new skillset would be cultivated. This structure allows for the fine tuning of the practitioner's psychosocial radar that, once piqued, precludes them from viewing the class in ways other than humans in STEM. From here, they can design strategies, however small, that are appropriate to their context.

IDENTIFY A SPECIFIC ACHIEVABLE STRATEGY

One consequence of chaos is to leave us feeling so defeated by the darkness that we are frozen into inaction. One consequence of a carefully calibrated learning process, however, is that it helps us to not be dwarfed by the enormity of the issue. In so doing it allows us to identify simple scalable strategies that can make a difference today. The nature of those strategies might depend on where you consider your level of awareness to be. Your next project might be diversifying your syllabus and being more intentional about centering the voices of Black and indigenous people of color in the examples and histories told about the subject matter. Others may rethink how group work is structured and enacted, paying particular attention to how assignments can encourage and promote difficult dialogues around social relevant issues in STEM. Those wishing to promote institutional transformation might be thinking about strategies that identify the levers of power and policy changes needed for inclusive practices to become more prevalent on a campus. Identifying one's current and potential sphere of influence is a critical part of this process. In the defeatist mindset, it is easy to lament the *lack* of influence that one has compared to the next level in the political hierarchy. However, in the uneasy mix of graduate students, professors of various "ranks," administrators, and other personnel, each individual does have *some* power to make change. It would be a better use of time to figure out how to maximize the privilege that we currently have as a separate project to restructuring the ways in which power is defined, structured, and operationalized in higher education.

The difficulty of journey means that practitioners will always need a support structure. Support in this context means logistical, financial, and emotional. The first two represent the core commitments that an institution of higher education, serious about a change, makes to support its faculty. Emotional support can come in the form of faculty communities, where practitioners from across campus connect over the commonality of their cause. Though the department contexts may differ, much strength can be gained from working with allies across campus who are treading the same paths toward inclusive classrooms. A group like this, working on common inclusive strategies, can then provide the proof of principle needed for an institution to identify which are effective, and provide avenues for scaling.

A faculty community group also provides the safe space for the continued exploration of the self through the continuous learning process. It is here that we need to be especially mindful and protective of each other's growth. All too often, the path toward cultural humility turns into a fierce competition of wokeness.

Members of the community at times find more joy in pointing out the flaws and slip-ups in our allies than recognizing that the process, even within ourselves, involves mistake-making and atonement. The social consequences of inequity are too deep, and the fight against it is too critical, for us to spend our righteous indignation on friendly fire.

ASSESSING EQUITABLE OUTCOMES

To repeat a question I asked earlier, if I were to walk onto your campus in 20 years, what would the classrooms, the meetings, and the hallways feel and look like? Addressing this aspirational question requires some careful thinking about how short-, medium-, and long-term outcomes are measured along the way. Too often, particularly in the celebration model of inclusive practices, the celebration itself is submitted as its own assessment. When pressed on what strategies they are taking to enact equity, campuses point to heritage month celebrations, multicultural affinity groups, and diversity awards. While these events are welcome and appropriate, they are not *ipso facto* measures that equity on campus actually exists. Colleges and universities serious about equity should be able to quickly point to climate surveys, student interviews, disaggregated academic data, and focus groups as bodies of evidence they are constantly engaging to understand their collective growth process. More importantly, institutions should be able to point to specific political and policy structures that have been revamped with equity as its core goal. For example, in cases where there are diversity officers and/or offices, what mechanisms are in place to ensure that their responsibilities do not exist on the periphery of the core functioning of the university? In what ways have hiring practices, review and promotion policies, and the support of inclusive pedagogies been revamped to reflect a commitment to equity? The answers to these questions require responses that go beyond position statements and necessarily involve budget line items and expenditure that is commensurate with the scale of the transformation process.

In the classroom, a similar level of aspiration and critical feedback should exist. The STEM pedagogical enterprise has evolved to center content acquisition as its primary purpose with an implicit assumption that meaning and purpose comes about by virtue of simply being part of the experience. Therefore, teaching strategies, even some marketed as inclusive, are often measured solely in terms of how they impact academic performance. If education is in fact meant to be a practice of freedom (Hooks, 1994), then there should be mechanisms in the classroom space that at least attempt to capture how its participants are moving toward this actualization. Several options exist in this regard. Rovai's (2002) Classroom Community Scale (CCS), for example, measures classroom community connectedness and has been validated for both face-to-face and online classrooms. However, other assessment structures should be considered, less sense of belonging, meaning, and purpose and things of this nature be always boiled down to a single number. If the inclusive classroom is meant to engender personal growth, then who better than the student to be positioned to speak to this process in a way that was unique to their experience? For my introductory biology classroom, I use the "Letter to a Future Freshman" prompt (Walton and Cohen, 2011). Here, students are asked to write (in 500 words or less) a letter to a hypothetical future first-year student advising them on strategies to successfully navigate their first semester at college based on the letter writer's own mixed experience just completing the same. In "passing down" this advice, the student is forced to look critically at their own choices, good or bad, and in so doing learn for themselves how those choices might inform their own future navigation of college. I can think of no more powerful measure of the student experience than articulation of the students' own voices.

IN CLOSING

Many historians agree that the televising of the assault of marchers on Bloody Sunday in Selma, Alabama awakened a nation's sensitivities to the violence of racism, and consequentially spurred Congress to pass the Voting Rights Act in 1965 (Augustine and Pierre, 2015). Similarly, viral videos of Black Americans dying at the hands of law enforcement over the Spring of 2020 and prior, and the groundswell of datasets showing the disproportionate death rates during the pandemic, can supply a similar impetus for new, more bold action on a national scale on equity. To the extent that we are part of a historic moment on moving the needle on race relations, it behooves those of us committed to equity to ask what our individual responsibilities are, to not merely be well-wishers, and to be active participants in generating solutions.

For this we must first recognize that the college teaching profession in its current structure, especially in STEM, has long abdicated its responsibility to liberation pedagogy. This is a tragic irony. During the chaos of the pandemic months, it became painfully clear that after the sports stadiums closed and social activities evaporated, the teaching of students is the one activity the university could under no circumstances discontinue. To reclaim liberation pedagogy as an expectation of the field, we must institutionally and personally take some steps back and lay out an aspirational vision as it pertains to equity on our campuses and our classrooms. We must then commit to a long-term process on understanding the scholarship of equity in education, backed by the political and financial muscle of our institutions. The reorientation of our radar should then lead to specific measurable strategies enacted with the goal of future, more sophisticated iterations informed by data, and scaling to campus-wide implementation where appropriate. Finally, we must assess the impact of our efforts with the same tenacity and rigor as we would any other compartment of our institutions, but ensure that no assessment is complete without the centering of the student voice.

In the years to come, we will be called to account for the energetic motivation to join book groups and issue public service statements in the wake of a chaotic Spring of 2020. When that time comes, it is my hope that we have more to show than book club membership. It is my hope that the allyship and fervor exhibited during the days of Black Lives Matter marches led to a transformation of our role and responsibilities as education practitioners. It is my hope that after statements were issued, there was then critical self-reflection that turned into leveraging our privilege to create a different type of education experience. An experience that turned us from mere purveyors of the information ubiquity, into humanistic cultivators of emerging adults, primed to shape their own, and the nation's equitable futures.

LITERATURE CITED

Augustine, J. C. and J. K. Pierre. 2015. The substance of things hoped for: Faith, social action and passage of the Voting Rights Act of 1965. *Cumberland Law Review* 46: 425.

Brown, A. L. and K. D. Brown. 2010. Strange fruit indeed: Interrogating contemporary textbook representations of racial violence toward African Americans. *Teachers College Record* 112: 31-67.

Dave, D. M., A. I. Friedson, K. Matsuzawa, J. J. Sabia, and S. Safford. 2020. *Black Lives Matter protests, social distancing, and COVID-19* (No. w27408). National Bureau of Economic Research.

Durakoğlu, A. P. D. A. 2013. Paulo Freire's perception of dialogue based education. *International Journal on New Trends in Education and Their Implications* 4: 102-107.

Hartley III, H. V. and E. E. Godin. 2010. A study of chief academic officers of independent colleges and universities: Who are they? Where do they come from? What are they doing? Where do they want to go? *Council of Independent Colleges*. https://eric.ed.gov/?id=ED510962

Hooks, B., 1994. *Teaching to transgress*. Routledge.

Kezar, A. 2012. Bottom-up/top-down leadership: Contradiction or hidden phenomenon. *The Journal of Higher Education* 83: 725-760.

Moje, E. B. 1996. "I teach students, not subjects": Teacher-student relationships as contexts for secondary literacy. *Reading Research Quarterly* 31: 172-195.

Rovai, A. P. 2002. Development of an instrument to measure classroom community. *The Internet and Higher Education* 5: 197-211.

Walton, G. M. and G. L. Cohen. 2011. A brief social-belonging intervention improves academic and health outcomes of minority students. *Science* 331: 1447-1451.

The Teaching Botanist: William F. Ganong and the Botanical Society of America

ABSTRACT

William Francis Ganong (1864–1941) was the first Professor of Botany at Smith College (1894–1932), a founding member of the Society for Plant Morphology and Physiology and a driver in the unification of the three American botanical societies that became the Botanical Society of America. He was the second President of the unified Society. He had a strong publication record in morphology, ecology, and physiology but was most well known as a botanical education reformer who promoted learning about the whole plant by integrating anatomy, physiology, morphology, and ecology. He is best known for the first of his several books, *The Teaching Botanist*. Ganong promoted, and implemented, many of the "modern" pedagogies we encourage today, from "flippling" the classroom to inquiry-based instruction that teaches science the way science is done. While the Royal Society of Canada eulogized him as "one of Canada's greatest scholars," his reputation in the BSA had nearly faded even before his death. A goal of this paper is to begin to remedy that situation.

By Marshall D. Sundberg
Roe R. Cross Distinguished Professor of Biology
Department of Biological Sciences
Emporia State University, Emporia, KS

I first learned about William Ganong as an undergraduate when I constructed and used a "modified Ganong Respirometer" in my plant physiology course. Later, as a graduate student, my major professor, Ernst Abbe, presented me with his copy of Ganong's *Textbook of Botany for Colleges* and shortly thereafter I purchased The Teaching Botanist at a used bookstore. But over the years I pretty much lost track of him. Even when the Teaching Section decided to create a BSA award for teaching in 1988, we named it not after Ganong, but rather after his contemporary Charles E. Bessey (Sundberg, 2016). I didn't even think of Ganong again until a few years ago when he turned out to have a significant role in botanical education in the decades around the founding of the BSA (Sundberg, 2014). It's time to take another look at the career of this Canadian polymath who happened to be a co-founder of our Society.

THE EARLY YEARS: DEVELOPING A BOTANICAL REPUTATION

William Francis Ganong (1864–1941) became the first Professor of Botany and Director of the Botanic Garden at Smith College (1894–1932). A charter member and driving force in the Society for Plant Morphology and Physiology, he helped coordinate its union with the American Mycological Society and

Figure 1. *William Francis Ganong, Professor of Botany, Smith College.*

the Botanical Society of America in 1906 to form today's Botanical Society of America (BSA) and was elected the 15th (2nd post-merger) BSA President (Figure 1).

Born on 19 February 1864, in Carleton, New Brunswick, Ganong remained a dedicated son of the province throughout his life. He began collecting and recording natural history specimens as a schoolboy. As an undergraduate at King's College (now the University of New Brunswick), his mentor, George Frederic Matthew (who studied with both Asa Gray and Louis Agassiz at Harvard) stimulated Ganong's interest in botany and geology. He graduated with a B.A. in Natural Science, with Honours, in 1884 and continued on for an A.M. (Master of Arts) in 1886 (Figure 2). In between, he published his first biological paper on the invertebrate animals of Passamaquoddy Bay (Ganong, 1885). He established a remarkably persistent personal calendar during his undergraduate years, which alternated a nine-month focus on academics with three summer months of field work in New Brunswick (Figure 3). With the exception of a summer in Germany working on his dissertation, this pattern continued until his retirement when, free of teaching, he could concentrate year-round on the history, natural history, and physiography of his home province. "Almost every year of his adult life, Ganong spent months exploring New Brunswick, alone or with a companion, 'on foot, by canoe, wagon, bicycle, and finally by car and carravan'" (Rees, 2016, p. 95).

Upon completing his Master's study, Ganong followed the advice of his mentor and enrolled at Harvard where he received a second A.B., Summa cum laude, in 1887. Ganong, awarded the Morgan Fellowship, was hired by the Botany Department as Assistant Instructor of Botany. Promoted in 1889, he served two years as Instructor of Botany, specializing in plant physiology under the direction of Charles V. Goodale (Quinquennial Catalog, 1895; Rees, 2016). In 1893 he travelled to

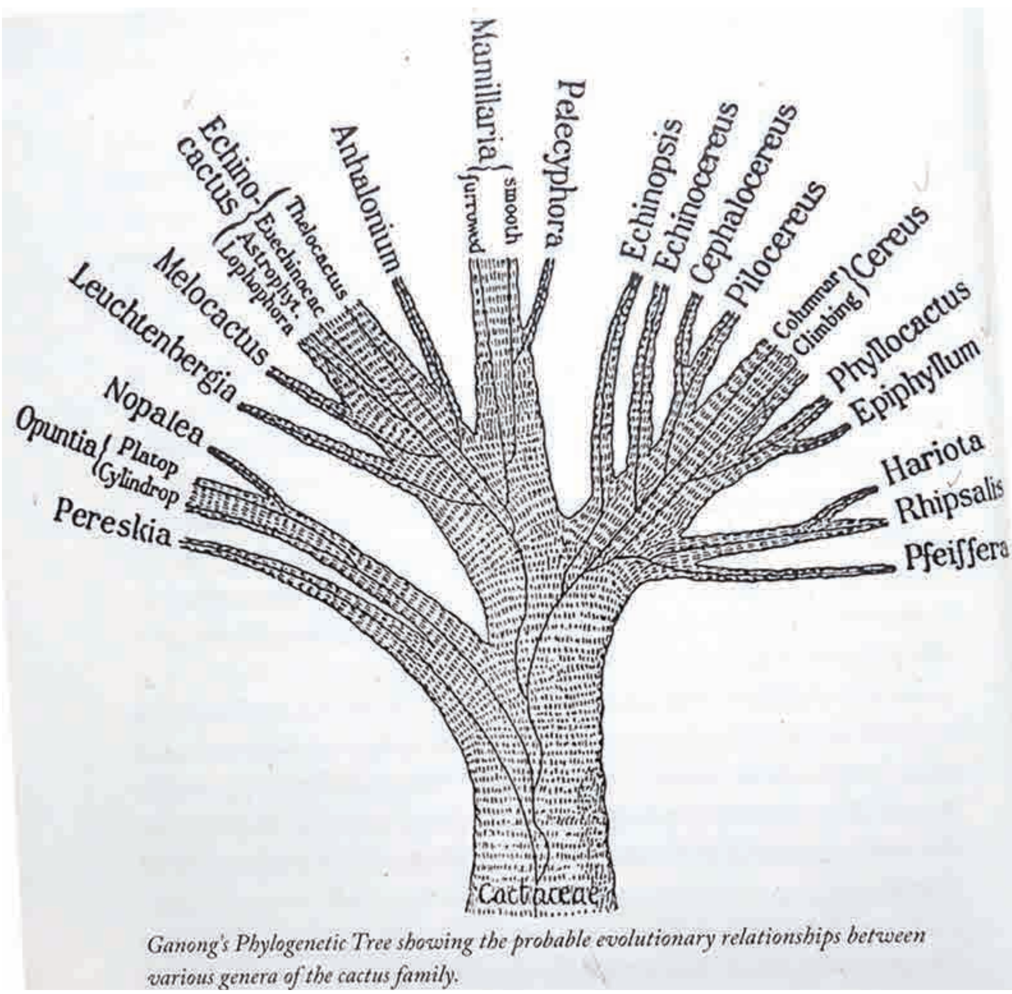
Figure 2. *Graduation photo from King's College, 1884.*

Figure 3. *Ganong at Holmes Lake, 1901 (photo is basis for commemorative statue erected in St. Stephen, New Brunswick, in 2017).*

the University of Munich where he studied under Karl Ritter von Goebel. In less than two years he researched, defended, and published a thesis (in German) on the morphology of cacti: Beiträge zur Kenntniss der Morphologie und Biologie der Cacteen (Ganong, 1894). Goebel established a major botanical garden for his research institute in Munich and had recently published the two-volume Pflanzenbiologische Schilderungen (1889, 1891), which included a major section on Cacti in volume 1, just prior to Ganong's arrival in Munich. With materials close at hand and a major professor interested in development of adaptive plant structure, Ganong fell into a perfect circumstance. It is noteworthy that three years later, Goebel published his opus, Organographie der Pflanzen, in which he cites Ganong's contribution to cacti (volume 2, p. 452). Eager to return home, Ganong accepted a position as the first Professor of Botany and Director of the Botanic Garden at Smith College, Northampton, MA, where he spent his entire professional career. One appeal was that Massachusetts is conveniently close to New Brunswick. Later, when asked about what part of his German experience he most enjoyed, he replied, "The part from New York back to Northampton" (Rees, 2016, p. 23). He never returned to Europe and rarely travelled in the U.S. except to meetings. There was always more to discover in New Brunswick.

During his first year at Smith, Ganong taught eight botany courses: General Botany, Microscopical Anatomy, Anatomy and Morphology of Cryptogams, Advanced Natural History of Cryptogams, Advanced Natural History of Phanerogams, Lectures upon the Physiology and Biology of Plants, Laboratory upon the Physiology and Biology of Plants, and Special Problems in Morphology or Biology of Phanerogams or Cryptogams Leading to Original Investigation. Six years later, the curriculum consisted of General Botany, Morphology and Ecology of the Groups, Classification, Cellular Anatomy and Embryology, Horticulture, and Physiology and Investigation (Smith Botanic Garden, 2020).

Ganong now began to expand his already extensive publication list on invertebrates in the *Bulletins of the Natural History Society of New Brunswick* with papers on the province's flora. With his dissertation published in *Flora,* he expanded his cactus research from comparative aspects of morphology and anatomy of major cactus groups, which allowed him to speculate on their evolutionary relationships, to the role of environment in driving xeromorphic adaptation (Ganong, 1895a, b). An obvious gap in the literature concerned embryo and seedling development, which he filled with a series of papers on polyembryony and a pioneering paper in *Annals of Botany*—the first comparative study of the cactus seedling development that allowed him to conclude that adaptive changes in the size and form of the embryos



Ganong's Phylogenetic Tree showing the probable evolutionary relationships between various genera of the cactus family.

Figure 4. *Tree based on embryology and seedling development published in* Annals of Botany, *1898.*

are preceded by changes in the adult plant, not the other way around (Ganong, 1898a, b, 1899a). Based on this study, he revised his evolutionary tree of the Cactaceae (Figure 4). The critical role of ontogeny in formulating evolutionary relationships was one of the "cardinal principles" in Ganong's view of morphology (Ganong, 1901a).

His work on the cacti made him keenly aware of the role of environment on plant growth, what he called "Phytobiology" (presumably based on Goebel's "Pflanzenbiologie") but others were calling Oecology or Ecology (Ganong, 1895c), so he now began to expand on his earlier work in New Brunswick (Ganong, 1891). This resulted in two major papers in the *Transactions of the Royal Society of Canada* on raised peat bogs (Ganong, 1897a, 1898c), a four-part series of papers in the *Botanical Gazette* on the "Vegetation of the Bay of Fundy Salt Marshes," (Ganong, 1903a-d), and a study of the Grande Plaine of Miscou Island (Ganong, 1906). Rodgers (1944) states that the salt marsh studies are "ranking among the first great ecological studies made in North America." For Ganong, it was critical that the ecological relationships observed in nature were based on the physiological and anatomical adaptations that evolve over time (Ganong, 1904). These studies were contemporary with those of his friend Henry Chandler Cowles on the southern shore of Lake Michigan.

THE SOCIETY OF PLANT MORPHOLOGY AND PHYSIOLOGY

Beginnings

Participation in professional societies provided Ganong a mechanism for continuing professional development. A natural target for his initial interest was the Society of Naturalists of the Eastern United States, which was organized in 1883. An interdisciplinary organization of botanists, geologists, physiologists, and zoologists, among other scientific disciplines, it provided a perfect fit for Ganong's interests. It is unclear when he joined the Society, but at the 1895 meeting in Philadelphia he was elected secretary of a committee of five, which also included C. E. Bessey and L. H. Bailey, to investigate the formation of a botanical section or society to meet annually with the Naturalists. Both Bessey and Bailey were already charter members of the newly formed Botanical Society of America, which held its first meeting four months earlier in Springfield, MA, in association with American Association for the Advancement of Science (AAAS). The early history of the original BSA is well documented by Tippo (1958) and Smocovitis (2006).

