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Editor: Marshall D. Sundberg
Department of Biological Sciences
Emporia State University
1200 Commercial Street, Emporia, KS 66801-5707
Telephone: 620-341-5605 Fax: 620-341-5607
Email: sundberm@emporia.edu



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During his plenary address at this year's Botany Education Forum Bruce Alberts, President of the National Academy of Science, made a strong case for overcoming what we all know is the "bad news" in education – inertia. His address, and the Botany 2003 plenary talk by E. O. Wilson, are summarized in the News from the Society section of this issue. Both provided reason for optimism and suggested strategies for achieving our goals. Both presentations also served to preface some of the salient concepts presented in the Myths About Botany Education Research Symposium. Two of these concepts are addressed in the feature articles of this issue.

In the first article David Hershey tackles some misconceptions commonly perpetuated in the botany classroom. The constructivist theory of learning posits that students build upon what they know to create new understanding. A major problem arises when students try to build on incorrect ideas. Such misconceptions, or alternative conceptions, are extremely difficult to overcome because typically they seem so "common sense." Our job as teachers is to first make sure we understand the concept ourselves, then to make sure that we don't inadvertently reinforce students' misconceptions through careless word choice or oversimplification. Helmont's willow experiments are classic in the history of botany -- but perhaps not as novel as most of us think.

The second article addresses the importance of making botany interesting to students -- especially to middle-school students for it is during these critical years that the creativity and enthusiasm for science of most elementary students is somehow squelched. Since Kwai Gideon has no botanical training, but she saw plants as a way to enrich her art curriculum and in the process turned her students on to the wonder of flowering plants. It was a tremendous experience for her, her students, and

for me as I fielded questions and shared in her students' discoveries. What a difference it would make to botany if each of the thousands of you who read this issue adopted a middle school class in your area. Imagine! Thousands of reinvigorated botanists! I bet Karl would have to deal with a boom of manuscripts in nine months -- and Wilson would have his boom of taxonomists in 19 years! Read, view, and enjoy! -- editor.

Misconceptions about Helmont's Willow Experiment

The 1648 potted willow experiment of Johannes Baptista van Helmont is widely discussed in biology teaching because it is the first known quantitative experiment in biology. Despite its familiarity, several misconceptions about Helmont's experiment have gotten into the teaching literature. The purpose of this article is to correct these misconceptions.

Helmont's Description

Helmont's willow experiment is often presented in its entirety because the description is so brief. Here is the first English translation from 1662 to refer to for the subsequent discussion,

"But I have learned by this handicraft-operation that all Vegetables do immediately, and materially proceed out of the Element of water onely. For I took an Earthen vessel, in which I put 200 pounds of Earth that had been dried in a Furnace, which I moistened with Rainwater, and I implanted therein the Trunk or Stem of a Willow Tree, weighing five pounds; and at length, five years being finished, the Tree sprung from thence, did weigh 169 pounds,

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POSTMASTER: Send address changes to:
Botanical Society of America
Business Office
P.O. Box 299
St. Louis, MO 63166-0299
email: bsa-manager@botany.org

Address Editorial Matters (only) to:
Marsh Sundberg, Editor
Dept. Biol. Sci., Emporia State Univ.
1200 Commercial St.
Emporia, KS 66801-5057
Phone 620-341-5605
email: sundberm@emporia.edu

and about three ounces: But I moistened the Earthen Vessel with Rain-water, or distilled water (alwayes when there was need) and it was large, and implanted into the Earth, and least the dust that flew about should be co-mingled with the Earth, I covered the lip or mouth of the Vessel with an Iron-Plate covered with Tin, and easily passable with many holes. I computed not the weight of the leaves that fell off in the four Autumnes. At length, I again dried the Earth of the Vessell, and there were found the same two hundred pounds, wanting about two ounces. Therefore 164 pounds of Wood, Barks, and Roots, arose out of water onely." (Helmont, 1662).

Helmont's Originality

Textbooks sometimes credit Helmont with the idea of the pot experiment to test if plants obtained their mass from the soil. For example, Moore and Clark (1995) noted that the "concept of plants as soil-eaters went unchallenged until 1648" when Helmont published his willow experiment. However, the consensus of historians is that Helmont's experiment was almost certainly inspired by Nicolaus of Cusa's 1450 book *De Staticus Experimentis*, which described a nearly identical thought experiment (Howe, 1965; Huff, 1966; Krikorian and Steward, 1968; Pagel, 1982). An English translation from *De Staticus Experimentis* reads,

"If a man should put an hundred weight of earth into a great earthen pot, and then should take some Herbs, and Seeds, and weigh them, and then plant or sow them in that pot, and then should let them grow there so long, untill hee had successively by little and little, gotten an hundred weight of them, hee would finde the earth but very little diminished, when he came to weigh it againe: by which he might gather, that all the aforesaid herbs, had their weight from the water." (Krikorian and Steward, 1968).

Nicolaus of Cusa was confident of the experimental results so he may have been relying on earlier sources, experimental data or common sense that gardeners did not have to routinely add soil to potted plants but they did have to water the pots frequently. Howe (1965) traced the quantitative pot experiment idea back to a Greek work of about 200 to 400 A.D. so Nicolaus of Cusa may not have been totally original either.

Helmont and his supporters, notably Robert Boyle, were part natural philosophers, part scientists, so they did not just rely on experimental data. They also used the theory of the ancient Greek philosopher Thales (62?-546 BCE) which stated that all matter arose from water (Krikorian and Steward, 1968; Walton, 1980). Boyle also cited the book of Genesis in the *Bible* as support for the theory (Walton, 1980).

Helmont and Water

Allchin (1993, 2000) stated that Helmont was "well aware that plants did not grow outside soil". However, herbals (Gerard, 1633) of Helmont's time described free-floating aquatic plants, such as "ducks meate" (*Lemna* spp.) or "frogge-bit" (*Hydrocharis morsus-ranae*) (Figure 1), that were common in Europe. Francis Bacon (1627) grew several species of terrestrial plants in water well before Helmont's experiment was published, including a rose he grew for three months. Bacon's conclusions were similar but not quite as strong as Helmont's, "It seemeth by these instances of water, that for nourishment the water is almost all in all, and the earth doth but keep the plant upright, and save it from overheate and over-cold." (Bacon, 1627). Other investigators used plant water culture in the mid-1600s including Robert Boyle, Thomas Browne and Robert Sharrock (Webster, 1966).

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Editorial Committee for Volume 49

Norman C. Ellstrand (2003)
Department of Botany and
Plant Science
University of California
Riverside CA 92521-0124
ellstrand@ucr.edu

James E. Mickle (2004)
Department of Botany
North Carolina State University
Raleigh, NC 27695-7612
james_mickle@ncsu.edu

Andrew W. Douglas (2005)
Department of Biology
University of Mississippi
University, MS 38677
adouglas@olemiss.edu

Douglas W. Darnowski (2006)
Department of Biology
Washington College
Chestertown, MD 21620
ddarnowski2@washcoll.edu

Andrea D. Wolfe (2007)
Department of EEOB
1735 Neil Ave., OSU
Columbus, OH 43210-1293
wolfe.205@osu.edu

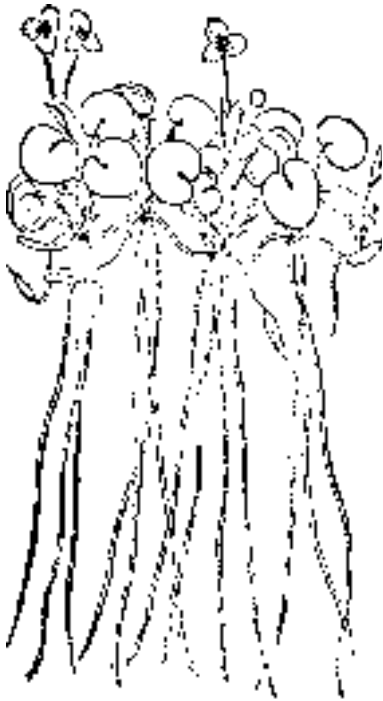


Figure 1. Frog's bit, a free-floating aquatic plant (Gerard, 1633).