Tippo (1958) suggested that there was some degree of antipathy toward the new BSA on the part of many Eastern botanists, including Ganong. Among their concerns was a preference for winter meetings over summer meetings, the relatively high dues of BSA, their preference for meeting with the American Society of Naturalists vs. the AAAS, and most importantly, the elitism of BSA, which admitted "only American botanists engaged in research, who have published work of recognized merit" (Minutes, BSA, 1893, p. 1). Membership was by invitation. Many of the Eastern botanists felt that membership in a botanical society should be open to anyone who was interested in joining. The following year the Naturalists met in Boston. Ganong, William Farlow, Emily Gregory (who authored the first U.S. Plant Anatomy textbook the previous year) (Gregory, 1895), and six other botanists met in the Harvard Cryptogamic laboratory at 10 a.m. on Wednesday, Dec. 30, 1896 to discuss a response to a circular Ganong sent out earlier that year about forming a new plant-oriented society (Table 1). Although only a few respondents expressed active interest, the group concluded that two or three more members would be sufficient and thus

Table 1. *Charter and first-elected Members, Society for Plant Morphology and Physiology. (women in bold)*

The Committee organized at Cambridge, Dec. 30, 1896		
W. G. Farlow Harvard University	**Emily Gregory** **Barnard College**	H. M. Richards Barnard College
W. P. Wilson Philadelphia Museums	B. L. Robinson Harvard University	J. M. Greenman Harvard University
J. M. MacFarlane University of Pennsylvania	T. Thaxter Harvard University	W. F. Ganong Smith College
Added to the Committee, February, 1897		
G. L. Goodale Harvard University	W. C. Sturgis Connecticut Expt. Station	L. H. Bailey Cornell University
Clara E. Cummings Wellesley College	J. E. Humphrey Johns Hopkins	G. F. Atkinson Cornell University
D. P. Penhallow McGill University	B. T. Galloway U. S. Dept. Agriculture	E. A. Burt Middlebury College
G. E. Stone Massachusetts Agr. College	E. F. Smith U. S. Dept. Agriculture	
Elected at First Meeting, Ithaca (Sage College) Dec. 29, 1897		
V. M. Spalding University of Michigan	D. G. Fairchild U.S. Dept. Agriculture	H. C. Porter University of Pennsylvania
H. J. Webber U.S. Dept Agriculture	R. A. Harper University of Wisconsin	**Harriet L. Merrow** **Rhode Island Agr. College**
W. T. Swingle U.S. Dept. Agriculture	A. F. Woods U.S. Dept. Agriculture	Theo. Holm "withdrawn"
W. W. Rowlee Cornell University	A. J. Pieters U. S. Dept. Agriculture	J. W. Harshberger University of Pennsylvania
G. H. Hicks U.S. Dept Agriculture		

they should proceed to organize a botanical organization that would meet annually with the American Society of Naturalists. They agreed to invite "other botanists known to sympathize," primarily from the Eastern states, and focus on forming not a general group or one focused on taxonomy, but rather one targeting plant morphology and physiology "and it's dependent (applied) subjects." Ganong, serving as secretary of the group, played a vital role in establishing the new society. Twelve days after the meeting he sent the organizers summary minutes and a request for additional nominees (Society for Plant Morphology and Physiology [SPMP], p. 59). Ten days after that, "in the absence of definite instructions," he preemptively nominated 11 other botanists to join the fledgling organization. This was sent as a ballot to the organizers for their approval (SPMP, p. 67). Within two weeks a majority of the organizers agreed and Ganong posted a 3rd Circular, a formal invitation to the original 9 organizers and the 11 nominees, summarizing the December meeting and formally inviting each to present at the December, 1897, Naturalists meeting. While there, they would formally organize the new society (SPMP, p. 72). In April, Ganong sent out a 4th Circular verifying that all 20 "members" indicated interest in participating and encouraging them to be "personally responsible for the success of the meeting" (Table 1). It is noteworthy that two of the "select" 20 were women; Emily Gregory was among the original 9 members and Ganong invited Clara E. Cummings, a cryptogamic specialist, among the 11 he nominated (SPMP, p. 74). (By comparison, Elizabeth Britton was the lone female charter member [of 25] of the original BSA.)

At the end of October, Ganong sent a reminder (Circular 5) that began with a sad notification that two original organizers had died, Dr. Gregory in April and Dr. Humphrey. Ganong then described the recent successful meeting of the BSA as evidence "of the widely and rapidly spreading activity in the pursuit of all departments of the science…with such a growing interest in morphological and physiological investigation, a winter meeting devoted especially to those subjects should be abundantly successful." He reminded members of their obligation to actively participate in the upcoming meeting and encouraged them to recruit additional interested botanists to attend and participate. Finally, he included a questionnaire to be returned: Do you expect to present? Do you expect to read your paper? Do you approve of inviting others? If so, whom do you suggest be invited (SPMP, p. 80)?

In early December, Circular 6 informed the committee members that 14 papers "were promised" for the upcoming meeting "with some others reported as probable." Ganong also suggested that as the papers were scheduled to be presented early Tuesday morning, the group should meet at 8 p.m. Monday night to discuss "important subjects of scientific and geographical scope, name, constitution, conditions of membership, etc." Attached was a survey to indicate acceptance for an earlier organization meeting and the full titles of papers for inclusion in the meeting program (SPMP, p. 94). Ten days later Ganong sent out the program (Circular 7), which included 13 papers by "members" and an additional 16 by other invited botanists. Among the latter were four women: a high school teacher, Dr. Martha Bunting of Philadelphia High School; Dr. Adeline Schively of Philadelphia Normal School; University of Pennsylvania grad student Caroline Thompson, who became professor of Botany at Wellesley; and recent graduate, Dr. Lucy Wilson who also took a position at the Philadelphia Normal School. Also presenting were five U.S. Department of Agriculture scientists including plant explorer David Fairchild, who presented two papers (SPMP, p. 97; Anon., 1913, 1916). It was agreed that the members would meet Monday evening at 8:45 p.m. in Dr. Atkinson's office to discuss "the most important and critical steps in the history of the organization" (SPMP, pp. 97-100).

Ganong called the meeting to order and D. P. Penhallow moved to form a Society for Plant Morphology and Physiology; the motion carried. There would be no geographic restriction on membership, but meetings would be held north of Washington DC and no further west than Buffalo. There would be no annual dues; fees would be assessed to meet "necessary expenses." Two standing committees, Admissions and Program, were appointed with Ganong chairing the latter as Secretary/Treasurer of the Society. Candidates for membership should be nominated by two members and show "ability in original research." A total of 16 rules for operating the society were adopted (SPMP, Records No. 1). Thirteen new members were elected (Table 1) (SPMP, pp. 1-3, Records No. 1; Smith, 1898). The first meeting exceeded expectations with 22 papers presented. Abstracts of the papers, and brief histories of the organization, were reprinted in both *The American Naturalist* and *Botanical Gazette* as well as the records of the Society (Ganong, 1898d, e; Smith, 1898; SPMP, Records 1).

We know much about the creation of the Society for Plant Morphology and Physiology because of the detailed organizational skills and meticulous notes that characterize Ganong's work. Rees (2016, p. 66) says, "He described himself as a pre-Raphaelite: a precise, small-details man, a pointillist not a brush-waving Romantic." His handwritten notes, copied correspondence, detailed summaries, and copies of programs and annual records as Secretary/Treasurer fill a ledger documenting the 9-year existence of the Society, from 1897 to 1906, that is comparable in size, and considerably more detailed, than the corresponding volume that documents the first 32 years of the BSA from 1894 to 1926.

Major Initiatives

Membership and participation in the Society grew every year and a variety of amendments were made to the rules. An interesting 1898 resolution was "that this Society recognizes the metric system as the standard of measurement when employed in its working and members are requested to observe this rule in the preparation of papers" (SPMP, p. 6). The following year, the Society initiated work on the first of two large initiatives.

Botanical Literature

In the last decade of the 19th century, the *Botanical Gazette* (published by the University of Chicago) was the primary journal for publishing—not only primary research, but also brief reviews of published or presented American research. This paralleled some major European journals, but there was little overlap across the Atlantic, which diminished exposure of American work. At the 1899 New Haven meeting of SPNP, President Farlow, in his outgoing address, noted the "increasing need and demand for prompt, synoptical, descriptive reviews of new botanical papers and books…" (SPMP, Botanical Literature, p. 1). The Society decided to approach the *Botanisches Centralblatt* to see if better reviews could be obtained, and Professors Farlow, MacDougal, and von Schrenk were appointed to investigate this matter. MacDougal, who was Secretary of the Section G (Botany) of AAAS, invited them to the June AAAS meeting at the New York Botanical Garden to discuss an approach, but as we will see later, the SPMP chose not to meet with AAAS. Although not a committee member, as Secretary of the Society, Ganong took the lead, and on January 19, 1900 he addressed a letter to Dr. Oscar Uhlworm, Editor-in-Chief of *Botanisches Centralblatt*, in which he summarized the request of the group. The committee realized that such reviews were already contained, in part, in the *Centralblatt*, but that many were relegated to the *Beihesste*, which required a separate subscription. They suggested that American botanists would strongly support collecting all of the timely and descriptive reviews of new botanical works in the *Centralblatt* (Ganong, 1900). At the end of April, Uhlworm replied to Ganong. Perhaps he misunderstood some of the Americans' concerns, but one of his concessions would allow two or three American editors onto the editorial board. Yet, the main concern went unaddressed. In October, Ganong replied on behalf of the Committee that: (1) it would not be possible for the Americans to subsidize the change to the Centralblatt, (2) simply increasing the size of each volume would not be a solution, (3) if some material shifted to another journal, one should not be required to separately subscribe to both, and (4) the idea of adding American botanists to the editorial board "would contribute greatly to make the *Centralblatt* acceptable to American Botanists." Uhlworm ultimately agreed, but ownership of the journal changed as it became the organ of the new International Association of Botanists. Seven American editors, coordinated by William Trelease, were appointed to the board (Anonymous, 1902; Bessey, 1901; SPMP, 1900–1902). This initiative was considered by many to be the primary accomplishment of the Society for Plant Morphology and Physiology as it added to the prestige of all American botanists (Rodgers, 1944, p. 220).

College Entrance Exam

As a new faculty member, Ganong was not invited to be a part of the "Committee of Ten" charged by the National Education Council (NEA) in 1894 to devise a common botany curriculum for schools. The botany recommendations closely follow Bessey's *Textbook of Botany* (Bessey, 1896; Sundberg, 2012; Table 2). But five years later Ganong had the opportunity to react. The NEA called for another report to specify college entrance requirements for botany. Committee members were drawn from the regional accrediting agencies, AAAS, and NEA. Both Ganong, representing the New England region, and Bessey, representing AAAS, served on the botany section. Much of the report paralleled the earlier work except now, thanks largely to Ganong, ecology and physiology composed about half of the botany course. The traditional recitation approach, focusing on memorizing morphological parts and using taxonomic keys to identify flowers, was "entirely inadequate." Ideally, instruction should focus on the laboratory and microscopic analysis of structure and development. The committee considered the compound microscope to be useful and necessary to demonstrate many important structures. However, Ganong suggested, "The compound microscope is a difficult piece of apparatus for a young student to use intelligently…demanding considerable training…and longer periods than are given in secondary schools." Alternatively, observational study should focus on plants as living things in the context of their ecology and physiology. These should make up the first half-year of the course. The second half-year should focus on comparative morphology and the evolution of plant groups. "In connection with both of these courses your committee would call special attention to the great importance of drawing as a means of securing definite observation." Furthermore, Botany should be offered either in the junior or senior year (Table 2). At the end of the report Bessey authored a page of comments dissenting from the majority view on several points. Not surprisingly, given his focus on the microscope in laboratory instruction (see Sundberg, 2012, p. 115), he noted examples of successful use of microscopes in some "fourth, fifth, and sixth grades of certain public schools in Nebraska" (NEA, 1899, p. 175). He also objected to the focus on ecology because it was so new to botany that no teachers will have been suitably trained to teach it. Similarly, he thought that the emphasis on the processes of physiology would be a challenge for teachers to go beyond "any but the loosest way by secondary pupils." He also thought too much had been cut from a survey of the plant kingdom to make room for these more advanced topics.

Partially in response to the formation of new college governing boards for the Northeastern and Middle States and Maryland, and perhaps also in response to this dissent by Bessey, the following year Ganong presented a paper, "Suggestions for an attempt to secure a standard college entrance option in botany," at the annual meeting of SPMP at Johns Hopkins. In response to his paper, the Society appointed a committee of Ganong (chair), F. E. Lloyd, and George Atkinson to prepare such a document on behalf of the Society. They successfully argued that education in a scientific specialty "should be a chief care of any scientific society" (Ganong, et al., 1908, p. 594). The committee completed a preliminary draft in April of the following year, followed by two revisions based on recommendations received from the membership (Table 2). The committee presented a third revision at the 1902 meeting in New York. Ganong and Lloyd were appointed to a permanent committee charged to make the report "as useful, educationally as possible and to keep it in touch with changing educational conditions" (Ganong and Lloyd, 1902, p. 2). This report was accepted by the College Entrance Examination Board and served for several years as the basis for college admission to botany programs. This committee carried over through the merger with the Botanical Society of America to become the Committee on Education of the BSA with the fourth and final report published in 1908 as publication No. 35 of the BSA and in *The School Review* (Ganong, 1908). Furthermore, as part of the vote for authorization, the BSA recommended: "That all members of this society who are connected with universities or colleges be requested to bring before their respective faculties the fact that examinations are now being held every June …in a year's thorough course in botany… and that it is desirable…that it be widely, or indeed universally, accepted by colleges as an option for entrance" (Ganong, 1908, p. 595). Not surprisingly, the recommended course follows very closely the outline provided in Part II of *The Teaching Botanist* (Ganong, 1899b; Table 2).

Table 2. *Comparison of botanical topics covered in Guidelines and Textbooks.*

Author	Ecology	Physiology	General Morphology	Gross Morphology	Special Morphology
NEA (1894)	Not Mentioned	Not Mentioned	Very Important	Not Mentioned	Not Mentioned
NEA (1899)	Very Important	Important	Important	Important	Somewhat Important
SPMP (1901)	Important	Important	Important	Important	Not Mentioned
Bessey (1896)	Somewhat Important	Somewhat Important	Very Important	Important	Somewhat Important
Ganong (1899b)	Important	Important	Important	Important	Not Mentioned

Abbreviated from the table in Trafton, 1902.

Merging the Societies: the Botanical Society of America

The final activity of SPMP was to participate in a mutually agreeable union of the three American botanical societies to establish the current BSA. As usual, Ganong played a major role. In 1899, the SPMP met at Yale where D. T. MacDougal, newly elected to the Society but also Secretary of the botany section of AAAS, extended an invitation to the members to attend the next AAAS meeting, which would be held in New York in June of the following year. As mentioned earlier, MacDougal's purpose was to allow BSA to also engage in the *Botanisches Centralblatt* negotiations. Rather than meet jointly with the BSA at AAAS, the SPMP chose to stay with the Naturalists who met at Johns Hopkins in December. The following year, when SPMP met at Columbia University, MacDougal initiated a discussion on "the most profitable relation of the American botanical societies to one another" (SPMP, p. 28). After all, at least seven of the 60 members of SPMP in 1901 also belonged to the BSA: George Atkinson, Liberty Hyde Bailey, John Coulter, William Farlow, Byron Halstead, Conway MacMillan, and William Wilson. In 1902 the BSA also began to discuss the advantages of unifying the botanical societies. The following year saw the formation of the third botanical society, the Mycological Society of America, and an SPMP Committee on Relations with other botanical societies, which included President George T. Moore, Ganong, and Past-President Duncan S. Johnson. Discussions favored a union, in principle, but only under certain conditions. First, all members must share an equal voice in the affairs of the combined society (there should be full members only, no associate members). Second, all sections should have an equal voice in nominating officers, preferably by some form of proportional representation. Third, membership of sections should be controlled by the sections. Fourth, fees should be kept down to an amount necessary to cover cost of administration, and there should be no separate admission fee. Finally, if a plan for union was agreed upon by the respective committees, it should be printed and sent to the SPMP membership as soon as possible to allow ample opportunity for consideration before the next meeting (SPMP, p. 42). At the same time, two BSA Past Presidents, Bessey and Lucien Underwood, and President Charles R. Barnes served as the BSA Unification Committee. Rodgers (1944) has some interesting quotes that present a BSA perspective toward union of the societies:

- Underwood to Bessey (p. 222): "…Altho [sic] this society was really organized as a sort of protest against our own… I do not see that we have anything to gain by any formal union with them and very much to lose if we modify in any way either the matter of our elections or our fees system….[organization of the mycological society] doubtless will have the effect to reduce the interest in the Soc. Pl. Morph. And Phys. Since several of the leading spirits of that organization are mycologists...I do not think it will affect us one iota…"
- Barnes to Bessey (pp. 222-223): "I believe it should be the policy of the B.S.A. to make itself the dominant force so far as organized botanical activity is concerned, and I believe it can only do this by uniting all…"
- Bessey to Underwood (p. 223): "Let us not discourage them [other botanical societies], while on the other hand perhaps we need not give a boisterous encouragement…In this way we may have for a time a 'struggle for existence' resulting in the 'survival of the fittest…."
- Underwood to Bessey (p. 224): "They [SPMP] have certain members…that I could not honestly vote for and I believe they have quite a number what would not poll a majority of the votes of the Botanical Society…"

In December, 1904, all three societies met jointly in Philadelphia with the three committees on unification negotiating and reporting back to their respective societies. The main order of the SPMP business meeting was to accept the principles recommended by the committees of conference for union and to authorize a new committee charged to bring the union into effect. The SPMP committee consisted of Past-President G. T. Moore, President E. C. Jeffrey, and Ganong.

It was also announced that SPMP was invited to send a delegate to the International Congress of Botany at Vienna in June, 1905; the membership selected former President Farlow to represent the Society. Farlow did not attend, nor did a representative of the other two societies. Although 16 American botanists attended as independent delegates, "American societies were sadly negligent, and many were unrepresented which might have delegated authority to some of the sixteen" (Barnes, 1905). Barnes observed that the display of materials for botanical instruction was "particularly noteworthy," especially with apparatus for plant physiology experiments. "The equipment puts to shame all of our high schools and nine-tenths of our colleges" (p. 71).

The final meeting of SPMP was held at the University of Michigan in December, 1905. Twelve papers were presented, including "On the erroneous physiology of elementary botanical text-books" by Ganong. The report of the Committee on Union of the Botanical Societies was adopted as presented. There would, after all, be two grades of membership with one fifth of the members of SPMP (and the Mycologists) now being relegated to associate membership of the unified society (all members of BSA retained full membership). Selection of associates from SPMP was simple: if your name began with D or later and were elected in 1902, and all new members elected in 1903, 1904, and 1905, would become associate members (SPMP, Record #9, p. 3). There was no election of officers; current officers would continue until union was affected the following year. Ganong signed off on the Society's approval on 28 December and forwarded his report to the BSA (Minutes, p. 93).

The 13th annual meeting of BSA, and first of the united BSA, was held at Columbia University on Dec. 27-31, 1906. The logistics of combining the Societies filled the first day. Ganong presented and was the signatory for the SPMP membership and financial records and was appointed to the auditing committee of the new BSA. He moved that the records of both SPMP and the Mycologists be deported to the library of the Missouri Botanical Garden for preservation "after having served the immediate purpose of the Secretary and Treasurer of the BSA" (Minutes, pp. 101-104). He also moved that the SPMP Standing Committee on College Entrance Options in Botany be continued and offer a final report the following year. George Atkinson, one of two scientists with membership in all three merging societies, was elected 14th president of the BSA (and first of the unified BSA) in 1906. Ganong was elected 15th BSA President in 1907. (Margaret Ferguson, one of the six female botanists who transitioned from the SPMP in 1906, became the 36th [and first female] BSA President in 1929.) Interestingly, MacDougal, who was now President of Section G (Botany) of AAAS, was not listed at all on the combined BSA membership (Minutes, pp. 96-101, Table 3).