Allchin (1993, 2000) stated that Helmont had no conception of distilled water. However, Helmont said he used distilled water in his experiment (Helmont, 1662), and distillation as a purification method was well known in Helmont's era (Multhauf, 1956). Alchemists, such as Helmont, often used redistilled rain water (Nash, 1957). Given Helmont's concern that dust might add to the dry weight of his soil, it seems clear that Helmont specifically used rain or distilled water because of their purity. Less pure water sources, such as well water or river water, would have contained more dissolved or suspended solids that would have added to the soil dry weight. In 1770, Antoine Lavoisier dismissed numerous water culture and Helmont-type experiments as inconclusive evidence that plants were formed exclusively from water because they had not used rain water or distilled water (Nash, 1957). However, Lavoisier could not criticize Helmont's experiment for that weakness.

Helmont and Gas

Allchin (1993, 2000) said "carbon dioxide [was] a substance wholly outside his [Helmont's] conception." However, Helmont coined the term gas, discovered carbon dioxide and is the "real founder of pneumatic chemistry" (Leicester and Klickstein, 1963). Helmont described several

sources of gas sylvestre, his name for carbon dioxide, including belches, fermenting wine and burning charcoal, which is of plant origin (Leicester and Klickstein, 1963; Pagel, 1972). Helmont even wrote that when 62 pounds of oak charcoal were burned, they would yield 61 pounds of gas and 1 pound of ash (Leicester and Klickstein, 1963). Thus, Helmont knew that dry plant matter released large amounts of carbon dioxide upon burning. Helmont was apparently so dogmatic about the water-forms-all-matter theory that he ignored his data that plant dry matter was composed largely of carbon dioxide gas and his data that a small amount of soil was missing from his pot. Had he not been so dogmatic, Helmont might have used his data to conclude that fresh plant matter consisted largely of water but that dry plant matter consisted mainly of carbon dioxide gas and a small amount of soil minerals. That kind of conclusion would have advanced plant biology by well over a century.

Helmont's Pot

Allchin (1993, 2000) thought Helmont was "rather clever" and deserved "credit" for "isolating the relevant soil system within the boundaries of a pot." However, growing trees in pots was common in Helmont's time so Helmont was just using a standard technology. The wealthy in Helmont's era often grew potted tropical plants, especially orange trees, and overwintered them in caves, stoves, greenhouses, or orangeries (Muijzenberg, 1980). Plants had been grown in pots as early as ancient Egyptian times (Baker, 1957). As mentioned earlier, historians have concluded that Helmont's experiment was almost certainly inspired by Nicolaus of Cusa's 1450 description of a nearly identical thought experiment that involved growing plants in a pot.

Allchin (1993, 2000) said that Helmont sunk his pot in the ground "as if the location was a significant parameter" to control. It is not known why Helmont sunk his pot in the ground so that is a guess. Hershey (1991) suggested some practical reasons such as greatly reducing the irrigation requirement by minimizing evaporation from the porous pot walls or preventing the planted pot from being blown over by the wind. The pot being blown over and spilling the soil could have ruined the experiment. Gerard (1633) illustrated a planted pot sunk in the ground (Figure 2) so it seems likely gardeners of Helmont's time knew of one or more of the practical advantages. Sinking the pot may have also prevented the roots from being killed by subfreezing temperatures (Hershey, 1991). Perhaps Helmont sunk the pot to prevent someone from falling in the hole left after the 200 pounds of soil were removed or because Mrs. Helmont didn't want a big, ugly pot sitting aboveground in the yard



Figure 2. Cypress vine (*Ipomoea quamoclit*) growing in a pot sunk in the ground (Gerard, 1633).

for five years. Maybe Helmont did not even make the decision to sink the pot because it is quite likely that the wealthy Helmont had his gardener do some, if not all, of the experiment. Boyle had his gardener carry out his Helmont-type experiments (Krikorian and Steward, 1968).