In his address as retiring president of the BSA, Ganong reflected on the state of botanical education in America in 1910; it is uncannily prescient for today (Ganong, 1910a). He began by enumerating several widely recognized problems. First, that science tends to be difficult for most people because it depends on "reasoning, not feeling." Second, students are not only generally unprepared for college, but specifically unprepared for the sciences. In the schools, responsibility for learning has been shifted from the student to the teacher and students bring that attitude with them to college. Third, science, as a laboratory-based discipline, had only a single generation to develop and propagate an effective educational strategy. Finally, an inquiry approach to

Table 3. *Membership in uniting Societies at time of union.*

	Botanical Society of America (B)	Society for Plant Morphology and Physiology (S)	American Mycological Society (M)	Total
Full	32	34 (5 women)	23	89
Associate	13	14	3	30
Total	45	48	26	119
Multiple	**B & S**	**B & M**	**S & M**	**B, M & S**
Total	11	8	3 (1 woman)	2

teaching "is distasteful to the great majority [of students] … who prefer to absorb their knowledge from printed books upon which they can lean for authority" (p. 323).

He then went on to enumerate some of the problems that scientists have bring upon themselves in regard to teaching science, the most important of which is that "we are not faithful to the genius of our subject" (p. 324). "In a word, the first great need of our science teaching is to make it scientific" (p. 325). The current mantra is that we should teach science as we do science (Handelsman et al., 2004; Hanauer et al., 2006). Directly related is the generalization of introductory courses that "cover" the breadth of the discipline, an inch deep. Textbooks were, and continue to be, part of the problem. Much better is to concentrate on the basic ideas and go into enough depth to cultivate understanding. A second impediment to effective teaching, Ganong suggested, is to focus solely on the subject while ignoring the students. Success in teaching is directly proportional to one's ability to communicate with others. Thus attitude and diplomacy are important: "gloving the iron hand of the scientific method by the soft velvet of gentle human intercourse" (p. 325). Providing some context of the history and personalities of scientific discovery are also useful tools to engage students. Another problem, particularly in the laboratory, is putting too much trust in the technologies and not enough in the individuals. What's important is not the equipment, but how you use it and how you interpret the results. Finally, the method of training teachers is wrong. Science professors at colleges and universities are good at cloning themselves to provide researchers for the future, but they are totally unprepared to teach future teachers, at any level. For his own part, he acknowledged a philosophical change:

> "It took me many long years to free myself from the feeling that I must continue research or else sacrifice the good opinion of my colleagues. But I am free, and in the two or three years I have been so the added keenness of my pleasure …I propose to try to convince the society that its rules ought to be altered as to make teaching, of approved merit and service, a sufficient qualification for membership. Meanwhile, I advise all of my colleagues engaged in collegiate work to join in my declaration of independence. Let us show the universities that teaching hath her victories no less than research" (p. 329).

Indeed, Ganong experienced a revelation that significantly shifted his goals and expectations. He continued his BSA roles on the Auditing Committee and Committee on Education for two more years and twice he was selected a Councilor (at-large member of the Council). In 1914 he served on the committee to nominate the first Editorial Board of the Society's new journal, the *American Journal of Botany*, but he never again presented at a BSA meeting and only rarely published botanical (teaching) articles—notably dealing with plant physiology. Instead, he focused on his teaching and his students at Smith.

The Teaching Botanist

Graeme Wynn (2017) calls William Ganong a "prodigious polymath." Beyond all else, however, Ganong was "The Teaching Botanist." His philosophy of teaching stressed that instruction should be based on first-hand study of living plants, in the field or in the laboratory. Furthermore, when the student is studying botany, the teachers' primary concern should be studying the student and how best to facilitate learning. One could easily argue that while writing about teaching botany for the 20th century, he was actually anticipating teaching botany in the 21st century. *The Teaching Botanist*, which went through two editions, is the teacher's manual for how educate students about plants (Ganong, 1899b, 1910b).

His first precept is that college teaching should be carried out as an investigation, or at least in that spirit. "The revival in students of the spirit of inductive inquiry, a spirit which they naturally possess, but which is usually crushed out of them by the school course, is the first and greatest task of any teacher of a Science" (Ganong, 1899b, p. 17). Thus, for any topic, laboratory work should precede the lecture and the textbook should be used only as supplementary reading. Especially in introductory courses, students bring a wide variety of preparation and the teacher's task is to determine what each student is best fitted for, and then to set out to help the student reach that point. Most students will not major in botany, but all will find some use for it in their lives and their instruction will need to be thorough and "in considerable amount." Those few who intend to go on should be challenged to a level beyond their expectation.

While he acknowledged the differences in opinion as to the content that should be covered in the introductory course, particularly compared with Bessey and others, his primary learning outcomes had nothing to do with content. (1) Exact observation; start with the familiar, but focus on active seeing, not passive looking, and sketch what is observed. (2) Critical comparison and generalization. (3) Faith in causality: "anatomy and morphology should from the first be viewed in the light of the factors determining them … physiology and ecology." "The cultivation of testing the connection of causes and effects by experiment is a most important part of botanical training" (p. 26). (4) Evaluating evidence and forming conclusions, whether supported or not. (5) Promoting terse, logical, and complete expression of the results, using appropriate botanical terminology. (6) Intellectual honesty and forming a habit of objectivity; eliminate anthropomorphisms and promote intellectual independence. Botanical content should focus on: (1) the position of plants in nature, (2) the structure of plants and how they live, (3) adaptations of plants to their environment, and (4) the nature of irritability and plants' response to their environment.

The heart of the book is Chapter 3, "On things essential to good botanical teaching." "The true teacher of Botany, as of any other subject, is born, not made. But a chief birthmark is a determination for incessant improvement" (p. 46). The path to teaching begins with a college career dedicated to providing a depth of understanding of the major fields. Beyond college, this should extend to summer schools and workshops to stay current in the field. A program of self-study and some kind of original investigation hones the skills to be taught. This could also include what today we call the scholarship of teaching and learning: "investigation into better and more economical ways of utilizing the science in education… and this line of investigation is as legitimate, as difficult, and as important for the advancement of botanical science as is the elucidation of vegetative parts, chromosome numbers, or transpiration currents" (p. 50).

In terms of teaching temperament, one should be sympathetic, but an uncompromising and yet genial critic of students' accomplishment. "He was kindness itself to his students but he never once told us anything we could find out for ourselves" (Brixter, 1942). He notes that the tendency in education had been to shift responsibility for learning from the student to the teacher, but that "this is a very wrong attitude; the responsibility for learning should be kept upon the student" (p. 53).

The laboratory is the primary focus of investigation and ideally should have no more than 16 to 20 students (the ideal is 10) over at least a 2-hour period, preferably twice a week. The amount of work should be adjusted to "rather above the average student." The best students may complete the work in the allotted time and be held to a high standard, but make-up work should be completed outside of class. The laboratory should always be accessible to students. Considerable freedom of movement and conversation must be allowed "during the laboratory and students must be expected to clean up after themselves." Whenever possible, answer questions with questions to promote the thinking process—from known to unknown.

Many of the laboratory manuals available in Ganong's time (as well as our own) were very precise in their instructions to students and designed to reinforce known expectations (Cookbook labs). Ganong's philosophy allowed students to make mistakes and to analyze their results based on trust in their data. "The good teacher, too, will not be above employing many little tricks and devices to arouse interest, keep attention, and encourage application" (p. 62). Because of time and equipment constraints, many physiological experiments must be set up as demonstrations, but each student should observe and record her own results and deduce conclusions as if the experiment was her own. Lectures, which occur *after* the lab work on a topic, are valuable for reinforcing what was learned (the reverse of the traditional relationship between lecture and laboratory and a model of what we now call a "flipped classroom"). "They do not like the process at first, but their satisfaction in the obvious worth of the results, and especially their pleasure in the exercise of a power they did not know they possessed, makes them in time like the process itself" (p. 68).

Table 4. *Student publications.*

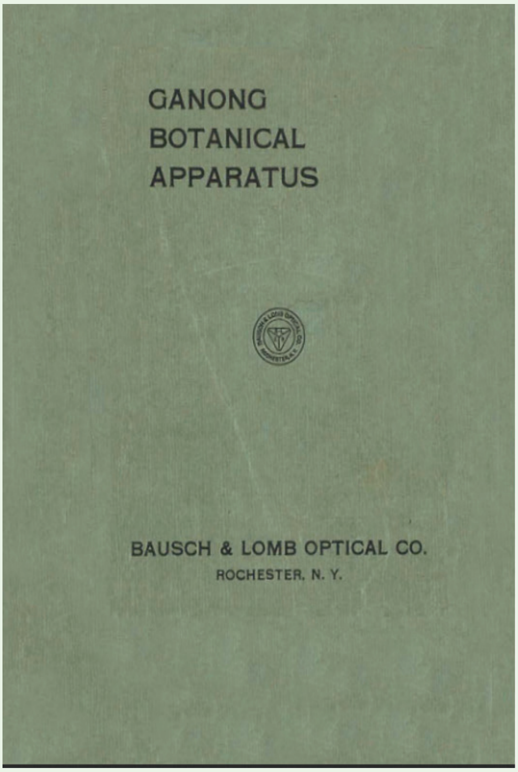
Student	Year	Citation	Topic
Sophie Eckerson	1905	*Bot. Gaz.* 40: 302–305	Spectra of chlorophyll solutions
Sophie Eckerson	1908	*Bot. Gaz.* 45: 50–54	Root pressure
Grace Clapp	1908	*Bot. Gaz.* 45: 254–267	Transpiration
Grace Bushee	1908	*Bot. Gaz.* 46: 50–53	Protoplasmic streaming
Sophie Eckerson	1908	*Bot. Gaz.* 46: 221–224	Stomatal distribution
Sophie Eckerson	1909	*Bot. Gaz.* 48: 224–228	Starch production in leaves
Julia Paton	1922	*Am. J. Bot.* 8: 471–501	Pollen enzymes

Finally, one should teach by example. "It is an inspiration to students to see their teacher himself a student always striving to learn and advance" (p. 65). One proof of his method is that several of Ganong's students published their own undergraduate research done under his direction (Table 4).

As mentioned above, Ganong thought it was important for students to record observations in their notebooks, thus he included a chapter on scientific drawing and descriptions. His advice is as salient today as it was 100 years ago. To sketch requires careful observation first, before outlining, in light pencil, the general patterns observed. Later, once proportions are correct, details can be added, either to the original sketch or as an enlarged insert to highlight the detail. The scale should always be indicated, preferably in metric, and neat labels arranged so that straight-edge lines can connect labels to the appropriate parts. Diagrammatic accuracy should be stressed, which makes it easy for the instructor to evaluate what the student has seen. Ganong also included chapters on the design of laboratories and their equipment, botanical collections, and books for teaching. Critical to the teaching laboratory was the greenhouse and garden plantings (Ganong, 1897b, 1910c). The experiment house of the greenhouse range was directly connected to the laboratory classroom and was used extensively by upper division students for plant physiology experiments (Figure 5). Ganong designed a variety of physiology apparatus for the classroom. Most of these appear in his Plant Physiology textbooks (Ganong, 1901b, 1908) and the catalog of apparatus manufactured to his design and available from Bausch & Lomb Optical Co (Ganong, 1914) (Figures 6, 7). The collections chapter includes suggestions

Figure 5. William Ganong, c. 1910, with botany honors class in the experimental house at Smith College. Next to Ganong is likely Helen Ashhurst Choat, Assistant in Botany. The students—Elizabeth Green, Mabel Bray, Louise Elder, and Elizabeth Johnson (all class of 1913)—are shown gathering data from Auxograph devices, designed by Ganong to automatically measure and plot shoot growth. (Photo by Katherine McClennan, with permission of Smith College Archives.)

A



B

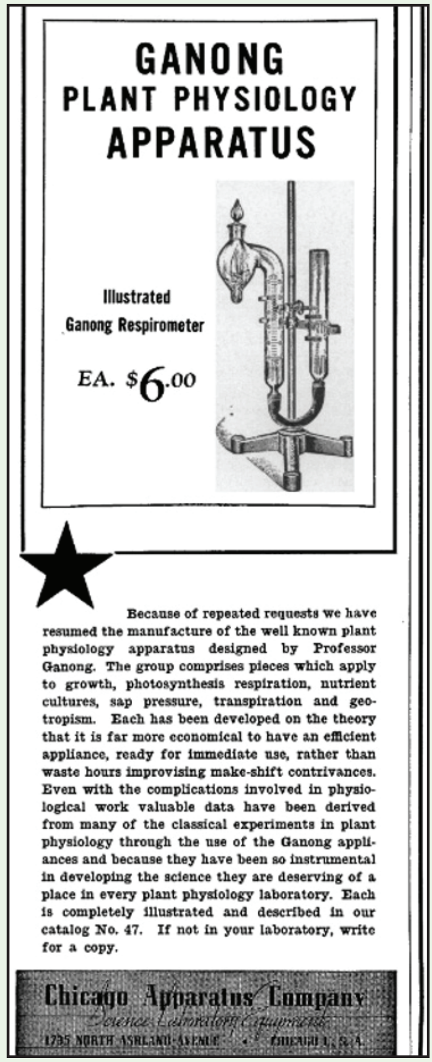


Figure 6. *(A) Bausch & Lomb 1914 Catalog of Ganong Plant Physiology apparatus.*
(B) Ad from 1938 Science *advertising Ganong Respirometer.*

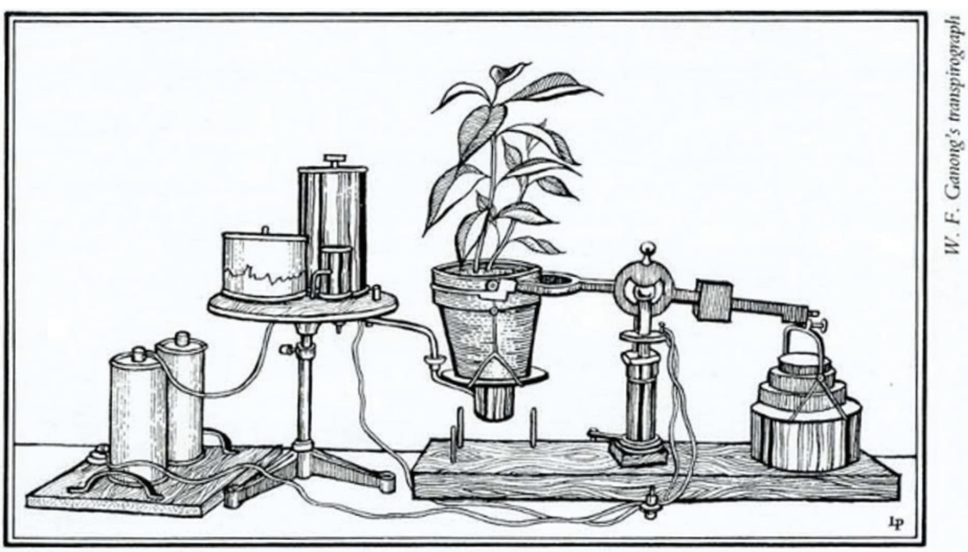


Figure 7. Diagram of Ganong's transpirograph ($75) with transpiration balance ($80).

for living collections, charts, and models, and collecting and preparing both preserved and herbarium specimens. The nearly 100 recommended books range from classic German and British texts to American floras and contemporary textbooks. Also included are all of Darwin's botanical books and Wallace's *Malay Archipelago*.

The final chapter of part I is "On some common errors prejudicial to good botanical teaching." In Gager's review of the second edition, he says, "The writer believes that there is no error more widespread or more erroneous than that knowledge of a subject, alone and of itself, confers teaching power or is the sole need in the preparation of a teacher. 'The Teaching Botanist' is a protest against this point of view, and a positive, constructive contribution toward the solution of the problem of more effective botanical teaching" (Gager, 1910). Part II of the book, "An outline for a synthetic elementary course in the science of botany," is an application of Ganong's philosophy to the topical outline of content he espoused in the beginning with the NEA guidelines of 1899 through the BSA guidelines for the college entrance course of 1908.

The philosophy and general organization found in *The Teaching Botanist* is mirrored in each of Ganong's other texts but the target is now students, not their teachers (Figure 8). "I was once such a learner, and I have tried to write such a book as I would then have delighted to read" (Ganong, 1913, p. v). His goal is always to emphasize the big ideas and go into depth to explain the interpretation or principles involved. Whenever possible, these principles are put into the context of humans' relationship to plants. These were not typical texts. The writing was a narrative, not a sequence of numbered concepts to be memorized for recitation. The convention for botany texts, introduced by Almira Hart Lincoln Phelps around 1830, numbered sequentially each of the concepts introduced in a textbook (Sundberg, 2012). Bessey and others still used this format into the late 1910s. Ganong was an early deviant. Ganong's order of content coverage also differed significantly from Bessey. Bessey (1905) used the still familiar bottom-up approach beginning with the structure of cells, tissues, tissue systems, and organs before considering the structure and function of whole plants. Ganong began with a discussion of the scope and value of botanical study and the distinctive characteristics of plants followed by an integrated treatment of the structure and function of the distinctive plant organs: leaves, stems, roots, flowers, fruits, and seeds and their relation to the environment. Both treated plant classification in part 2 of their text; Bessey concentrating on morphology and Ganong integrating

Figure 8. Sampling of Ganong's texts.

ecology and physiology with the morphology. Whereas Bessey concludes with the taxonomy of flowering plants, Ganong provides a chapter on the ecological classification of plants.

By 1917 the Smith Botany Department expanded to seven faculty members serving about 200 students majoring in some aspect of botany. Most students followed the technical track in preparation for teaching or laboratory work. Required courses included Systematic and Economic Botany, Morphology, and Physiology with electives of Ecology and History of Botany. Those in the Gardening track took Horticulture and Landscape Gardening and either Systematic Botany or Ecology. The Economic track required Bacteriology and Plant Pathology with electives of Systematic and Economic Botany or Physiology. A research problems course could be taken in Physiology, Morphology, or Ecology. The enlarged greenhouse range now included experimental houses for both Plant Physiology and Horticulture and the Department shared a new Biology Building with the Zoology Department. "In all we try to remember that while good facilities are fine tools for skilled workmen, the ideal of education is still Mark Hopkins and the log. If the spirit of Mark Hopkins be present I suppose it does not matter if the log be polished oak" (Ganong, 1917). After 38 years of service, Ganong retired from Smith in 1932. A tribute in the *Alumnae Quarterly* noted, "They [former students] remember the delight of his buoyancy and enthusiasm in lecture-room and laboratory, his whimsical humor, his eagerness in bringing to their immature minds the inspiration of the attitude of research" (Seelye, 1932).

The year prior to retiring, Ganong confided in a letter to a Canadian colleague that although he had not lost interest in teaching, he thought he was losing touch with his students and a "great gulf" had opened between them. While he remained idealistic with his head in the clouds, they had their feet planted firmly on the ground and focused on a career (Rees, p. 197). Free of teaching, "But Oh! The luxury of not having to go at any fixed time to classes! The cartography goes on, however, I can always drop anything and turn to that with joy" (Rees, p. 198). He could now pursue

BOX 1
Some of Ganung's Honors and Awards

- 1893: Corresponding Member, Royal Society of Canada
- 1898: Honorary PhD, University of New Brunswick
- 1900: Fellow, American Association for the Advancement of Science
- 1909: Fifteenth (2nd unified) President, Botanical Society of America
- 1920: Honorary LL.D., University of New Brunswick
- 1931: J. B. Tyrell Historical Medal, Royal Society of Canada
- 1940: Charles Reid Barnes Life Membership, American Society of Plant Physiologists

the mountains of data from summers in New Brunswick and supplement with additional field work, new research, and publishing. But that was another life.

Throughout the years he received several honors and awards, and in 1940, the year before he died, he received another (Box 1). The American Society of Plant Physiologists held their 17th annual meeting in Philadelphia and at the annual dinner, on 30 December 1940, awarded Ganong the Charles Reid Barnes life membership award. "Dr. Ganong was an excellent teacher, a very exacting and careful laboratory technician, inventor of many devices for physiological experiments, and a writer of textbooks and manuals which exerted a profound influence upon the teaching of plant physiology." Furthermore, they dedicated Volume 16 (1) of Plant Physiology to Ganong "in celebration of the seventy-seventh anniversary of his birth (ASPB, 1941). Although in poor health and suffering from Parkinson's, he returned, as usual, to New Brunswick that summer. He died on 7 September 1941. Upon his death he was eulogized in the Transactions of the Royal Society as one of Canada's "greatest scholars" (Webster, 1942a, b) and in *Science* (Smith and Choate, 1941). The BSA published no obituary and the council minutes state simply, "The secretary reported on the deceased, resigned, and dropped members of the society for 1941" (Minutes, 1941, p. 41).

Conclusion

William Francis Ganong was a driving force during the early years of professional botany in the United States. He produced pivotal studies in plant morphology and systematics, plant ecology, and plant physiology and was the first to integrate these sub-disciplines in teaching botany. He was the first American botanist, if not the first scientist, to advocate using a scientific approach to teaching science. And all of this was his vocational occupation, that gave way every summer, and during his "retirement," to pathbreaking achievements in a variety of other disciplines in which he demonstrated recognized expertise. Why do more botanists not recognize his name? Why does the BSA have a Charles E. Bessey teaching award and not a William F. Ganong teaching award? Perhaps botanists were offended by his Presidential Address (Ganong, 1910a) where he challenged the Society "to make teaching, of approved merit and service, a sufficient qualification for membership" (p. 329). Perhaps it was because he admitted in the same paragraph that after many years he was finally "…able to free myself from the feeling that I must continue research or else sacrifice the good opinion of my colleagues." While researching a previous paper, I thought it peculiar that the BSA sponsored a symposium on Botanical Teaching at the 1911 meeting in Minneapolis and Ganong was not one of the presenters. Bessey spoke on preparing botanical teachers, Otis Caldwell focused on botany in the high schools, and Frederick Clements addressed the methods of botanical teaching. These presentations were followed by a discussion session let by John Coulter and Frederick Newcombe. The themes chosen were all from Ganong's Presidential Address two years earlier (Sundberg, 2014). Did Ganong choose not to go or did the organizers choose not to invite him?

To answer the question "Why this grudging recognition?", Ganong's biographer suggests the following.

> "Ganong's misfortune was to straddle two countries and several fields of research, which he was careful to keep separate…His life was so thoroughly

> compartmentalized that fellow workers in one compartment could not see into the next". (Rees, 2016, p. ix)

Upon Ganong's death, the chief of the map division of the U.S. Library of Congress commented:

> "Few geographers interested in cartography know that Ganong was eminent as a botanist and that his principal work was in that field. Conversely, I suppose many botanists do not know of his work in cartography and other allied geographical subject…his series of monographs on crucial maps in the early cartography and place nomenclature of the Atlantic coast of Canada constitutes one of the most important contribution in this field ever published in America" (Martin, 1942).

Rees and Martin are correct. But one might also argue that Ganong simply stopped publishing and shifted gears to teaching. Botanical publishing, yes, but publishing scholarship? Definitely not. Ganong's CV would list more than 600 published items (Box 2). More likely is that he was working at a predominantly undergraduate college and was not producing PhDs to promote his school of thought. For instance, among Cowles students were Victor Shelford, William Cooper, and Paul Sears, and among Bessey's were Fredrick Clements, Conway MacMillan, and Per Axel Rydberg—all of whom were prominent male scientists in their own right. Ganong's students were mostly undergraduates and all female. With this legacy, and at that time period, I suppose it is not too surprising that the BSA lost track of William Francis Ganong. I hope that now you will agree with me that he was indeed "the teaching botanist"!

BOX 2
Ganong's Publications
(more than 600 total published items)

- Bulletins of the Natural History Society of New Brunswick: 138 articles
- Botanical and other scientific writings: 64
- Botanical education: 33
- Historical Monographs: 14
- Historical Geographical Document: 49

LITERATURE CITED

American Society of Plant Biologists. 1941. William Francis Ganong, *Plant Physiology* 16(1): Plate 1 and dedication, 215-216.

Anonymous. 1902. The International Centralblatt for botany. *Science* 15: 196-197.

Anonymous. 1913. News and Notes. *Science* 37: 948.

Anonymous. 1916. Geographical Record. *The Geographical Review* 1: 225.

Barnes, C. R. 1905. The Vienna Congress. *Botanical Gazette* 40: 68-73.

Bessey, C. E. 1896. *The Essentials of Botany*. New York, Henry Holt and Company.

Bessey, C. E. 1901. Reviews of current botanical literature. *Science* 13: 298-301.

Bessey, C. E. 1905. *Botany for High Schools and Colleges, Seventh Edition*. New York. Henry Hold and Company.

Brixter, J. S. 1942. P. 16. *In:* J.C. Webster, *William Francis Ganung Memorial*. Saint John, New Brunswick. New Brunswick Museum.

Gager, C. S. 1910. Review of *The Teaching Botanist, Second edition*, by William F. Ganong. *Torreya* 10: 208-210.

Ganong, W. F. 1885. On the zoology of the invertebrate animals of Passamaquoddy Bay. *Bulletin of the Natural History Society of New Brunswick* 4: 87–97.

Ganong, W. F. 1891. On Raised Peat Bots in New Brunswick. *Botanical Gazette* 16: 123-126.

Ganong, W. F. 1894. Beiträge zur Kenntniss der Morphologie und Biologie der Cacteen *Flora* 40: 1-40. https://hdl.handel.net/2027/hvd.32044107241259 [accessed 19 July 2020. (see also Canadiana.org [archives.org]).

Ganong, W. F. 1895a, b. Present problems in the anatomy, morphology and biology of the Cactaceae. *Botanical Gazette* 20: 129-138, 213-221.

Ganong, W. F. 1895c. The Term Phytobiology. *Botanical Gazette* 20: 38.

Ganong, W. F. 1897a. Upon raised peat bogs in the Province of New Brunswick. *Transactions of the Royal Society of Canada*. Section IV, number vi: 131-163.

Ganong, W. F. 1897b. The Botanic Garden of Smith College. A study of an educational adaptation. *Garden and Forest* December: 512-514.

Ganong, W. F. 1898a. On Polyembryony and its morphology in *Opuntia vulgaris*. *Botanical Gazette* 25: 221–227.

Ganong, William F. 1898b. Contributions to a knowledge of the morphology of cactaceae. The comparative morphology of the embryo and seedlings. *Annals of Botany* 12:423-474.

Ganong, W. F. 1898c. Upon raised peat bogs in the Province of New Brunswick. *Transactions of the Royal Society of Canada*. III, iv, 131-163.

Ganong, W. F. 1898d. Society for Plant Morphology and Physiology. *Botanical Gazette* 25: 106-118.

Ganong, W. F. 1898e. News. (History of the founding of the Society for Plant Morphology and Physiology). *Botanical Gazette* 25: 143-144.

Ganong, W. F. 1899a. On polyembryoney and its morphology in *Opuntia vulgaris*. *Rhodora* 1: 127.

Ganong, W. F. 1899b. *The Teaching Botanist*. New York, The Macmillan Company.

Ganong, W. F. 1900. 10 January and 5 October letters to Dr. Oscar Urlworm, Editor-in-Chief, Botanisches Centralblatt. *In:* Society for Plant Morphology and Physiology, Minutes and Records.

Ganong, W. F. 1901a. The Cardinal principles of morphology. *Botanical Gazette* 31: 426–434.

Ganong, W. F. 1901b. A laboratory course in plant physiology. New York, Henry Holt and Co.

Ganong, W. F. 1903a, b, c, d. The vegetation of the Bay of Fundy Salt Marshes – an Ecological Study. *Botanical Gazette* 36: 161-186, 280-302, 349-367, 429-455.

Ganong, W. F. 1904. The cardinal principles of ecology. *Science* 19: 493-498.

Ganong, W. F. 1906. The nacent forest of the Miscou Beach Plain. *Botanical Gazette* 42: 81-106.

Ganong, W. F. 1908. A laboratory course in plant physiology, second edition, extended to form a handbook of experimentation for educational use. New York, Henry Holt and Company.

Ganong, W. F. 1910a. Some reflections upon botanical education in America. *Science* 31: 321–334.

Ganong, W. F. 1910b. *The Teaching Botanist, New and Revised Edition*. New York, The Macmillan Company.

Ganong, W. F. 1910c. The place of botanical gardens in collegiate instruction. *Science* 31: 644-648.

Ganong, W. F. 1913. *The Living Plant.* New York, Henry Holt and Company.

Ganong, W. F. 1914. *Ganong Botanical Apparatus for use in Plant Physiology A. General Catalog (second edition).* Rochester, N.Y. Bausch & Lomb Optical Co.

Ganong, W. F. 1917. The botanical equipment of Smith College: a study in educational adaptation. *Smith Alumnae Quarterly* 8: 183-191.

Ganong, W. F. and F. E. Lloyd. 1902. Third Report of a Committee Appointed by The Society for Plant Morphology and Physiology to consider the Formulation of a Standard College Entrance Option in Botany. *School Science* May: 1-8.

Ganong, W. F., F. E. Lloyd, and H.C. Cowles. 1908. Fourth report on the college entrance course in botany. *School Review* 16: 594-600.

Goebel, K. E. von. 1889, 1891. *Pflanzenbiologische Schilderungen* 1, 2. Marburg, N.G. Elwertsche Verlagsbuchhandlung. Website: https://www.biodiversitylibrary.org/item/16695#page/9/mode/1up [accessed 24 September 2020].

Goebel, K. E. von. 1898, 1901. *Organographie der Pflanzen, insbesondere der Archegoniaten und Samenfllanzen. 1, 2.* Jena. Gustav Fisher. Website: https://www.biodiversitylibrary.org/item/84403#page/5/mode/1up [accessed 24 September 2020].

Gregory, Emily L. 1895. *Elements of Plant Anatomy*. Boston, Ginn & Company.

Hanauer, D. I., D. Jacobs-Sera, M. L. Pedulla, S. G. Cresawn, R. W. Hendrix, and G. F. Hatfull. 2006. Teaching Scientific Inquiry. *Science* 314: 1880-1881.

Handelsman, J., D. Ebert-May, R. Beichner, P. Bruns, A. Chang, R. DeHaan, J. Gentile, et al. 2004. Scientific Teaching. *Science* 304: 521-522.

Martin, L. 1942. Page 11 *In:* J.C. Webster, William Francis Ganong Memorial. St. John, New Brunswick, New Brunswick Museum.

Minutes of the Council, Botanical Society of America, 1893-1926.

Minutes of the Council, Botanical Society of America, 1939-1949.

National Educational Association. 1894. Report of the Committee of Ten on secondary school studies with the reports of the conferences arranged by the Committee. New York, The American Book Company.

National Educational Association. 1899. Report of the Committee on College Entrance requirements. Chicago, University of Chicago Press.

Quinquennial Catalog of the officers and graduates of Harvard University, 1636-1895. 1895. Cambridge, University Press, John Wilson and Son.

Rees, R. 2016. *New Brunswick was his country: The life of William Francis Ganong*. Halifax: Nimbus Publishing.

Rodgers, A. D. 1944. *John Merle Coulter: Missionary in Science.* Princeton, Princeton University Press.

Seelye, A. B. 1932. Professor Ganong. *The Smith Alumnae Quarterly* 23: 407–408.

Smith Botanic Garden. 2020. Early History 1875-1920**.** Website: https://garden.smith.edu/about/history/early-history-1875-1920. Accessed, 12 July 2020.

Smith, E. F. 1898. The first annual meeting of the Society for Plant Morphology and Physiology. *The American Naturalist* 32: 96-110.

Smith, F. G. and H. A. Choate. 1941. William Francis Ganong, 1864-1941. *Science* 94: 317-318.

Smocovitis, V. B. 2006. One hundred years of American botany: A short history of the Botanical Society of America. *American Journal of Botany* 93: 942-952.

Society for Plant Morphology and Physiology. 1897-1906. Minutes and Records.

Sundberg, M. D. 2012. Botanical education in the United State. Part 2, The nineteenth century – Botany for the masses vs. the professionalization of botany. *Plant Science Bulletin* 58: 101-131.

Sundberg, M. D. 2014. Botanical education in the United States: Part 3, The Botanical Society builds the discipline, 1895-1960. *Plant Science Bulletin* 60: 28-61.

Sundberg, M. D. 2016. Botanical education in the United States: Part 4, The role of the Botanical Society of America (BSA) into the next millennium. *Plant Science Bulletin* 62: 132-154.

Tippo, O. 1958. The early history of the Botanical Society of America. *In:* Steere, W. C., *Fifty years of botany: Golden jubilee volume of the Botanical Society of America*, New York, McGraw-Hill.

Trafton, G. H. 1902. A comparison of recent authorities on methods of teaching botany. *The School Review* 10: 138-145.

Webster, J. C. 1942a. William Francis Ganong (1864-1941). *Transactions of the Royal Society of Canada* 36: 9.

Webster, J.C. 1942b. *William Francis Ganong Memorial*. St John, New Brunswick, New Brunswick Museum.

Wynn, G. 2017. Review of Ronald Rees, New Brunswick was his country: The life of William Francis Ganong. *The Acadiensis Blog*, September 13, 2017.

SCIENCE EDUCATION

BSA Awarded $3.9m Grant for PlantingScience

Grant will continue developing teacher/scientist collaborative professional development and researching Plantingscience.org's effectiveness

The Botanical Society of America is extremely excited to announce that we have recently received a 5-year, $3.9M grant from the National Science Foundation! The NSF Discovery Research K-12 program (DRK-12) will fund the new project, titled "Comparing the Efficacy of Collaborative Professional Development Formats for Improving Student Outcomes of a Student-Teacher-Scientist Partnership Program: PlantingScience F2"(Grant #2010556). We will be working closely with BSCS Science Learning, education researchers from the University of Colorado: Colorado Springs, and PlantingScience partnering organizations to carry out the grant. We refer to the newest grant as "PlantingScience F2" as a reference to the second filial generation concept in genetics: the new project represents the recombination of ideas from two previous funding rounds. The F2 project builds on previous research on PlantingScience, which showed improvements in student achievement and attitudes toward scientists.

By Dr. Catrina Adams, *Education Director*

Dr. Jodi Creasap Gee, *Education Technology Coordinator*

PlantingScience.org

BSA developed the PlantingScience online mentoring program in 2005 as a low-barrier way for scientists to get involved in K–12 education. Partnerships and mentoring support from 18 other scientific societies have enriched the program over the past 15 years. In 2011, the program won a Science SPORE prize as a valuable online resource. One of the unique features of

PlantingScience is its availability to all students in the classroom rather than just to those who are high-achieving or able to participate in extracurricular programs. Each of 10 available PlantingScience themes takes small teams of students through guided investigations that prepare them for culminating, independent investigations of their own choosing. Each student team works with a volunteer scientist mentor who motivates and helps them develop research questions, design experiments, analyze data, and interpret results. One of the unique features of PlantingScience is its availability to all students in the classroom rather than just to those who are high-achieving or able to participate in extracurricular programs. Student teams communicate asynchronously with their mentors through the PlantingScience website, where they can discuss their research, upload photos and files, and ask for feedback. Students can also ask their mentor about what they do as a scientist. Over 30,000 students, 275 teachers, and 1000 scientist mentors have participated in PlantingScience since 2005. Participating teachers come from 45 states and five countries, and mentors come from 39 countries.

Digging Deeper (DIG)

The new F2 grant will include a replication of the research conducted as part of our previous NSF-DRK 12 grant, "PlantingScience Digging Deeper Together - A Model for Collaborative Teacher/Scientist Professional Development" (Grant #1502892, $2.9M, 2015-2021). We designed the DIG research as a cluster-randomized, pre-test/post-test control group impact study to determine the effectiveness of PlantingScience's Power of Sunlight photosynthesis and respiration module to improve students' science achievement and attitudes about scientists. Sixty-four teachers and 1535 students participated in the research study. The students came from schools that are highly generalizable to the overall population of U.S. high schools according to available 2012-2013 Common Core data. We randomly assigned teachers to either (1) participate in a week-long summer collaborative teacher/scientist professional development and then participate in the PlantingScience online mentoring program with their students in the fall, or (2) teach photosynthesis and respiration topics as they usually would during the fall semester. We designed pre- and post-test questions to link science concepts and practices around photosynthesis and respiration. We gave both sets of teachers prior access to the assessment questions and learning goals. An additional pre- and post-test evaluated students' attitudes about scientists.

Our research's core finding was that implementing the Power of Sunlight module combined with high-quality PD for teachers and scientists resulted in positive and statistically significant effects on student achievement and attitudes toward scientists (standardized mean effect size $g = 0.284$ and 0.280, respectively). Future students of these teachers also benefited as 75% of participating teachers continue to use materials from the module, and evaluators reported significant gains in teachers' preparedness to support student science learning generally. Early-career scientists also benefited from the experience, making them more aware of best practices in instruction. As one interviewed PlantingScience scientist related, "...It made me realize that a lot more can go into a lecture than just PowerPoint... I want to give students experiences like those high school students are experiencing."

The new project builds on PlantingScience and Digging Deeper

This newly funded research has the potential to add important data to the science education literature. First, it will serve as a replication study to substantiate and confirm the findings of the Digging Deeper research. These replication studies are rare but are increasingly recognized as important. A new component of the research will be the development and testing of an online collaborative teacher/scientist professional development format so we can test the effectiveness of this approach compared with a face-to-face approach for professional development. The online format, if effective, should enable many more teachers to take part in a cost-effective way. When we recruit teachers to participate in this project, we will make sure to focus on teachers who serve rural and underserved areas. We want to reach students who do not have access to scientist mentors or who do not feel they can succeed in science. The new grant will also allow us to continue refining our PlantingScience web platform to make it easier to use and to implement new accessibility features.

The BSA community's continued support will help make this project successful

Scientists who volunteer to serve as mentors for students are integral to the success of PlantingScience and this upcoming research study. We welcome scientists to sign up as mentors for PlantingScience, and we anticipate that this new project will require many new mentors. Stay tuned for a call for volunteer mentors as the grant moves forward. We will need your help and expertise to make this effort a success!

We are incredibly grateful to the BSA community for the continued support of this unique and powerful program for bringing plant biology into middle and high school classrooms. Your volunteer mentoring efforts, the programmatic assistance you provide as part of the Master Plant Science Team, and your donations over the years have kept this program growing. We are proud of the success of PlantingScience and its value as a model for successfully leveraging scientists' passion and expertise in service to the next generation of scientists and informed citizens.

THANKS TO PLANTINGSCIENCE'S EARLY-CAREER SCIENTIST SUPPORT TEAM

PlantingScience student teams need personalized attention and monitoring to ensure they get scientist feedback at key points in their investigations. To provide this level of support requires a strong and dedicated team. We are excited to welcome Dr. Gwynne Lim as our new PlantingScience intern for the fall 2020 session. Gwynne is also working as the Executive Secretary of the International Commission on Zoological Nomenclature. Before that, she earned her Ph.D. in Plant Biology at Cornell University in 2018, and her Masters and Bachelors of Science (Biological Sciences) at the National University of Singapore in 2010 and 2007, respectively. She

Dr. Gwynne Lim interns with PlantingScience starting Fall 2020.

has been talking peoples' ears off about science, nature, and natural history as a volunteer or instructor for over 15 years. Interns help get the website set up for participating teachers, coordinate the Master Plant Science Team's work, and help monitor and support hundreds of active student teams.

We'd also like to recognize the 2020-2021 Master Plant Science Team (MPST) cohort. These graduate students and postdocs serve as mentors to teams of students and as liaisons for PlantingScience teachers. They help teachers find suitable mentor matches for their teams and step in to help keep all the student/scientist and teacher/mentor conversations going strong. This fall BSA is supporting 16 scientists on the MPST: **Asawari Albal, Foong Chee, Chloe Drummond, Fiona Duong, Ana Flores, Sara Johnson, Jared Meek, Rebecca Panko, Lydia Paradiso, Chelsea Pretz, Klara Scharnagl, Tatyana Soto, Cameron Sweisthal, David Thomas, Lydia Tressel,** and **Bethany Zumwalde.**

Members of the MPST make it easier for high-school teachers to teach more plant biology in the classroom, which is so essential to capturing student interest and increasing appreciation for plants. Please thank them for their service to the field!

Learn more about the benefits and requirements of being on the MPST and consider joining next year's MPST cohort of graduate students and postdocs: https://plantingscience.org/joinmpst. Applications will open at the end of this academic year.

THE TREE-MENDOUS BENEFITS OF TREES! NEW PLANTINGSCIENCE INVESTIGATION THEME

PlantingScience staff is pleased to introduce a new investigation theme created by PlantingScience mentor Dr. Monica Lewandowski, with support from the American Phytopathological Society. Teachers and faculty can use the new "Tree-mendous Benefits of Trees" module as a stand-alone module if pressed for time in their curriculum or can use it to introduce or supplement one of our other investigation themes. In the module, students are encouraged to go outside—in their backyard, neighborhood green space, or on campus—and make detailed observations of the trees around them before investigating various ways to estimate the benefits those trees provide. The module is well suited for distance learning during the pandemic. More information on this new module is available at: https://plantingscience.org/benefitsoftrees.