Helmont's use of a metal pot lid to keep out dust is sometimes considered one of the more impressive parts of the experimental design (Krikorian and Steward, 1968). Helmont even coated the iron lid with tin to prevent rusting. However, common sense indicates that a metal lid with many holes would be ineffective in keeping out dust. Any dust that accumulated on the lid would have simply been washed into the pot when it rained. The lid would have been effective in keeping leaves, twigs, and other debris out of the pot. It might have also prevented larger animals from burrowing in the potted soil and prevented rain from splashing soil out of the pot. However, it would not have been effective in preventing surrounding soil from being splashed into the pot. Soil splashing into the pot was a disadvantage of sinking the pot in the ground.

Criticisms of Helmont's Methods

Allchin (1993, 2000) thought Hershey (1991) criticizing Helmont's experiment for not using replication lacked historical context. However, Boyle in the 1640s (Hoff, 1964) did three Helmont-type

experiments before he had read Helmont's experiment (Krikorian and Steward, 1968). Boyle found 0 pounds soil missing, then repeated the experiment and found 1.5 pounds missing (Krikorian and Steward, 1968) which revealed substantial experimental error. Boyle lost the data of the third experiment (Krikorian and Steward, 1968). Woodward (1699) criticized the accuracy of Helmont's weighing and soil drying methods.

"I must confess I cannot see how this experiment can ever be made with the nicety and justness that is required, in order to build upon it so much as these gentlemen do. 'Tis hard to weigh Earth in that quantity, or plants of the size of those they mention, with any great exactness: or to bake the Earth with that accuracy, as to reduce it twice to the same dryness." (Woodward, 1699)

Helmont's Design and Analysis

Allchin (1993, 2000) stated that Helmont's experiment was "designed and interpreted appropriately" in the context of Helmont's time. However that is untrue.

- As mentioned above, common sense indicates that the metal lid would have been ineffective in its stated purpose of keeping dust out of the pot, and sinking the pot in the ground would have created a problem of rain splashing soil into the pot.

- Helmont made no mention of the impossibility of completely separating soil and roots, which would have been a source of experimental error. Anyone who has tried to completely separate roots from soil knows that it is basically impossible.

- Helmont's description is contradictory because he says he grew the willow for five years but had only four autumn's worth of leaves. There would have been five autumns in five years. Helmont's said his 164 pounds of willow included just "wood, barks, and roots" (Helmont, 1662) so what happened to the leaves from the fifth season?

- Helmont made no mention of weighing inaccuracies even though accurate soil weighing was the heart of his experiment. Even Woodward (1699) noted that twice drying and weighing 200 pounds of soil could not have been done with any great accuracy.

- Helmont was inconsistent in his weighing technique because he determined soil dry weight but plant fresh weight (Krikorian and Steward, 1968). It was common knowledge in Helmont's time that plants did require water and contained large amounts

of water because plant products were routinely dried before use, including firewood, grains, peas, beans, tobacco, cooking herbs, medicinal plants, hay, and some fruits, such as grapes to make raisins. Thus, the key question was what plant dry matter was composed of.

Helmont's description of his experiment was very incomplete. He did not even mention the species of willow he used.

Helmont is lauded for being quantitative but he ignored his missing two ounces of soil because he believed so strongly that all matter arose from water. Helmont was well aware that a small amount of ash or earth remained after burning plant material but did not consider the possibility that the ash represented soil minerals.