RECORD ATTENDANCE FOR VIRTUAL 2020 LIFE DISCOVERY: DOING SCIENCE CONFERENCE

The Life Discovery: Doing Science Conference is a stand-alone education conference for high-school teachers and undergraduate faculty cohosted by the Botanical Society of America, The Ecological Society of America, and the Society for the Study of Evolution. We recently held the sixth Life Discovery Conference with the theme "Biology Education in an Evolving Landscape." The virtual format made attendance easier and less expensive, and a record ~200 faculty and teachers were able to attend, about double the usual attendance. Highlights included daily keynotes: "Ecology Education goes 4D" (Dr. Ken Klemow), "Taking Steps Toward Multidimensional Learning with 4DEE" (Dr. Luanna Prevost), "Reclaiming the 'Intro' in Introduction Biology" (Dr. Bryan Dewsbury), and a keynote panel on "Online Teaching and Learning - Undergraduate and High School" which featured "My very own Bioblitz" (Dr. Concepcion Rodriguez-Fourquet), "The SIFT Virtual Experience: How being thrust into virtual learning was just the kick in the pants we needed!" (Andy Klingensmith), and "The Power of Place-based Ecology and Online Possibilities during Distance Learning" (Jordan Gonzales).

The Life Discovery Conference is a highly interactive conference, with many discussion opportunities around the conference themes. Despite moving to a virtual format, discussion and interaction were preserved through a program that included an Education Share Fair where participants could share work-in-progress, Panel Discussions and Breakouts, and small group Networking Topic discussions. Attendees enjoyed the practicality of the conference topics and the ease-of-access that the virtual format provided. One attendee wrote: "I really appreciated this conference and the focus on practical applications of ideas. I've attended other similar events that were more focused on theories, analyzing effectiveness data, etc. (all of which are worthy pursuits, of course), but those experiences left me wondering, "How do I actually apply this?" I teach non-majors classes at a community college and I was able to benefit by the presentations made by colleagues teaching at a variety of levels."

The 7th Life Discovery: Doing Science Conference will be held next October in Estes Park, CO, from Sept 30-Oct 2, 2021. The theme is "Pushing Past Barriers: Ecological Science for All." Please save the date and consider presenting. A call for proposals is open until December 27, 2020. Check out the conference website for more information: http://www.esa.org/ldc.

STUDENT SECTION

Shifting Gears: Fieldwork, Benchwork, and Greenhouse Studies during COVID-19


By Shelly Gaynor and Imeña Valdes
BSA Student Representatives

COVID-19 is continuing to shape botanical research moving forward, but it remains important, despite the barriers it may currently face. Recent publications highlight some of these changes; for example, Vandebroek et al. (2020) discussed the barriers COVID-19 has placed on ethnobotanical research. Additionally, Weng (2020) highlighted that research involving plants is extremely important for treating infectious diseases, controlling future pandemics, and finding solutions to other crises (e.g., climate change).

This summer, we collected BSA members' experiences with COVID-19. Since it remains persistent, we want to continue to share stories and advice from BSA members. Responses included messages of hope and moving forward, despite big changes to research plans and physical and mental well-being. In addition, there were stories sharing defeat. Everyone has been impacted differently from COVID-19, and returning to fieldwork/benchwork/greenhouse work may be too risky for some.

We know that this is a hard time for students, even more so for those starting or finishing degrees. If you are currently in transition, try to stay connected with your previous mentors and lab mates. Connect with other BSA students via the new BSA Slack. Find out more ways to interact with BSA at: https://tinyurl.com/y82ff94b. Also check out the Botany2020 Virtual Networking Board at: https://tinyurl.com/yau5uqgb.

FIELDWORK

Elena Loke

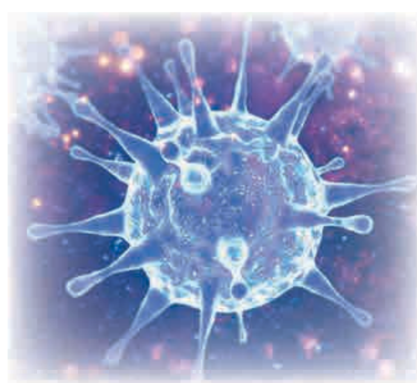
"This spring I was going to be doing lab work and in the summer I had planned to do fieldwork in Hawaii. My lab work has been shifted to this fall and winter, and to take the place of the fieldwork I included more phylogenetic analyses. When COVID-19 began, I had not started lab work or fieldwork, so my plans were not interrupted, only modified. However, the focus of my research has changed from being more about conservation, which would have involved the fieldwork, to more about testing newer analytical methods with the increased number of phylogenetic analyses. Despite these changes, I expect to graduate within the normal 2-year MS timeframe. Fortunately, I am still able to use all the funds from the grants I was awarded this winter/spring because I didn't budget for any travel. During these times, it has been very important for me to be flexible and adaptable and to maintain open, honest communication with advisors and peers. Every day I remind myself of the things for which I am grateful and that I am learning new things, even if they are not what I expected to be learning before COVID-19."

Diego Paredes-Burneo
Louisiana State University

"I had a trip to Peru for this past September, but it got cancelled. Since it was a collaboration with the New York Botanical Garden, it gets more complicated (especially in the future) due to this institution's budget administration. I am currently doing lab work, but I am doing everything (beginning with DNA extractions) from scratch: no one could guide me. Because of this, my learning process has become longer than planned."

Bryan MacNeill
University of Alabama

"I was going to start my field work in Mexico this last summer with a single collaborator from National Autonomous University of Mexico (UNAM). I had to cancel my field work completely because of travel restrictions. However, I've been able to get in contact with multiple herbarium curators and professors at institutions across Mexico to get specimen samples for my molecular work. Never be afraid to "cold email" someone to ask for help—you would be surprised how willing people are to help! Now I have cultivated collaborative relationships with professors and curators from across Mexico, and look forward to meeting with them when I eventually get to go!"



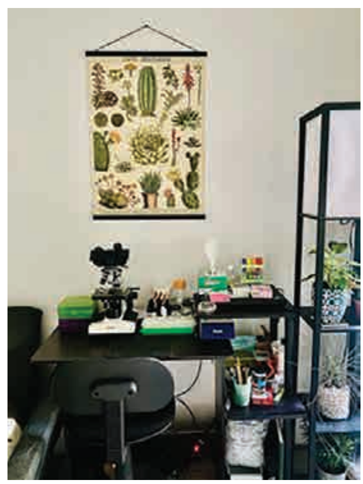
Sara Johnson
University of Illinois: Urbana-Champaign

"When COVID-19 stay-at-home orders were put in place, I had just returned home from a conference in Georgia. I was in the stage of preparing models for field validation during my field season from June to August. We put off the decision to cancel the field season as long as possible, but lodging was continually difficult to find, work permissions were challenging to get, and long-distance travel and coordinating safe logistics was consistently risky throughout the summer. Fortunately, this was the second year of data for my MS project, and essentially extra data; however, it was disappointing to miss out on a year of fieldwork, data collection, and experiences. Fortunately, I have been able to adapt my project and formulate a plan for wrapping up my thesis work mostly uninterrupted. Also, we were fortunate to have our grant extended for continued and ongoing work. I am grateful for the extra time it has given me to focus on restructuring my thesis goals, work on a manuscript, and begin writing earlier than I had anticipated, as well as the time to take care of myself during these stressful times."

BENCHWORK AND GREENHOUSE

Allison Miller

"We developed separate standard operating procedures, schedules, and maps to space people out in the lab. In the field, we put together detailed standard operating procedures for each individual field site. The Plant Growth Facility at my institution constructed detailed schedules, spacing plans, and protocols for safe greenhouse work. The result has been that we have fewer people working at any one time, the hours people are working have moved to earlier and later in the day to accommodate the most work at lower densities, people are spaced out in different areas of the lab/field, and everyone is wearing masks at all times."



Bethany Zumwalde
University of Florida

"Although my research was stunted by the pandemic, I was able to adapt my work and set reasonable goals to move forward. When COVID-19 began, I had just started to collect data for my project. When stay-at-home mandates were implemented, I utilized that time to work on writing grants and papers. Access to campus became heavily restricted and I had to quickly improvise by transforming my small apartment into a greenhouse and lab. My porch became jam-packed with cacti sent from collaborators, and I was able to purchase a cheap phase contrast microscope to set up in my living room for chromosome counts and epidermal peels. Fieldwork was the trickiest part to navigate during the pandemic. I had originally planned to recruit an undergraduate student to assist me with fieldwork in Texas, but this was simply not an option at that time since most students had moved home to quarantine. Luckily, a good friend and fellow researcher volunteered to help me in the field. We prioritized collecting at remote roadsides and limited our interactions in public spaces. Ultimately, my research was able to progress with resourceful solutions, maintaining reasonable expectations, and a huge amount of help from others!"

Sarita Muñoz-Gómez
University of Antioquia

"By the time the pandemic started in Colombia, I was in my last semester. Since we are required to do an undergrad dissertation before we graduate, I was just finishing my lab work and starting my bioinformatics work, plus writing. I was lucky because I could continue with my work mostly from home. Sadly, we did have to leave a few experiments out of my dissertation, since for the first few months of lockdown, entry to the lab was completely restricted. Of course, all our lab meetings had to be online, which made work a bit harder. Only one person was permitted into the lab at least for the first months, so he had to make sure everything was still working. Since we have plants in our lab, they all had to be taken to our PI's home to be taken care of, but our aquatic plant (*Aponogeton madagascariensis*) could not be transferred. I think my biggest tip is to keep communicating with your lab mates and to try to make the most of your time at home by writing, reading, or learning new skills. I also found a great science community on Twitter during quarantine, so I would suggest you join!"

MUSEUMS

Anonymous

"Before COVID-19 I was starting to conduct lab work on the plant fossils. Due to COVID-19, I cannot conduct the collection visits I had planned to do at the Field Museum in Chicago and European Collections. I also planned using SEM to study my specimens at the Field Museum, which is no longer possible. Regarding collection visits, that part of my project is no longer possible, and I have decided to remove that aspect of my project. Instead of conducting SEM, I am attempting to take close up photographs on my own or pay to have my specimens scanned at different institutions."

MENTAL HEALTH AND MOVING FORWARD

Tracey Simmons

"I graduated in December [2019], right before the pandemic. This put me in a difficult position. Because I've graduated, my affiliation with the lab at my undergrad institution is different. I would like to continue on to a graduate degree, but the pandemic has impacted my mental health in such a way that I do not feel I could be successful before a vaccine is available. I have tried to apply for jobs, but strict protocols in my area mean there are almost none available. I'm essentially unable to do anything, despite wanting very much to be working or doing research."

Unfortunately, this is only one example of how COVID-19 is negatively affecting students. It should be noted that COVID-19 affects different marginalized groups in a myriad of ways and to be conscious that your experience during this pandemic is not universal. We thank those who have openly shared their struggles with us and on social media and shed light that we are not alone in this.

It is essential to destigmatize mental health in academia, to create an inclusive environment, and support those in our community struggling with mental health. Depression and anxiety are about two to six times more likely in graduate students compared to the general population (Levecque et al., 2017; Evans et al., 2018). The pandemic has most likely increased the prevalence of mental health issues among students; as noted above, it has already greatly impacted career and research trajectories. Specifically, mental health disorders were found to have doubled among graduate and professional students in 2020 compared to 2019 (see Chirikov et al., 2020). **If you are currently struggling with mental health, know that you are not alone.** We do recommend reaching out for help:

- Mental Health America, resources for finding the right mental health care for you: https://www.mhanational.org/finding-right-mental-health-care-you
- ULifeline - mental health resources by university: http://www.ulifeline.org/static/must_select_a_school
- Active Minds (chapters at many universities) - resources for students: https://www.activeminds.org/

Though we recommend seeking out a professional to discuss your mental health, we want to share apps designed to help with anxiety, stress, and mindfulness:

- Shine: https://www.theshineapp.com/
    - For calming anxiety and stress
- Headspace: https://www.headspace.com/
    - For meditation, sleep, stress, and mindfulness

As students, we play many roles in our communities and have the ability to shape the future of academia. Therefore, there are many ways we can support our peers, mentees, and community now and in the future. Below we summarize just a few and provide some relevant literature.

Support Your Peers

Mental health resources have historically been limited. Do you know if your university provides mental health services? Know your options and share them with your lab mates and peers. At the University of Florida (UF), a Biology graduate student mental health committee reviews the graduate student health insurance and UF options each year, providing the rest of us a list of resources we can take advantage of. Setting up informal support networks is an amazing way to support your peers.

Support Your Mentees

To briefly summarize Cooper et al. (2020), mentors can support undergraduate researchers with depression by:

1. recognizing students depression as a valid illness,
2. encouraging a positive supportive lab environment,
3. developing personal relationships,
4. treating undergraduates with respect and praising them, and
5. normalizing failure.

Suggested Reading:

- Cooper, K. M., L. E. Gin, M. E. Barnes, and S. E. Brownell. 2020. An exploratory study of students with depression in undergraduate research experiences. *CBE—Life Sciences Education* 19: ar19.

- Cooper, K. M., L. E. Gin, and S. E. Brownell. 2020. Depression as a concealable stigmatized identity: what influences whether students conceal or reveal their depression in undergraduate research experiences? *International Journal of STEM Education* 7: 1-18.

Build an Inclusive Lab

As we continue in our careers, we hope to see the academic culture shift to be healthier and more inclusive (of mental health and more). Evans et al. (2018) highlighted the need to enhance access to mental health support and cultural changes. The papers below discuss creating environments that support the mental health of students, post-docs, and lab members.

Suggested Reading:

- Maestre, F. T. 2019. Ten simple rules towards healthier research labs. *PLOS Computational Biology* 15: e1006914.

- Ålund, M., N. Emery, B. J. Jarrett, K. J. MacLeod, H. F. McCreery, N. Mamoozadeh, J. G. Phillips, et al. 2020. Academic ecosystems must evolve to support a sustainable postdoc workforce. *Nature Ecology & Evolution* 13: 1-5.

- Dewa, C. S., K. Nieuwenhuijsen, K. J. Holmes-Sullivan, A. K. Singh, and G. Drakakaki. 2020. Introducing plant biology graduate students to a culture of mental well-being. *Plant Direct* 4: e00211.

We hope to continue to recommend "Papers to Read for Future Leaders" to BSA Student members. If you have papers you would like us to include, please share it with us via this Google form: https://tinyurl.com/y5dp8r4m.

LITERATURE CITED

Chirikov, I., K. M. Soria, B. Horgos, and D. Jones-White. 2020. Undergraduate and Graduate Students' Mental Health During the COVID-19 Pandemic. *UC Berkeley: Center for Studies in Higher Education*.

Cooper, K. M., L. E. Gin, M. E. Barnes, and S. E. Brownell. 2020. An exploratory study of students with depression in undergraduate research experiences. *CBE—Life Sciences Education*. 19: ar19.

Evans, T. M., L. Bira, J. B. Gastelum, L. T. Weiss, and N. L. Vanderford. 2018. Evidence for a mental health crisis in graduate education. *Nature Biotechnology* 36: 282.

Levecque, K., F. Anseel, A. De Beuckelaer, J. Van der Heyden, and L. Gisle. 2017. *Research Policy.* 46: 868–879.

Vandebroek, I., A. Pieroni, J. R. Stepp, N. Hanazaki, A. Ladio, R. R. N. Alves, D. Picking, et al. 2020. Reshaping the future of ethnobiology research after the COVID-19 pandemic. *Nature Plants* 6: 723–730.

Weng, J.-K. 2020. Plant solutions for the COVID-19 pandemic and beyond: Historical reflections and future perspectives. *Molecular Plant* 13: 803-807.

Getting Started in Tropical Field Research

Hi again everyone—this is your former BSA student rep, Minya. I hope you're staying safe and healthy, and taking good care of your physical and mental health. Back in 2019, Shelly and I decided to do a fieldwork-related student section for the Plant Science Bulletin *to help everyone prepare for all the fieldwork that was supposed to happen in 2020. But then, as we know, COVID changed our world and we had to postpone the fieldwork issue. Now, as we are trying our best to improve the current situation, we are happy to finally publish the essay that we invited Dr. Kadeem Gilbert to write.*

When I was trying to find a friend who has a lot of fieldwork-related insights to share, Kadeem came to my mind immediately. Surely, Kadeem has done fieldwork many times, particularly in Southeast Asia, but I also believed that we can learn so much more from him besides the logistics of how to do fieldwork. He travels around the globe not just to study the pitcher plants in different places, but his curiosity about the histories and the cultures of the regions are also infectious. He embraces different cultures fully, learns the languages (he speaks six languages!), becomes a strong advocate for them back in the U.S., and shows the beauty of them to everyone.

This fieldwork essay comprised two parts. In the first part, Kadeem gave some practical tips and guides for students who plan to do fieldwork. In the second part, Kadeem told us a vivid and thrilling story during one of his fieldworks that made even him have the thought of "I will stop doing tropical fieldwork."

Enjoy!

By Dr. Kadeem Gilbert
USDA-NIFA
Postdoctoral Research Fellow
Pennsylvania State University,
University Park, PA
E-mail: kjg5649@psu.edu

I have about a decade of experience doing tropical fieldwork, which began with in 2010 as an undergraduate. It is now 2020 (I find it hard to believe), and in the past year I finished grad school and started a postdoctoral fellowship. Despite not being exceptionally outdoorsy as a child—I grew up in a fairly urban part of New Jersey and spent far more time reading about biology than I did actually going outside—I had always fantasized about going to distant countries to explore tropical ecosystems. How does one actually get started doing tropical fieldwork as part of their career? If you're an undergrad and like me didn't do much camping as a kid, I would recommend gaining some field experience (any field experience) as soon as possible to determine whether fieldwork is truly for you before fully committing to it as a career.

The idea of fieldwork may sound exciting and glamorous in the abstract, but there are many difficulties involved: strenuous climbs, hot and muggy temperatures, torrential downpours, and biting mosquitoes. There are many great programs out there that offer experiences in tropical field biology for undergraduates, including Operation Wallacea and the Organization for Tropical Field Studies (OTS). It is a great idea to apply for programs like these if you think you may want to do a lot of field research in your career, whether in or outside of academia. To get my feet wet as a junior, I did both an NSF REU (National Science Foundation Research Experiences for Undergraduates) program based in Indonesia, as well as a Drexel-run study abroad program, which is open to students from all universities and incorporates field research in addition to classes, in Equatorial Guinea. In my case, this was after I got acquainted with doing local temperate fieldwork.

The best way to do fieldwork as a graduate student is to apply to work with an advisor who has experience doing fieldwork in the specific country you are interested in. Know that the exact process for getting all of the necessary permits to do research in a foreign country depends on the country, and it can be quite long and arduous—for some countries moreso than others. So, if you have a specific country in mind, it's definitely to your advantage to keep that in consideration and factor it into your application process if you're currently thinking about applying to grad school. If you're already a grad student and it's not the case that you're working with someone who has an active research program in your specific country of interest, your advisor can at least help you find another researcher to connect with who knows the specifics of your target country. It may also be important to keep an open mind and be flexible about where to work. I went into graduate school strongly desiring to work in Indonesia, but I ended up doing projects in Singapore and the Philippines instead because it was easier to get permits to do the work that I wanted (I work on Southeast Asian pitcher plants) in a more convenient time frame.

All in all, my major tips for fieldwork (especially tropical fieldwork abroad) boils down to having a network of people to support you:

- Make connections with researchers already working in your region of interest; they can help you with the specifics of the permit application process. It may also be possible to initiate your fieldwork more immediately by getting added to their existing permit and joining an upcoming expedition they've planned.
- The longer or more remote the expedition, the more important it is to have a team of people with you, including experienced fieldworkers who understand all of the logistics.
- The most successful field expeditions will include local guides on the team; they know the land better than any visitor could ever hope to, and they are the most prepared to respond to any emergencies that result from run-ins with dangerous flora or fauna. The cultural exchange that comes from interacting with local people is also one component that makes fieldwork enjoyable and exciting. You might consider learning the local language to enhance this experience.
- Always be prepared for challenges at every step. This can refer to the research itself (you might sadly find that forces beyond your control impede data collection, maybe you get to your site and find out that a drought has caused your plants to dry up and die), but it also applies even more to personal safety. Be mindful of your steps (literally) when climbing precarious slopes or walking through thick vegetation. Wear long sleeves and pants to protect your skin from insect bites and spiny vegetation, and make sure it's a breathable quick-dry material. A wide-brimmed hat can protect you from the oppressive heat of the equatorial sun, and wearing a bandana is useful for keeping sweat out of your eyes.
- Keep a resolved constitution in the face of an emergency.

I initially wanted to talk about my fieldwork experience overall to expound upon some of these points above. I wanted to give a brief summary of an incident in 2014 to illustrate the principle of keeping a resolved constitution in the face of an emergency, but once I began writing, I felt compelled to go into more detail about the experience—a story that I have recounted many times to friends in person, yet up until now neglected to write down (I lament my constant failure to keep a journal). I decided to write out this entire narrative. I will preface this by saying that I don't want to scare anyone out of doing fieldwork, but this is a tale of extreme danger and fear. It recounts a life-threatening event that did make me reconsider continuing to do fieldwork, but it did not stop me. It also, I believe, touches upon how some of the points above can keep you safe and secure in the field. I hope you enjoy.

FIELDWORK: BOTH PLEASURE AND PAIN

It is June of 2014, and I am in a small clinic in a small town almost in the middle of nowhere in the southern tip of the island of Luzon, the Philippines. My entire body is in pain like I've never felt before (or since). It's difficult to even describe how intense it was at the time; I think my brain refuses to let me remember the full extent of the sensation. It was as if jolts of lightning were electrocuting my muscles, and I could barely move. How did I get here? Just a few hours ago, I actually was in the middle of nowhere, up on a ridge of a caldera on Mount Bulusan. My expedition team had hiked up something like 8 or 10 hours to get up to the point where we pitched our tents, in the flat crater surrounded by ridges on all sides, towering in a 360-degree panoramic view. (How surprised I was to still see such sharp relief in the landscape at that point, after all we had already scaled.) The site was absolutely breathtaking—some of the most gorgeous, awe-inspiring, unspoiled tropical forest that I've had the pleasure of seeing (and fortunately I've experienced a few such places both before and afterwards).

When we had arrived at part of the caldera, it was late afternoon and we had time to rest and plan for the morning. You see, this was meant to be our home base for a few days, but not the final point—there was more climbing to do to find what I wanted. I mentioned I was with other researchers, but our goals were not the same. We (me, two other scientists, and our local field guides) had already broken apart from the larger group we had arrived at Bulusan with; the rest of the group remained at a lower elevation site. I was then going to break off from the other two scientists the next morning to work in a different part of the site (though of course the plan was for us to meet back up at the home base each evening for the 3 to 4 days we planned to be there). These two invertebrate zoologists quickly identified which of the surrounding slopes they would use to search for ants and harvestmen. I was actually kind of tagging along on this big expedition made up mostly of entomologists, and I as a fairly early grad student was just scouting the site as a possible new project site. I was looking for *Nepenthes*, and I asked one of the guides where I might find some of the plants (I pointed to photos in my *Field Guide to the Pitcher Plants of the Philippines*). Whereas the invertebrate zoologists had decided on a relatively flat slope to the left of where we were facing, the guide pointed to a slope on the exact opposite side—it looked almost vertical in its ascent. He said that they (some other park rangers were already stationed up here in addition to the ones who climbed up with us) had just started cutting a trail up that section recently, and it might be a bit dangerous because the potential trail is still nonexistent and the slope is thickly covered in spiny rattan (Calamoideae). However, they caught sight of some *Nepenthes* during their initial bushwhacking. He asked if that's the spot I wanted to climb in the morning, even though it might be a bit dangerous, and I, keen to find my plants, thought about it seriously for a few seconds and answered, "Yes, definitely". I did not know it, but the next day I would end up at the clinic.

With our respective plans in place, we rested that evening and did a little exploring of our immediate surroundings. I tracked the sound of a calling frog and located him (possibly a *Platymantis*) calling from his perch in a water-filled *Pandanus* leaf axil. On that same plant, I found a crab nestled in the furrow of another leaf—quite interesting to find a crab so far from the sea! I wondered if that species was fully terrestrial like the neotropical bromeliad crab; it would make sense, considering that the pockets of water in *Pandanus* definitely host frogs as bromeliads do. I am all about studying the tiny ecosystems in plant-held waters (phytotelmata), which is the main thrust of what I continue to focus on with *Nepenthes*.

Anyway, I realize I probably have held you readers in suspense for too long. First thing in the morning, the other two scientists and a couple guides headed to their slope, and I with one guide headed up mine. It was not the anticipated dangers that brought me to the hospital: the steepness didn't end up bothering me that much, and my long sleeves and pants protected me from the rattan spines (I even had on thick work gloves, as suggested by my guide). My point in telling this story is that there is always a risk of unexpected incidents in fieldwork like this; I had accepted that risk by choosing to do tropical fieldwork, but experiencing a real emergency actually solidified my perception that the risks are worth it. Today, I do not regret making the decision to climb up that slope, even though it was the singular event when I most feared for my life. My climb that morning was cut short by a vicious bee attack. It came unprovoked, without warning; I never even saw their nest. We had climbed maybe only about an hour and had just gotten to a relatively flat point and took a brief pause, when the first one suddenly appeared flying *toward* me and bombarded me in the forehead.

I turned to my guide who was behind me at the moment to say, "I think I just got stung!?!" (with a tone of puzzlement), but in that very instant the rest of her swarm descended down upon us. Puzzlement then instantly became pure terror as bees entirely covered my view. There were literally hundreds of them (a conservative estimate) and dozens of them (again, a conservative estimate) proceeded to sting me all over my face and head throughout the course of this attack. I could smell the astringent scent of their pheromones as the stings continued. The sound of their loud buzzing filled the air (to this day, any buzzing sound can make my heart skip a beat), and at one point I felt one actually crawl into my ear. From the start of this attack, the guide shouted that we have to get down and urged me to move quickly, but after being stung several times that very first minute—they came one after the other—my body immediately felt weak. Numb is not the right word, as I felt the intense bodily pain, but I mean I was numb in that it became hard to lift my limbs. On top of that it was a very steep descent and gravity could overtake me even if I were in full control of my limbs. Furthermore, I could not see where I was going due to my efforts to keep the bees away from my eyes at least (I swung my bandana in front of my face and angled my head down), but on top of that there was no trail to even see—it was thick vegetation all around.

We were both getting stung, but I was apparently bearing the brunt of the attack as I was the larger target and less able to navigate away. Also, I had never been stung before in my life—I didn't truly *know* that I wasn't allergic. I owe my life to several brave guides who worked together to get me to safety. The one guide with me on the slope at this time got on his walky-talky to call up some more who were at the base camp. They helped me get back down to the tents as quickly as possible. The bees continued to sting me until we made it back to the tents, after maybe 30 minutes that felt like an eternity. (Adding to the puzzlement of this unprovoked attack: if they were defending a hive, why continue attacking me long after moving away from the place that it started?) A couple of guides lay me down in a hammock and pulled the stingers out of my face and head. I said, "I think I may need to go to a hospital"; I could barely even move a finger and my entire body was on fire with pain. Also, I could not hear out of my right ear since there was a bee lodged in it. I told the guides about the bee in my ear, but they couldn't see it and said I might be mistaken—maybe the hearing loss was an effect of all that venom.

Using the hammock as a stretcher, a cadre of guides carried me down all the way to the base of the mountain (in apparently a fraction of the time that it took us to climb up, since the sun had not yet set when I left the hospital) and down further to the nearest road out here in the middle of nowhere. I'm not sure, but I think it was luck that eventually a vehicle passed by, and eventually one with the capacity to take me in as a passenger. (It was one of those motorcycles with an attachment in the back—not a comfortable ride, but thankfully I did not throw up again as I did going down the mountain).

So, to return to where I began the story: the doctor gave me an antihistamine shot at the clinic and said that my swelling should subside and that I'd recover in a few days. I asked if she could remove the bee from my ear. Puzzled, she looked in with an otoscope and didn't see anything at first (it must have been deep in there), but then succeeded getting that dead *Apis dorsata breviligula* worker out with forceps. We were all shocked to see just how large the insect was—it was difficult to imagine how it could fit in my ear. I kept the specimen in a vial of ethanol and carried it around with me throughout the rest of the trip like a trophy. I initially intended to bring it back to America with me to keep it always as a memento, but I ended up donating it to science when I ran into a bee taxonomist in Singapore who, after IDing the species for me, stated that he was working on doing a species delimitation for the *Apis dorsata* complex (he suggested that several subspecies might need to be elevated to species status) and asked me if he could keep the specimen.

This might all sound like an unimaginable nightmare to you, reader, and it certainly was to me at the time. However, my point is not to dissuade anyone from fieldwork; it did not discourage me. While I was being attacked, I honestly thought I was going to die and felt fear like I never felt before or since. One of the many thoughts that flashed in my head was that if I got out of this situation, I would never decide to do fieldwork again. While I was being carried down the mountain in the hammock-stretcher, I amended this thought to, "I will stop doing tropical fieldwork." Laying on the actual stretcher in the clinic, I thought, "I'll never do fieldwork in a really remote site again, but I want to continue doing tropical fieldwork." I felt unable to climb back up Bulusan to complete the plan of staying at the caldera site for the remainder of the week—the attack happened on the first morning at the caldera, and sadly I didn't even see any pitcher plants on that slope—but I chose not to leave the Philippines.

After recovering for 2 or 3 days, I was flying over to the next island that my main expedition team had planned visiting, and I happily (if slightly apprehensively) climbed yet another remote mountain. I am actually not a "thrill-seeker-type." Despite such adventures, I don't see myself as an Indiana Jones rushing headlong into danger. I'm just so fascinated by the natural world and so love every moment of being out in the wilderness that it drives me to take these calculated risks. Even the negative experiences are worth the chance to experience nature's grandeur, which is truly awesome in the classical sense of the word. The good and the bad, the pleasure and the pain, are two sides of the same coin that imparts upon me the intense, ineffable emotion that can only come from Nature. Nature to me is like living art, and while fieldwork has inspired me to write stanzas like "Only the cleansing/Rays of the sun upon me/Can distill my pain," it has inspired many more stanzas of pure awe and wonder like "The mountains exhale/Ethereal white breath spews/Forests join with sky" or "Countless insects scream/In polyphonic chorus/Wondrous night music."

All in all, I sincerely hope that any student reading this with the passion to do so gets to experience amazing fieldwork like I have—and stay safe!

FROM THE *PSB* ARCHIVES

60 years ago

Wilson Stewart discusses recent controversies in paleobotany:

"For the past five years I have become increasingly perplexed by the frequency of articles supporting the claim that vascular plants with lycopsid affinities occurred in the Cambrian. If the evidence justified the conclusion, then this would be one of the most spectacular paleobotanical finds since Lang and Cookson's (1935) discovery of bona fide vascular plants in the Silurian rocks of Australia."

--Stewart, Wilson N. "More About the Origin of Vascular Plants" *PSB* 6(5): 1-5.

50 years ago

"Harlan Banks presents the Address of the Retiring President of the Botanical Society of America, presented at the Society's annual banquet, August 26. 1970, at Bloomington, Indiana.

"Yes, I visualize the day when we'll know many Devonian plants as plants rather than as isolated organs, when we'll be able to speak intelligently about habitats and associations, when we'll know the length of time that was required to evolve new species, and the algae from which vascular plants did evolve. I think we'll learn whether the origin of vascular tissue was related to the origin of metabolic pathways for the manufacture of lignin (perhaps in the Silurian). I think we'll know much more about the possible role of O2 concentration in the atmosphere, its role in the formation of ozone, and their role in shielding Earth's surface from lethal ultra-violet radiation, thus permitting the occupation of dry land. And of course I'll be watching for confirmation of my wildest statement, actually a primitive attempt at precision, that all the phylogenetically important innovations among vascular plants are found during the 50-million-year adaptive radiation of land plants that occurred in the Devonian Period. Ted Delevoryas has picked me up on this one and allowed as how all the evolution after Devonian time was just 'frosting on the cake.'"

--Banks, H. P. "Chipping Away at Early Land Plants: Of People, Places, and Perturbations" *PSB* 16(4): 1-6.

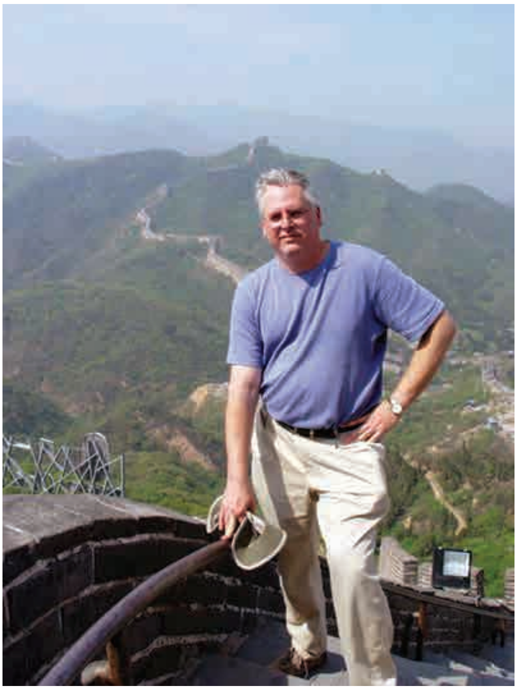
40 years ago

Paul B. Conant, President of Triarch, Inc., a supplier of microscope slides since 1926, has asked that members of the Botanical Society write to him to assist in the decisions relating to the continuation of the firm. The squeeze between rising costs and reduced educational budgets has placed the company in the position where it is unable to meet increased salary requirements. Mr. Conant would like to hear from members as to their needs for prepared slides in years to come and other information on the problems associated with Triarch.

--HELP!. *PSB* 26(4): 29.

ANNOUNCEMENTS

In Memoriam



BRIAN JOSEPH AXSMITH (1963–2020)

It is with great sadness that we share that our friend and colleague Brian Joseph Axsmith, 57, of Mobile, AL, passed away on May 5, 2020. Brian contracted the COVID-19 virus and in combination with other health issues succumbed to its virulence. His battle with the virus was brief but valiant.

Brian was born in Pottstown, PA on June 3, 1963. He was the son of the late Joseph J. Axsmith. He is survived by his mother Kathryn Boyer Axsmith; son Jeffrey Tristan Axsmith, who often visited while he worked; his companion and loving wife Jennifer; and sister Doreen Axsmith Inmon, with whom he remained close.

Brian describes his early school years as a time when he was not an especially good student. But his curiosity about nature drove him to places where he collected snakes and frogs, but in a limited number because his mother was not particularly fond of having to share space with these creatures in her house. His interest in fossils and collecting them began at an early age. As is somewhat typical of kids, the captivation of dinosaurs and their ancient remains fueled his imagination and no doubt had some bearing on his interests in studying the ancient remains of the Earth. At this point, he had little interest in the fossil remains of plants, but it is apparent by his life's work that his choice to focus on these important organisms became far greater than he could have possibly imagined.

Brian graduated high school (St. Pius X, Pottstown, PA) in 1980, and from there moved on to Millersville University of Pennsylvania in Millersville, PA. One of his professors at Millersville University, where Brian developed a curiosity for fossil plants, became his mentor. In fact, he published his first paper before even contemplating graduate school, describing Triassic fossil plants from the Stockton Formation in Pennsylvania with his good friend Peter Kroehler (who now works on fossils at the Smithsonian Institution in Washington, DC). His botany classes with Millersville professors Dr. David Dobbins and the late Dr. James Parks played a key role in his interest in living plants.

His early educational experiences at Millersville University, Pennsylvania, where he received his Bachelor of Science degree, no doubt set a course for his continued interest in biological sciences, a direction that would steer him toward paleobotany. This love of paleobotany subsequently guided him to The Ohio State University, where he would begin his pursuit of a doctoral degree under the guidance of Thomas N. Taylor. Apparently one of the reasons that Taylor accepted him into his lab was something Brian often related in a post-graduation story about a conversation between Tom and Brian's father. It went something like this:

Joseph Axsmith: What did you see in Brian to accept him into your lab?

Tom Taylor: His intense work ethic—he is a hard-working S.O.B.

His time at The Ohio State University was cut short and a sudden change of venue sent him to the University of Kansas, where he completed the requirements for his degree. In 1998 his status officially changed to Dr. Brian Axsmith, a title he achieved with honors. After a short post-doc, Brian secured a position as an assistant professor at the University of Southern Alabama in Mobile in 1999 and rapidly rose through the ranks to become full professor.

Over the next 20 years, he built an impressive academic career in which he played many roles within his department and the university. He was a committee member for multiple M.S. students in both the Biology Department at University of South Alabama and at the University of Mobile. He served as chairperson to three graduate students (Debra Stults, M.S., 2003, and Ph.D., 2011; Elizabeth Creen, M.S., 2006; and Patrick McAnerny, M.S., 2019) who completed projects focusing on various paleobotanical questions. Additionally, he provided guidance and mentorship to at least 10 undergraduate students involved in numerous paleobotanical topics. He also had the opportunity of hosting a post-doctoral

Axsmith collecting near Monroeville, AL.

palynologist from Nepal (Farhat Iqbal) in which they explored Mesozoic and Neogene localities. His work with colleagues from the U.S., South America, Europe, and China produced several significant publications, which are cited frequently.

Early in his career (1990), Brian received the Outstanding Biology Student Award from the Commonwealth of Pennsylvania University Biologists, which is given to a student who best exemplified scientific scholarship and achievement. This extraordinary honor of distinction is given to one student. The award represents the qualities and knowledge possessed by students who attend the State System of Higher Education Universities. In 1993 he received the prestigious Isabel Cookson Award, presented by the Paleobotanical Section of the Botanical Society of America. This award is given to the student who delivers the best contributed paper in paleobotany or palynology at the Society's annual meeting. In 2003 he received the Arts & Sciences Junior Faculty Award for Excellence in Scholarship and Academic Achievement. His many accomplishments were further recognized by the national honor society Mortar Board, which is made up of college seniors from around the country. Mortar Board members select outstanding educators for their devotion to academia, teaching style, accessibility, knowledge of their subject, and other special qualities unique to the educator. He received this honor in 2007, 2009, 2013, and 2014. In the 2014–2015 academic year, Brian received the Dean's Lecture Award, which is presented for excellent scholarship or academic achievement throughout the faculty member's career. It was also at this time that he received the Olivia Rambo McGothern Outstanding Scholar Award, given by the USA National Alumni Association for excellence and high achievement in an academic discipline.

His academic activities were just a part of what made Brian tick. He enjoyed participating in various activities in and around the Mobile area. He also loved to get others involved in the collecting of fossils, be it students, interested local collectors, or local groups of teachers or geologists. His passion for his research and studies was reflected by the crowds he drew and his popularity among students. He was gifted with a talent for explanation and often could accept a sudden request for presentation without much preparation because he could develop the topic "on the fly." He became involved in the Evolution vs. Creationism debates presented on campus, which were also open to the public. He adeptly presented the facts and handily countered the opposition so much so that he was asked to serve in this capacity several years in a row.

At all times Brian was on the lookout for new and previously discovered sites with fossil floras. His early research centered on Mesozoic floras and included those from multiple continents including Antarctica, Asia (northeastern China), and North America (Chinle Formation and Newark Supergroup). When he moved to Alabama, he became involved with one of the floras that Edward Berry had worked on during the early 20th century. This "rediscovery" began a two-decade revival of the Citronelle Flora (late Pliocene). He continued collecting and working on other localities including eastern North American Cenozoic floras extending from the Oligocene and into the lower Pliocene. He was particularly interested in these areas due to the lack of a good published fossil record for the region. His interests extended into the Pleistocene flora along the Mobile River. These floras are currently awaiting further investigation.

By now his reputation and the fact that he was local (now from Alabama) opened additional doors for research, which included the Ingersoll Shale flora (Cretaceous). With the help of Mississippi paleontologist George Phillips and Mississippi geologist James Starnes, he was able to acquire local material, and Mac Alford from the University of Southern Mississippi helped with the acquisition of material from middle Miocene Hattiesburg Formation.