Helmont did not have the data needed to conclude that 164 pounds of plant matter came from water alone because he had not measured the amount of water added to the pot during the experiment. The logical conclusion based on Helmont's published data would have been that very little of the plant fresh weight came from the soil.

Helmont ignored common knowledge that manure greatly improved plant growth. Manure promotion of plant growth was well known long before Helmont's time (Tisdale and Nelson, 1975). Even Helmont supporter Boyle used that as a criticism in his 1666-67 work, *The Origin of Forms and Qualities*,

"And indeed experience shews us, that several plants, that thrive not well without rain water, are not yet nourish'd by it alone, since when corn in the field, and fruit-trees in orchards have consum'd the saline and sulphureous juices of the earth, they will not prosper there, how much rain soever falls upon the land, till the ground by dung or otherwise be supply'd again with such assimilable juices" (Hunter and Davis, 1999).

Helmont as Hero and Fool

Allchin (1993) stated that it was the "Most Outlandish Use of History in Biology Education" to portray Helmont as "both hero and fool." However, in his era Helmont was regarded exactly that way (Pagel, 1972) because his "combination of mysticism, magic, alchemy, and new science irritated even his contemporaries" (Heinecke, 1995). Even Helmont admirer, Boyle had that hero-fool view because Boyle thought a mysticism-heavy treatise written by Helmont was misattributed to Helmont by his detractors (Heinecke, 1995). Boyle couldn't comprehend how Helmont, who made many

important scientific discoveries, could also produce such unscientific nonsense. Pagel (1972) noted that Helmont's writings are difficult for modern readers because his scientific work is mixed in with his nonscientific discourses on such things as religious metaphysics and cosmology. Helmont also believed in spontaneous generation, that the philosophers' stone could be used to turn other metals into gold and that applying salve to the weapon that caused a wound would promote healing of the wound (Pagel, 1982). A publication on the latter subject got Helmont arrested and convicted of heresy under the Spanish Inquisition (Pagel, 1972).

Woodward Disproves Helmont

Textbooks often follow up a description of Helmont's 1648 experiment with a discussion of Joseph Priestly's 1770s experiments (Kaufman *et al.*, 1989; Moore and Clark, 1995; Weier *et al.*, 1982). They rarely mention how John Woodward (1699) disproved Helmont's willow experiment. Woodward (1699) used water culture experiments in which plant growth was much greater in water containing a little soil than in plain water or distilled water (Table 1). Unlike Helmont, Woodward (1699) measured the water used by his plants and provided the first quantitative measurements of transpiration (Table 1). Woodward improved upon Helmont by using replication and growing his plants indoors under more controlled conditions. However, Woodward (1699) too failed to measure plant dry weight or make the connection that the dry matter absorbed from the water was insufficient to account for the entire gain in plant dry weight.

Table 1. Effect of water source on spearmint (*Mentha spicata*) growth and transpiration in water culture (Woodward, 1699).*

Water source	% fresh wt. gain	Transpiration Ratio**
plain rep. 1	100	111
plain rep. 2	126	95
plus soil rep. 1	222	64
plus soil rep. 2	309	53
distilled	36	215

*Glass containers were covered by parchment to prevent evaporation. The stem was inserted through a hole in the parchment. Plants were grown for 56 days in a windowsill in June and July 1692.

**Grams of water lost divided by grams of fresh weight gained by plant.

Although Woodward (1699) showed that Helmont's conclusion was wrong, Woodward's work has been largely overlooked (Stanhill, 1986) while Helmont's willow experiment is still widely mentioned in biology textbooks and histories of science. The detailed case history by Nash (1957) does not even mention Woodward. Even in his own time, Woodward (1699) was overlooked. For example, Stephen Hales reported many transpiration measurements in his classic 1727 book, *Vegetable Staticks*, and made conclusions virtually identical to Woodward's but just briefly mentioned Woodward (Stanhill, 1986). In 1770, Lavoisier did not mention Woodward in his repudiation of Helmont's pot experiment and plant water cultures as proof that matter arose from water alone (Nash, 1957).