Brian's love of paleobotany and the many rewards that came with it provided opportunities for him to discover the treasures of past life. His love for fieldwork, whenever and wherever the opportunity arose, never wavered and his enthusiasm for removing tons of rock, which, on some occasions would reward him with a bounty of fossil plants or teach him the value of wearing gloves and digging in the right place, remained ever present. Working in the field with a diverse group of prominent or amateur collectors gave Brian a great sense of paleontological history and of those who contributed to it and to new types of collection techniques. The values of hard work and observation were subsequently passed on to his colleagues and students alike. He knew the benefits of teaching, especially when the facts were presented in an understandable and unbiased way. To keep science simple and interesting meant that he could reach a larger group of people where the benefits would be far reaching. His research and professional career allowed him to travel the world collecting material, from the back roads of Alabama to the remote wilderness of China. The collection of material, especially from the Mobile area, allowed him to publish numerous scientific papers representing his ideas and interpretations on various groups of fossil plants. Some of these papers will ultimately stand the test of time; others may not be so lucky. At times, his research challenged the ideas of his colleagues, which he thought was necessary to keep the field of paleobotany moving forward. His academic contributions will remain etched in stone, which ultimately show a legacy of career success through hard work and commitment.

Brian represented the best within us, and he knew that hard work and perseverance would ultimately provide rewards that few people could ever achieve. His role as a husband, father, scientist, colleague, and friend will forever be remembered and occupy a place in our hearts where it will live on. He will be most dearly missed by his wife Jennifer and son Jeffrey and by those who had the opportunity to cross paths with him. His kindness and witty humor will remind us that life is a precious gift that allows us a fleeting moment to pursue our dreams and to make the world a better place. For the short time that Brian was with us, he earned the trust, respect, and friendship of countless individuals from many walks of life. As we go forward, let us remember to use his many contributions and examples as a guide to enrich our own lives and the lives of others we know. May our friend rest in eternal peace and never be forgotten.

--Rudolph Serbet, University of Kansas, and Debra Stults, University of Southern Alabama

Note: A special fund has been set up in honor of Brian by the University of Southern Alabama. All contributions will be used to support the Brian Axsmith Memorial Scholarship in Biology: https://giving.southalabama.edu/axsmith.

MEMBERSHIP NEWS

YEAR-END GIVING

BSA is proud to provide over $125,000 in awards and grants to our members every year. Most of these are funded directly by the generosity of our members via donations to specific award funds. Professional members are also given the opportunity of increasing their annual dues by $25 in order to support the Graduate Student Research Award fund. We are pleased to say that over 60% of our Professional members opted in to support the GSRA in this way, allowing for over $24,400 in additional funds for the GSRA in the last fiscal year. Thank you!

We hope that you will consider making a donation to our many funds including student, professional, and sectional award funding when you renew your membership this year. You can also visit www.botany.org and click Donate to start giving.

THIS IS THE SEASON OF GIVING GIFT MEMBERSHIPS!

Do you know a student or developing nations colleague that would benefit from being part of the BSA community? BSA offers gift memberships for these two membership types for only $10 each! You can purchase gift memberships during your renewal process or go to www.botany.org, click on Membership on the top menu, and then click Gift Memberships.

We are giving back! Any gift membership recipient who starts their membership before January 31, 2021 will be entered into a drawing for a free registration for Botany 2021!

Got questions about your membership? Email Amelia Neely at aneely@botany.org.

By Amelia Neely

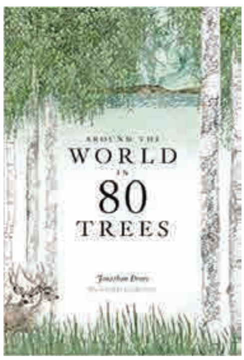
BSA Membership & Communications Manager

E-mail: ANeely@botany.org

BOOK REVIEWS

Around the World in 80 Trees

Jonathan Drori; illustrations by Lucille Clerc
First published 2018. Paperback first edition 2020. ISBN 9781786271617 hardcover; 978-1-78627-606-3, paper
Hard cover, $24.99; paper, $19.99; Kindle $16.25; £12.99; 240 pp.
Laurence King Publishing Ltd., London.



Adapting Jules Verne's title of *Around the World in Eighty Days*, Jonathan Drori's fantastic adventure—his metaphorical circumnavigation—introduces reader to a selection of trees that are prominent to the cultures of each named country, organized geographically: Northern Europe, Southern Europe and North Africa, eastern Mediterranean, Africa, Central and South Asia, East Asia, South East Asia, Oceania, South America, Mexico, Central America and Caribbean, North America.

What a winning combination! The stunning illustrations by Lucille Clerc illuminate the rich text by Drori about iconic trees, from the mundane, Brooklyn's Tree of Heaven (*Ailanthus altissima)*, to Missouri's majestic Black Walnut (*Juglans nigra)*. Trees as diverse as the bulky long-lived, fruitful Baobab (*Adansonia digitata*), are juxtaposed with delicate domatia-bearing whistling thorn (*Vachellia drepanolobium)*, featured together in this compact volume, packed with botanical details.

Drori's writing is dense with facts and entertains on each page. Every tree biography is filled with dynamic writing (e.g., Pomegranate: "The turgid grains interlock satisfyingly with one another—a triumph of efficient packing" and "Perhaps we shouldn't dismiss the psychological benefits of a fruit whose consumption requires our undivided attention"). Sir Jonathan's endeavors earned him the prestigious award in December 2006—Commander of the Order of the British Empire (CBE), the highest-ranking Order of the British Empire award—rewarding contributions to the arts and sciences, work with charitable and welfare organizations, and public service outside the civil service.

Drori brings decades of expertise to Trees, as a BBC Executive Producer and Director, responsible for more than 50 popular BBC science and technology documentaries and series. He prepares short films for plant- and seed-collecting expeditions and is also known for several TED talks on pollen, seeds, and flowers that have been viewed more than 3 million times. He is Trustee of The Eden Project, a member of the Council of Ambassadors of the World Wildlife Fund, and a former trustee of The Woodland Trust and the Royal Botanic Gardens, Kew. He is Chairman of Ravensbourne University London, a Fellow of the Linnean Society and the Zoological Society of London, a full voting member of British Academy of Film and Television Arts, and a Visiting Professor at Bristol University, specializing in science misconceptions.

Clerc is a meticulous illustrator with seasoned artistic ability strengthened by intelligence that informs every stroke she places, applying subdued browns and green colors. She works within the field of editorial design and illustration and produces most of her work using hand-drawn images, with considerable attention to detail. She is also well known for her influential graphics of broken pencils following the Charlie Hebdo attack. Together, Drori's essays and Clerc's sketches present a visually rewarding travelogue crammed with botanical and cultural information.

Associations of animals with the trees that support them are also featured, e.g., the mopane worm intrinsic to *Colophospermum mopane*, a large caterpillar in the Emperor moth lifecycle that feeds primarily on mopane tree leaves and is a popular snack in Namibia and Zimbabwe, which is a food staple in rural areas and regarded as a highly nutritious delicacy. Goats graze fruit and leaves in Morocco's Argan trees, *Argania spinosa*, oblivious to their thorns. Thereafter, the goats excrete or spit out the nuts of argan fruits, which can later be retrieved from the goats' manure, for processing into a precious edible oil, which is also utilized in expensive cosmetics.

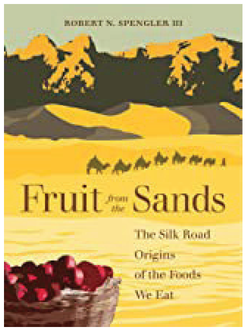
The book opens with the English London Plane, *Platanus acerifolia*, "a tree of pomp and circumstance," first planted in Berkeley Square, Mayfair, in 1789. A hybrid of the American sycamore and the Oriental plane, it has been adopted by urban planners worldwide; in fact, it's the most common street tree in New York City. India's sacred Banyan tree, *Ficus benghalensis*, revered in temples, offers sanctuary and inspiration; Berlin's best-known boulevard, Unter den Linden, is named after *Tilia europaea* with its intoxicating, sweetest, most powerful perfume known to the plant kingdom.

This book's paper cover is heavy, thus durable; the book is well bound and stitched, and the pages are sturdy to withstand being thumbed through often. The script, which reads like a love letter to Mother Earth, should be required reading in biology classes, introducing a semester's worth of environmental science study in delightful form. I am completely won over by this collaboration. It may seem unusual to gush over visual aids in a reader about trees, but this beautiful volume is a page-turner, propelling readers forward with imaginative drawings of each tree, and its folklore and uses.

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

Fruit from the Sands: The Silk Road Origins of the Foods We Eat

Robert N. Spengler III.
2019. ISBN 9780520303638
Hardcover, $34.95; £29.00;
eBook, $34.95; £29.00. 392 pp.
University of California Press,
Oakland



The Nobel Peace Prize 2020 awarded to the World Food Program for its efforts to combat hunger and its contribution to bettering conditions for peace in conflict-affected areas sparked my interest to read *Fruit from the Sands*. Robert Spengler's interdisciplinary endeavor refers to a broad array of archaeological, botanical, and historical evidence as he traced crop movement from every direction: north, south, east, and west across the regions of Central Asia. Through the preserved remains of plants found in archaeological sites, his field exploration, revealed through photos, encompasses Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, along with Central Eurasia, adjacent regions to the north and east: western Mongolia, the Tuva region of Russia and Xinjiang, Qinghai, and Tibet in China. The focus of previous renowned scholars (e.g., Vavilov and Harlan) has been on major agricultural centers of crop origin: the Near East, the Far East, etc. Here, Spengler introduces the vast region between these centers, the core of a complex network of interaction and exchange. Central Asia was the crossroads of the ancient world for five millennia; some of the largest empires in the ancient world were located there.

Spengler, Archaeobotany Laboratory Director of the Max Planck Institute for the Science of Human History, presents the subject with a geographic introduction to the region and chapters tackling many regional foods: millets, rice, barley, wheats, legumes, grapes and apples, leafy vegetables, roots and stems, spices, oils, and tea. Spengler devoted considerable research to expanding information about the domestication of the "charismatic" apple, sufficient to result in additional extended scholarly publications (Spengler, 2019, 2020). One of the most economically and culturally significant temperate fruit crops, apple provides the opportunity to study the domestication process in trees. The number and identity of the progenitors of the domesticated apple and the erosion of genetic diversity associated with the domestication process have been debated. The Central Asian wild apple has been identified as the main progenitor, but Spengler examines other closely related species along the Silk Route. Beyond originating in the Tien Shan Mountains, along the core artery of the ancient Silk Road, the trade routes themselves gave rise to our modern fruit. Genetic studies have demonstrated that the apple is a hybrid of at least four wild apple species. Three of these wild apples had large fruits before humans came along, and they represented easy targets or "low-hanging fruit" for early foragers. People were likely maintaining the populations of these wild apple trees for thousands of years before they started moving the seeds along the Silk Road. Eventually, as people started planting apple trees across Eurasia, they brought these four wild populations into contact. Bees naturally pollinated them, and the resulting offspring represent distinct hybrids with desirable traits, notably larger fruits.

Spengler depicts a surprising concentration of archaeological remains across the fertile mountain foothills of Inner Asia. Increasingly, as archaeobotanical finds become more prevalent in these regions, the sites are providing evidence for crop cultivation and, in many cases, elaborate farming systems. The past residents of this region fostered the spread of innovations along the Silk Road, along with advances of their own, including the domestication of a series of fruit trees. Parts of Central Asia were centers of intellectual thought during the Islamic Golden Age, and vast luxurious palaces with elaborate gardens were erected for various Turkic rulers. However, increased nautical trade in the 13th century, clinched by the Mongol invasions, caused overland trade via Central Asia to gradually lose its prominence. The destruction of irrigation systems, salination of soils, and the deforestation of the mountain foothills likely contributed to the fall of Inner Asia. The final defeat was undoubtedly colonial advances from Europe—starting with Russian conquests.

Together with my admiration for this work, I have a few slight criticisms. The index is incomplete; it omits entries that I located during careful searches for specific terms. Surprisingly, some crops of importance in the region were omitted (e.g., Spengler barely mentions mulberry, widely consumed in the region [Bedigian, 2020]). Assessing the book by way of his single page on the subject of sesame, it is disappointing to note that Spengler fails to cite any primary source (e.g., Bedigian 2011, 2014, 2015), referring instead, twice, to a secondary source. He reports no archaeobotanical investigation, omitting our archaeobotanical evidence from Xinjiang (Qiu et al., 2012).

The unique contribution of this book is its ability to bring evidence from archaeological plant remains to life, in a style that could be readily appreciated by readers with a variety of interests.

LITERATURE CITED

Bedigian, D. ©2011. Introduction. History of the cultivation and use of sesame, pp. 1-31. *In* D. Bedigian (ed.) Sesame: the genus *Sesamum*. Medicinal and Aromatic Plants - Industrial Profiles series. CRC Press, Taylor & Francis Group, Boca Raton, FL.

Bedigian, D. 2014. A new combination for the Indian progenitor of sesame, *Sesamum indicum* L. (Pedaliaceae). *Novon* 23(1): 5-13.

Bedigian, D. 2015. Systematics and evolution in *Sesamum* L. (Pedaliaceae), part 1: Evidence regarding the origin of sesame and its closest relatives. *Webbia: Journal of Plant Taxonomy and Geography* 70: 1-42.

Bedigian, D. 2020. An extended commentary about *Mulberry* by Peter Coles [2019. Reaktion Books, London]. *Plant Science Bulletin* 66: 145-150; 164.

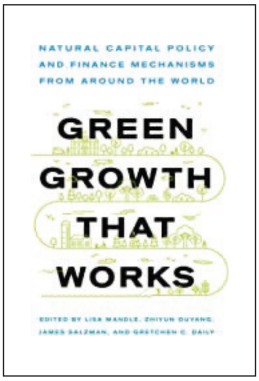
Qiu, Z., Y. Zhang, D. Bedigian, X. Li, C. Wang and H. Jiang. 2012. Sesame utilization in China:New archaeobotanical evidence from Xinjiang. *Economic Botany* 66: 255-263.

Spengler, R. N. 2019. Origins of the Apple: The role of megafaunal mutualism in the domestication of *Malus* and Rosaceous trees. *Frontiers in Plant Science* 10: 617.

Spengler, R. N. 2020. Anthropogenic seed dispersal: Rethinking the origins of plant domestication. *Trends in Plant Science* 25: 340-348.

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

Green Growth That Works: Natural Capital Policy and Finance Mechanisms Around the World



Lisa Mandle, Zhiyun Ouyang, James Salzman, and Gretchen C. Daily (eds.)
2019.
ISBN: 978-1-64283-003-3
Paperback, US$35.00.
336 pp.
Island Press, Washington, DC

Amidst the dire news about environmental degradation and climate change, an international network of scientists and social leaders has been steadily generating positive change in the way we perceive and use natural resources. Building on the idea that ecosystems provide services essential to human life—for example, fresh water, soil fertility, climate and air quality regulation—the 1992 United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, called for nature valuation, or the integration of environmental and economic value, as a component of sustainable development (Potschin and Haines-Young, 2016). A decade later, a tremendous effort resulted in the Millennium Ecosystem Assessment, a series of global-scale status and trends reports that document the links between economic development, ecosystem impacts, and human well-being. These two steps, nature valuation and ecosystem assessment, are at the heart of the natural capital approach to "inclusive green growth" described in *Green Growth That Works: Natural Capital Policy and Finance Mechanisms Around the World*. The book is an edited collection of case studies that highlight the many ways that cities, watersheds, and even nations have utilized spatial data and innovative partnerships to design policies that acknowledge the true costs of natural resources extraction.

The editors and authors of *Green Growth That Works* are experienced practitioners of the natural capital approach. They are experts from the government, financial, and research sectors that, along with civil society organizations, compose the partnerships necessary to implement "nature-based solutions" to the main challenge of our time: How will we raise the standard of living for all humans while securing the irreplaceable benefits of nature for future generations? *Green Growth That Works* is intended to function as "a practical guide to how policies and finance mechanisms have been implemented… across a diversity of contexts" (p. 7). A tone of optimism pervades the book and inspires action in an arena notoriously difficult to navigate.

The book is organized into three parts: an overview of the natural capital approach, descriptions of successful finance and policy mechanisms, and examples of system-wide change and innovation. Each chapter includes case studies illustrating the diversity of geographic contexts, scales, and ecosystem services involved. A standard format for the case studies includes details such as: the ecosystem service(s), beneficiaries and providers, terms and mechanism for the transfer of value, and key lessons learned. This feature is the book's key strength; it demonstrates how to transform a tangle of location-specific details into an approachable problem and provides practitioners with a framework for dialogue and action. Capacity-building, for example, emerges as a precondition to financing in cases as diverse as Indonesia's Readiness Fund and Belize's Integrated Coastal Zone Management Plan. How to redesign existing policies is demonstrated across different geographic scales by a catchment-scale study of the Fowey River in England and an analysis of forest conservation mechanisms in Costa Rica.

Green Growth That Works uses standardized flow diagrams to depict the flow of money and assignment of tasks for six finance mechanisms and their modifications. The diagrams enable a quick comparison of the mechanisms and function as reference points for navigating the case studies. Government subsidies, for example, flow from the government to the providers of an ecosystem service needed by the public, while eco-certification is a market-based mechanism that relies on consumers paying for services directly. In both cases, the public benefit originates on private land, and quality is determined by land management practices. The Conservation Reserve Program (CRP) in the U.S. and the Rainforest Alliance (RFA) coffee certification program illustrate these two approaches to agricultural payments.

The CRP recognizes that securing public goods derived from private land requires landowner support. Private landowners may resist absorbing the cost of improved management that lowers yield, such as reducing fertilizer to improve downstream water quality. The alternative is that society must bear the cost of treating water through higher payments to a water utility. The CRP incentivizes improved management by paying farmers an annual rental fee to convert sensitive croplands to natural vegetation.

The RFA program is an example of commodity, or supply chain, certification that uses performance standards to generate a premium price for sustainably produced coffee. Agricultural commodity certification can secure a number of ecosystem services related to soil, water, land cover, and biodiversity. Again, these services benefit the public, but the funding mechanism is private: both the farmers paying for certification and the consumers purchasing certified coffee support the enhancement of natural capital. The RFA standards also include social benefits such as fair treatment of workers. The CRP case study highlights the role of government in both securing and monitoring water quality improvement, whereas the RFA example demonstrates the use of third-party certifiers to evaluate compliance.

Additional case studies in Part II explain regulatory mechanisms, voluntary mechanisms, water funds, and multilateral and bilateral mechanisms. The chapter on water funds is especially insightful; it demonstrates the synergy resulting from coordination of diverse stakeholders and the range of benefits secured by implementing long-term investments. For those new to nature valuation, the two tables describing the Upper Tana-Nairobi Water Fund explain benefits in both environmental and economic terms. In fact, *Green Growth That Works* includes many figures and maps that, although small and grayscale, serve to communicate the types of data that are generated during an ecosystem assessment and reveal why this approach is crucial for empowerment, inclusion, and discussion of alternatives.

The systemwide application of the natural capital approach in China and Costa Rica, described in Part III, provides a glimpse of a future in which we prioritize the preservation of socio-ecological systems and stem the tide of environmental degradation. Opportunities remain for proactive planning and greater inclusion of poor and marginalized people who often live in areas with high-value natural capital. *Green Growth That Works* is an excellent sourcebook of ideas and demonstrates that the acquisition of natural capital through inclusive and life-enhancing strategies is no longer theory but a real possibility. The writing is accessible, and reference lists at the end of each chapter can further guide readers who are unfamiliar with the philosophy and science of ecosystem assessment. This book should be added to the toolkit of anyone directly involved in natural resources policy, including educators and science communicators who seek to share information about developments in conservation finance.

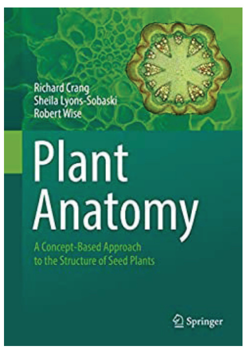
LITERATURE CITED

Potschin, M. and R. Haines-Young. 2016. Ecosystem services in the twenty-first century. In: M. Potschin, R. Haines-Young, R. Fish, and R.K. Turner (Eds.), *Routledge Handbook of Ecosystem Services* (pp. 1-9). Routledge.

—Andrea G. Kornbluh, Member, Botanical Society of America

Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants

Richard Crang, Sheila Lyons-Sobaski, and Robert Wise
2018. ISBN: 978-3-319-77208-0
e-book: 51 €. 725 pp.
Springer



Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants by Crang, Lyons-Sobaski, and Wise is a beautifully illustrated, 600+-page textbook highlighting the wonderful diversity of anatomical form in plants. The layout of the chapters follows many traditional plant anatomy textbooks, as one would expect from a book designed for the classroom. *Plant Anatomy* begins with an overview of plant morphology and proceeds through evolutionary time and across systems (Chapter 1: The Nature of Plants) before zooming into the microscopic, internal world of plant structures and their function (Chapter 2: Microscopy and Imaging, through Chapter 8: Phloem). Quite fortunately, historical context is described throughout these sections, highlighting seminal studies that have shaped the plant sciences over the past 300+ years.

The book includes an overview of the fascinating diversity of the major plant groups, stunning microscopic images that scientifically and artistically present the comparative shapes and structural proportions across groups. My attention was focused on photos and microscopy images so much (e.g., Fig. 2.9 of autofluorescence of a blade of grass) that I almost missed some of the interesting biographical sections of founders of the field. For example, Katherine Esau was an immigrant due to war who worked to develop a disease-resistant sugar beet before being recruited to graduate school, after which she wrote multiple, foundational textbooks in plant anatomy and received the National Medal of Science in 1989. Plant anatomy students will easily engage with this historical overview and introductory material but should be encouraged to focus on microscopy images and ensure they understand them early on since they are a prominent component throughout the textbook.

The vegetative structures section (Chapter 9: Epidermis, Chapter 10: Roots, Chapter 11: Stems, Chapter 12: Leaves) includes contemporary studies and goes deeper into function than similar textbooks in plant anatomy. Each chapter includes colorful photographs to show living examples of the anatomical characteristics and functions being described. Most chapters also include diagrams and microscopy images of major characteristics and important, sometimes recent findings in the field. All readers will appreciate the bolded text indicating corresponding definitions in the substantial, 20+-page glossary.

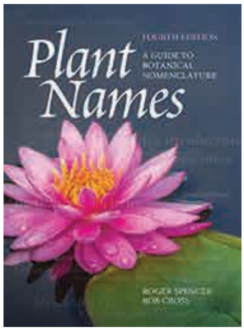
The most interesting and engaging chapter describes the structural diversity of external and internal anatomical features that secrete oil, tannins, resins, salts, etc. from trichomes, cavities, ducts, and idioblasts (Chapter 13: Secretory Structures). This might be the most interesting chapter because of how easy it is to anthropomorphize plants when reading about and seeing microscopy images of physical defense structures including trichomes, colleters, and stinging hairs. Or maybe it's reading about and seeing floral nectaries of a milkweed plant, learning how they manipulate pollinator behavior with complex anatomical structures that force the pollinator to remain on the flower long enough to ensure pollen will likely transfer to the next flower it visits. This chapter might also be the most engaging because of the images of calcium oxalate crystals that are illuminated with polarized light, showing the sharp, pointed, almost fear-inducing structures that, when consumed, "… can lead to a severe numbing of the mouth and throat and a temporary loss of speech."

Each chapter concludes with a Chapter Review section including a Concept Review subsection, which does exactly that. These sections also have standard quiz-like review questions, some multiple-choice answers or free response, and some with fill-in image identification or matching definitions to representative images. The value of visual aids in recalling information and definitions in the Chapter Review is clearly demonstrated when reading about diagnostic characters in wood (Chapter 15: Wood: Economics, Structure, and Composition). A challenge here is to go through microscopy images for 10 species and match the images to descriptions one would use to identify species or products, possibly for forensics in the global furniture and lumber economies. Readers will learn the difficulty of taxonomic identification with fine-scale descriptions including, "Diffuse-porous; solitary and radial multiples; large to very large pores in no specific arrangement, very few; tyloses abundant; parenchyma vasicentric, lozenge, confluent, and marginal; narrow to medium rays, spacing normal." Fortunately, the authors make the process of learning plant anatomy concepts non-burdensome since the layout and progression of the chapters allows instructors to slowly build on concepts presented in previous chapters.

Overall, Crang, Lyons-Sobaski, and Wise clearly created *Plant Anatomy* to make the topic accessible and engaging to students at both undergraduate and graduate levels. The gorgeous pictures and colorful diagrams draw attention to interesting patterns and processes in the plant world and act as the backdrop to well-written, engaging, and contemporary text that will enable readers to enjoy learning about the structure of seed plants.

Author's note: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

-Daniel E. Winkler, Research Ecologist, U.S. Geological Survey, Southwest Biological Science Center



Plant Names: A Guide to Botanical Nomenclature, Fourth Edition

Roger Spence and Rob Cross
2020.
ISBN-13: 978-1486311446
Hardcover, US $29.95.
212 pp.
CSIRO Publishing, Clayton, Victoria, Australia

The rules and requirements surrounding the naming of plants can be quite daunting: the language is full of jargon and terms in Latin, the smallest difference in spelling can mean a big difference in plants, and the names seem to be constantly changing. *Plant Names: A Guide to Botanical Nomenclature, Fourth Edition* lays out the complications associated with naming plants in a clear, concise, and beginner-friendly manner. Roger Spence and Rob Cross, horticultural botanists at the Royal Botanic Garden Melbourne, carry on the work originally started by the late Peter Lumley, to whom this latest edition is dedicated. This book is separated into four main sections that address different aspects of botanical nomenclature.

Part one is dedicated to the naming of wild plants. The authors discuss the historical and cultural uses of common names as well as the utility of Latin or scientific names. Multiple examples help the reader understand both the value and confusion that can arise with both types of names. This section moves on to discuss the *International Code of Nomenclature for Algae, Fungi, and Plants*, and the fourth edition includes references to the updated ICN. This section also explains the hierarchical nature of biological classification, the naming of new taxa, and what to do with name changes. Overall, part one is a great primer for plant systematics.

In the second section, the authors discuss the naming of cultivated plants, or cultigens. This includes detailed definitions (including the differences between "cultivated plants" and "cultigens"), as well as the details of introducing and naming new cultigens, with references to how this process differs from wild plants. They also discuss aspects of marketing names, plant breeder's rights, and trade designations. The fourth edition includes new information on intellectual rights as they relate to cultigens. I enjoyed the historical illustrations found in this section and learned quite a bit about the cultigen side of plant names!

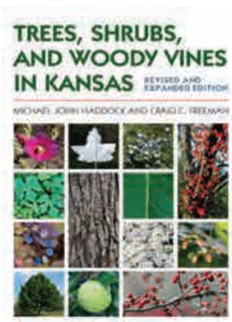
The third part discusses the usage of plant names, including a short section on writing and pronouncing plant names, proper usage of capitalization, italicization, and punctuation. The basic guide to Latin pronunciation was helpful, and I appreciated the caveat that there are no strict rules when it comes to pronouncing these plant names. The final part is a list of various resources to assist the reader in future endeavors, including books and websites for accurate and up-to-date names, the naming codes, and guides to pronunciation, classification, and plant breeder's rights. Many of these are divided and organized by region of the globe, and thus are accessible to a broad readership.

This book is extremely aesthetically pleasing, as the authors harness their knowledge of the wonderful flora of Australia to highlight plant names and features stunning photographs of some of these iconic plants. The tables are extremely helpful, and flowcharts elegantly outline the decision-making process for various questions related to plant names. Within the main text there are also useful "boxes" for additional information, asides, and real-world examples.

I believe that this book is a handy resource for anyone interested in plant diversity, including both wild and cultivated plants. It is extremely useful for both teachers and students of plant systematics or horticulture and is also written in a way that is accessible to a much broader audience of plant enthusiasts interested in gardening, house plants, or agriculture. This updated fourth edition not only reflects the most recent naming codes, but also includes conventions regarding intellectual rights and reading plant labels, which deal with the industry aspects of plant names. This book was a pleasure to read cover-to-cover and will also serve as a great resource in the future.

—Nora Mitchell, Department of Biology, University of Wisconsin – Eau Claire, Eau Claire, Wisconsin, USA

Trees, Shrubs, and Woody Vines in Kansas (revised and expanded edition)



Michael John Haddock and Craig C. Freeman
2019.
ISBN: 9780700627684
Paperback, US$26.95.
428 pp.
University Press of Kansas

H.A. (Steve) Stephens' 1969 first edition of this book is well known, and well used, in Kansas and has gone through seven printings. Finally, we have an attractive, revised, and updated edition thanks to Haddock and Freeman. The authors have expanded the treatment from the 114 species in the original to 166, primarily by adding full treatments for the 49 species Stephens specifically excluded because they were not native. They also provide brief notes, within species descriptions, to nearly 100 additional related woody species found in the state and include a brief enumeration of 28 "other Woody Species" at the end of the book. Even these are included in the keys to species at the beginning of the book, unless they are rare ornamentals that do not appear to be capable of reproducing and spreading.

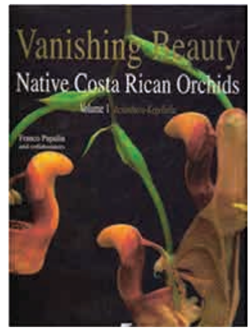
The general format remains the same except that color photos replace the black-and-white images of the original edition. Most species are treated in two facing pages with a distribution map and descriptive paragraphs for key characteristics of twigs, leaves, flowers, fruits, trunk, and some general comments on the top of each page and representative images filling the lower half of the treatment. The authors updated the distribution maps and added several useful new categories including the general Habit and Habitat, as well as Inflorescence description and the status of the plant: is it native or naturalized? With regard to the latter, the authors list four plants in the introduction that have become weedy pests: *Elaeagnus umbellate, Euonymus fortunei, Lonicera maackii,* and *Pyrus calleryana*. It would be useful to include this in the Status information on the respective species pages.

The general comment discussions have been rewritten rather than just edited. I think this strikes both ways. For instance, for *Maclura pomifera* (Osage Orange), Stephens informs us that the early American geologist William McClure is honored by the genus name and *pomifera* refers to "fruit-bearing"—some interesting "tidbits" for a general reader. Haddock and Freeman tell us that a current theory is that fruits and seeds may have been distributed by extinct megafauna—again interesting to the general reader, but also to specialists. This is actually a good representation of the main difference in focus of the new vs. the older edition. The original definitely targeted a lay audience and technical terms were kept to a minimum. It would be especially useful for middle school and high school biology or nature-study students. For instance, Stephen's description of the shape of the leaves as "egg-shaped, with long, tapered tip, rounded or bluntly tapered base…" becomes "blade ovate to ovate-lanceolate or elipitic lanceolate…base cuneate to rounded or subcordate…" in Haddock and Freeman. Similarly, the only taxonomic key in the original was to Kansas oaks, although there was a general guide based on a few leaf characters. Haddock and Freeman provide an extensive, but very workable, key to species, dividing first into major groups and providing genus keys where appropriate. Appended to the end of the book is an extensive, but succinct, glossary of terms and a bibliography of more than 80 works cited in the text. As a professor at one of the state universities, I much prefer the new edition as a resource for my students.

The obvious audience for this book lives in Kansas, but it will also be a very useful reference for anyone living in the prairie or plains region of the U.S. or Canada and an excellent addition to herbarium libraries and the libraries of botanists interested in taxonomy and plant distribution.

—Marshall D. Sundberg, Department of Biology, Emporia State University, Emporia, Kansas

Vanishing Beauty: Native Costa Rican Orchids



Franco Pupulin and 18 Collaborators
2020.
ISBN 978-3-946583-12-7
Hard cover: $280.
Color and line drawing illustrations,
pages 425-1003 (previous pages are in volume 1),
16 unnumbered pages.
Koeltz Botanical Books, Oberreifenberg, Germany

Despite being a small country, Costa Rica (19,730 mi^2 or 51,100 km^2) is reported to have more than 1600 orchid species. The first volume of this series, which I reviewed in 2006 (Arditti, 2006) covered *Acianthera* to *Kegeliella*.

This, the second volume [33.7 (h) × 2 (w) × 3.5 (thick), 4.28 kg] covers *Laeaena* to Pteroglossa. It is as magnificent as the first and now, like its predecessor, one of the most beautiful books in my orchid library, even when compared to the old tomes from Victorian England, which are illustrated with watercolor paintings. (Full disclosure: Franco and I have been friends since my visit to Costa Rica in 2003 to participate in an orchid lecture series.) It is certainly one of heaviest because of the very high-quality paper on which it is printed.

Every genus is described clearly and in detail. The descriptions include historical information, classical taxonomy details, and, when available, recent molecular findings. These data are followed by a discussion of the genus in Costa Rica. Horticultural information is included for species that are in cultivation (for example, *Lankesterella*). The results in each case are scholarly essays of varying length and content, which should satisfy even the most demanding readers.

Species are illustrated by at least one photograph and in some cases by line drawings. There are several photographs of species, which have more than one form (color, shape, size). For example, there are four photographs of *Laelia rubescens* (pp. 428, 430, 431).

Great care was taken in photographing (for details, see pp. 986-987) the orchids (with a Nikon D200 camera), which are described in this volume. The results are magnificent photographs of very beautiful orchids. Sadly, printing of some photographs does not always do justice to their photographic excellence and several illustrations are fuzzy (pp. 525, 598, 716, 838, 895, 957, and some others). All authors can do is provide their publishers with high-quality photographs. If these photographs are not printed properly, the responsibility is solely the publisher's.

Many of the statements in the books are well referenced. Cited literature is on pages 992–995. The number of literature-cited pages does not seem large, but due to the large page size of this book, they contain more references than usual.

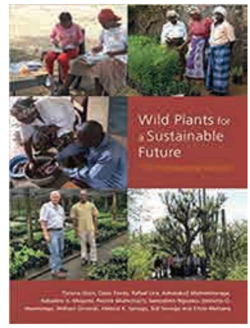
The book concludes with two indexes: taxonomic novelties (p. 906) and scientific names (pp. 997-1003). As a rule, I do not consider an index that contains only species names to be sufficient, but since this is a flora, additional indexing is not needed.

For its size and quality, *Vanishing Beauty* is not expensive. It would be an excellent book to acquire for private book collections or coffee tables, give as a present, or, at the least, recommend its purchase (and also volume 1) by institutional libraries. It is a good book to have, give, refer to, and use as an example of what an orchid flora should be. The only problem I have with it is the need for someone to help me lug it from my desk to a shelf in my library. It is heavy!

LITERATURE CITED

Arditti, J. 2006. Vanishing Beauty. *Plant Science Bulletin* 52: 105.

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



Wild Plants for a Sustainable Future: 110 Multipurpose Species

Tizinia Ulian, César Flores, Rafael Lira, Avhatakali Mamatsharaga, Kebadire K. Mogotsi, Patrick Muthoka, Samodimo Ngwako, et al., Eds. 2019.

ISBN 9781842466735;
e-ISBN 9781842466742
Hardcover, £40.00. 490 pp.
Royal Botanic Gardens, Kew
https://www.kew.org/sites/default/files/2019-04/Sustainable%20wild%20plants.pdf

Kew's Millennium Seed Bank Partnership has produced a noteworthy volume intended for practitioners in governmental institutions and non-governmental organizations working in Africa and Latin America. The publication forms one of the main dissemination achievements of the MGU-Useful Plants Project, to conserve and use sustainably wild plants important for rural communities. Institutional partners led the project in each country, involving rural communities, local authorities, and schools. The name MGU reflects the support provided by the philanthropist who funds the work of the Useful Plants Project.

Since 2007, the Useful Plants Project has been working collaboratively to conserve useful species in seedbanks, propagation in community nurseries and planting in community gardens, woodlots and forests, addressing the UN Sustainable Development Goals "to end poverty, protect the planet and ensure prosperity for all." The Useful Plants Project helps communities become better equipped to face such challenges by improving their livelihoods and using the surrounding resources in a more sustainable way.

The book presents detailed species profiles of 110 plants selected for their importance to communities and livelihood for everyday needs such as food, medicine, fuel, and building materials. The profiles are presented in a structured format, providing information on taxonomy and nomenclature, plant descriptions, fruit and seed structures, distribution, habitat, uses, known hazards and safety, conservation status, seed conservation, propagation, and trade, with literature references. The volume is organized into five sections, presented by country, compiled by experts from each. The rationale is a response to the range of threats that plants face, including climate change, over-exploitation, shortage of water, habitat loss, and invasion of exotic species. Most are trees and shrubs, along with cacti, sub-shrubs, and several perennial and annual herbs. Illustrations feature images of the plants in the wild, associated habitats, seed morphology, and cultivation. A glossary of botanical terms completes the book, with index of botanical names, list of common and vernacular names, and graphic presentation of habit and usage of each species.

The authors are based at universities, agricultural, forestry, and natural resource institutes, and although the book does not define the selection criteria about which countries were spotlighted, presumably they are the home countries of the participants. East and West Africa exemplify Kenya and Mali; South Africa and Zimbabwe, Africa's south; and Mexico represents Latin America. The deliberations upon which species included are not stated, but the project mission provides the following goals:

> Targeting and prioritizing useful plants with local communities. Enhancing the propagation of native useful plants in communities to support income generation through the sustainable use of plants or their products. Seed collections of useful plants have been made and seed lots stored in-country with duplicates tested in Kew's Millennium Seed Bank (MSB). The capacity of communities to conserve and use sustainably a wide range of plant species has been enhanced through training workshops and the improvement of local facilities: useful plant gardens have been established and plant nurseries enhanced with the provision of materials and seeds. As a result, species have been propagated in partner countries and planted in local community and school gardens involving farmers and students.

The project generated research including ethnobotanical, phytochemical, plant physiological, and plant population studies, and DNA profiling and in vitro propagation that has been carried out on priority species. Information about the uses, conservation, and propagation of the species has been compiled in leaflets, booklets, technical information sheets, and posters that have been disseminated within the country, to conserve and safeguard the associated traditional knowledge. The project has worked with village schools, leading to the establishment of environmental clubs, plant nurseries, and gardens.

I am personally gratified to learn that some captivating plants appear here about which

I had been told there was no known use in Sudan, such as *Citrullus lanatus* (Thunb.) Matsum. & Nakai, and *Ocimum gratissiumum* L.

Illustrations are among the volume's most indispensable contributions, helpful to consultants and broadly to future researchers. As species entries were written by multiple authors, there is some variation among the chapters. A few references cited are unpublished reports and theses that might not be widely available in practice; others are web resources, hence problematic in locations where internet services are unavailable or expensive. That aside, this input should help to build the capacity of local communities to successfully conserve and use these species sustainably.

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

Plant Science Bulletin

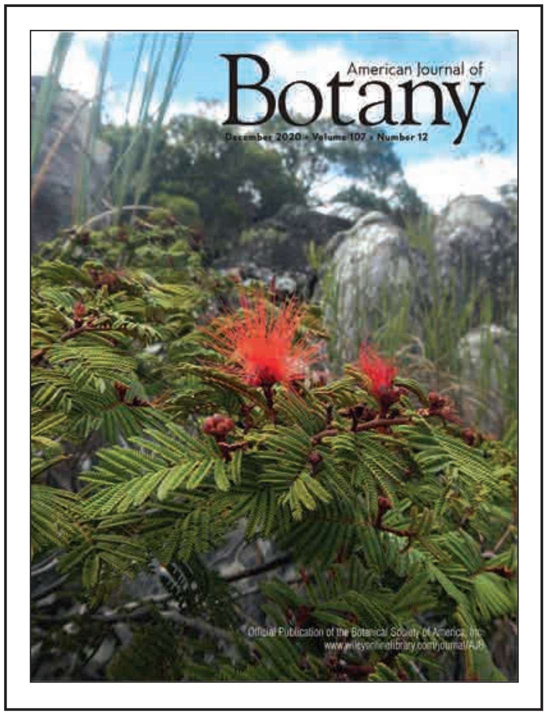
ISSN 0032-0919
Published 3 times a year by
Botanical Society of America, Inc.
4475 Castleman Avenue
St. Louis, MO 63166-0299

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

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

The Botanical Society of America is a membership society whose mission is to: promote botany, the field of basic science dealing with the study & inquiry into the form, function, development, diversity, reproduction, evolution, & uses of plants & their interactions within the biosphere.

Plant Science Bulletin



As the pages of the *Plant Science Bulletin* this year have reflected, the events of 2020 have had profound impacts on the research, the plans, and mental well-being of your colleagues and friends in the BSA and the botanical community. The lessons from this past year are still being learned, and we hope that positive outcomes are in our collective future. Here's to uniting globally and relying on each other in 2021.

In that spirit, we end the year with a splash of color from the final *American Journal of Botany* of 2020: a mimosoid legume courtesy of Dr. Erik Koenen! (See his related article at https://bsapubs.onlinelibrary.wiley.com/doi/10.1002/ajb2.1568.)

Fall 2020 Volume 66 Number 3