Woodward's (1699) convincing experimental data that Helmont's conclusion was wrong went largely unnoticed possibly at least partly because his reputation was later tarnished by severe professional disputes in his main fields of medicine and geology (Stanhill, 1986). These disputes resulted in a duel and his expulsion from the council of the Royal Society (Stanhill, 1986). Woodward's (1699) title was also vague. Had he used a title such as, "Experiments that Disprove Helmont's Willow Experiment," his work might have gotten more notice.

Lessons from Helmont's Experiment

The first sentence in Helmont's biography reads "Pessimism, scepticism and criticism are the outstanding key-notes of all of van Helmont's works and researches" (Pagel, 1982). However, he did not apply enough skepticism and criticism to his willow experiment. It was still a very useful and important experiment in the history of biology but was much less than it could have been. From a modern perspective, it does provide some valuable lessons for biology students.

Do not ignore your own data when making conclusions. Helmont ignored his missing two ounces of soil and his other data that charcoal, derived from plants, produced mainly gas when burned. Had Helmont concluded that plant dry mass consisted of a small amount of minerals absorbed from the soil but mainly of gas sylvetre, his name for carbon dioxide, he could have advanced plant science by more than a century.

Be objective and do not try to prove a particular hypothesis or theory as Helmont did. When you are not objective, you are likely to make wrong conclusions. Helmont's theory that water formed all matter made him conclude that all 164

pounds of willow came from water even though he had not measured how much water he had added to the pot. Helmont also ignored his missing two ounces of soil because his theory did not allow him to consider the possibility that the small amount of ash remaining after burning plant matter could have come from the soil.

Consider common sense or preexisting knowledge even if you have no quantitative data to support it. In Helmont's case, he ignored common knowledge that manure promoted plant growth and that fresh plant matter did contain large amounts of water.

Scientists sometimes overlook or do not acknowledge preexisting work as Helmont did for Nicolaus of Cusa's 1450 book describing a pot experiment like Helmont's and Bacon's 1627 work on growing plants in water. This was especially true centuries ago when scientific literature was not as widely available but can still occur. Allchin (1993, 2000) did not cite any historical literature on Helmont to support his claims and made errors.

When publishing an experiment, describe the materials and methods in enough detail so others can repeat it. It appears no one ever attempted to repeat Helmont's five-year experiment with a willow tree. Helmont scholar Pagel (1982) even warned that trying to repeat Helmont's willow experiment as described "may run into technical difficulties" and "may lead to different results." Describing an experiment as basically unrepeatable is one of the worst criticisms that can be made.

The first person who publishes an experiment gets the credit even if others proposed or did it earlier. If historians were convinced that Nicolaus of Cusa was actually describing a completed experiment in 1450, rather than just a proposed experiment, Nicolaus of Cusa would have gotten the credit instead of Helmont. Similarly, if Robert Boyle had published his Helmont-type experiment before 1648, he would have gotten the fame.

An experiment may be considered valid long after other published results that disprove it. Woodward (1699) showed Helmont's conclusion from his willow experiment was incorrect but Woodward was largely overlooked in his era and ever since (Stanhill, 1986).

David R. Hershey

Email: dh321z@yahoo.com

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Blooming Prints

I needed to get some flowers with some guts and muscles yet were beautiful and delicate. I didn't need these flowers to adorn my desk; I needed them for new information to give to students. I am an art teacher at Starlight Cove Elementary School in Lantana, Florida. These fifth grade boys and girls are budding into young men and women and I thought that delicately beautiful, gutsy muscled flowers would be something they could relate to. Our project, required by the Florida Sunshine State Curriculum, provides 5th Graders the experience of Relief Printmaking. Their suggested theme is Plants. Teachers are given leeway in how to focus their lessons.

In my experience of previous years, I have put up posters and silhouette shapes of flowers on the walls and passed around books about plants, and even brought flowers to school from my garden. However, I continued to get the question from the kids, "what do I draw"? That's mostly from the boys. The girls tend to make frilly daisy chains. Their prints came out well crafted but lacked some visual oomph. This year, I was determined to help them understand what they were looking at.

The best way I know how to get children to dig into more focused observation is through using Science

As my introduction.

So, this year, I decided to do some digging in the worldwide web garden to unearth information about the origins of Flowers. What I found out challenged T-Rex's legacy!

I found a willing scientific informant, Dr. Marshall Sundberg, who answered my questions on when and where flowers began in earth time scale. He said it was a timely question because evidence of floral beginnings has just recently been discovered in China. It seems that flowers began in the shallow warm waters as aqueous plants. The oldest known type of flower is the Magnolia cousin. Just last Spring, I planted the Southern Magnolia tree in front of my southern Floridian home. This new information makes me especially proud of my Magnolia sapling. As I gaze out upon the newly opened luscious blooms, I realize this delicately blended peach-blush-cream petal outlasted the biggest, meanest dinosaurs. A miniscule remnant of T-Rex, the brown anole, roams the candelabra branches.

I brought photos of the magnolia bloom to the children and the email printouts of the information I received from Dr. Sundberg. The printout was read to the classes. How flowers outlasted T-Rex caught the kids' interest. From there, with Dr. Sundberg's help, I went into the structure of the Flower using overhead transparencies as if I were their science teacher.

When students asked questions about flower parts that I didn't know with assurance, I wrote Dr. Sundberg. One such example is why the interior of some flowers has a different color than their outer petals. I let the kids guess and gave them their answer the following week. They guessed that nectar producers attract birds and bees. What they didn't know was that this method of attraction helped propagate the plants.

The boys especially were interested in the carnivorous plants and we let our imaginations have a wild moment thinking how scary it would be if one of those plants were human size. We have a variety of floating carnivorous plants in our black ponds nearby.

Settling back with factual information on Flowers, the students' awareness of "What to look at" increased dramatically from last year. When I passed around a few books on Flowers, such as the Audubon handbook on wildflowers and tacked up posters and photographs and other artists' paintings of flowers, the students set out to create. This was the proof of my effort: their drawings were strong and confident and much more botanically

correct than in previous years.

The next step took two stages: one was to draw four drawings of flowers; and the last step was selecting the clearest linear image from the four and transferring it onto the print plate.

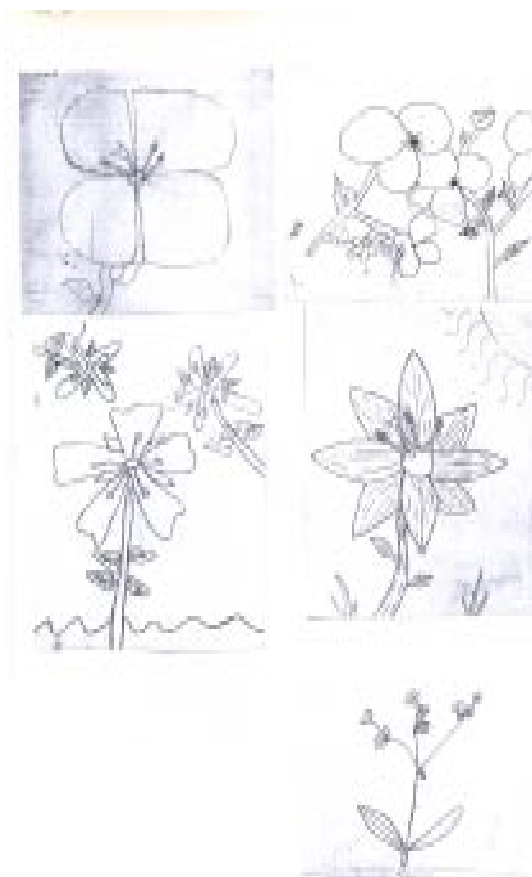
The three paper drawings were such excellent illustrations that I had the children mount them on large black construction paper and we have exhibited them in my classroom, our school media center and the school headquarters for our Palm Beach County Elementary School Exhibition.

The printed plate was used about eight times, creating prints with different colored printing ink and different colored paper. The student's pride in their work was evident with their industry and smiles.

Being their proud Art Teacher, I sent electronic images to Dr. Sundberg as thanks for his information and support. He said he was amazed at the detail.

I hope the Plant Science Bulletin enjoys the selections I have sent.

Sirce Kwai Giveon, Lantana, Florida.



News from the Society Botany 2003

From the FORUM *Science Education and the National Science Education Standards* Bruce Alberts

Our field has a real opportunity to have an impact on K-12 education said Bruce Alberts, President of the National Academy of Sciences, in his Keynote address at the Botany Forum. This would be a key element in his goal to create an enlarged scientific community. Traditionally this community consisted of scientists in academe, government and industry, but his vision is to incorporate science teachers at all levels and science journalists. The combined efforts of this broadened community will be necessary to affect the desired improvement in scientific literacy among the population at large.

This goal fits well with the charge of the Academy, which was chartered in 1863 to provide independent advice to the government on science policy and practice. While the majority of reports produced by the Academy fall into the category of "Science for Policy," providing the scientific background for policy makers to make informed decisions, an increasing amount of effort is going into "Policy for Science" reports that involve promoting science and scientific literacy. Alberts said it was clear to him, when he began his tenure as President, that the latter were particularly critical. All he had to do was think back to his first 10 years teaching at Princeton to realize that teaching students the same way he was taught, with introductory courses designed to weed out students who could not make the grade, was a part of the problem and not part of the solution.

The major accomplishment of his first two years in office was the publication, in 1996, of the National Science Education Standards. There were more than 18,000 reviewers who contributed to this effort and it quickly became clear that every scientist had strong opinions about what content in her or his field was critical. The task was to winnow down the list of essentials and to do this they devised an interesting strategy. Physicists, for instance would trim the biology list while biologists would do the same for the physicists. The result was the 250 page document that Alberts encourages us to consult for our own introductory courses. In fact Alberts suggested that the 25 page chapter on

Teaching is "a must read chapter" for all scientists in the classroom!

Subsequent to publication of the Standards, the Academy has concentrated on producing a number of supplemental booklets designed to help teachers implement the standards. These, of course, are all available to be read and/or purchased on the Academy web site. Inquiry-based strategies are prominent in these publications, not only because of their utility in science teaching but because they precisely fit the needs for modern workforce skills. Alberts said that as a scientist he was optimistic that changes in science education can be implemented, but unfortunately there is also some bad news - - INERTIA.

Change is always difficult, but it is particularly so in education where there are so many masters. Alberts noted a particular concern that he called the "tyranny of tests." He noted that most of us fail to appreciate the extent to which a high stakes exam can determine the nature and effectiveness of what is taught, how students learn, and their entire view of education. He was able to provide examples from his daughter, a teacher in California, who is now having to deal with pressure to "teach to the test." He also highlighted the statement from the Princeton Study Guide for the SAT II exam which literally tells students "you don't need to understand anything... just need to be able to make associations." Of course the real problem is not tests *per se* but the fact that the tests being used are "bad tests." "No Child Left Behind" and the creep of business-style accountability even into higher education makes it imperative that we develop "good tests" for the assessment process. He said that the Academy has recently embarked on a project to develop prototype tests that are computer aided, but that measure students' growth in understanding.

Our challenge, said Alberts, is to align our introductory college science courses with the standards. This means that we must incorporate inquiry-based teaching methods into lecture and show the relationship of science to society. It also means that we must incorporate inquiry-based, non-cookbook laboratory experiments into associated science laboratory courses. Beyond that, we as scientists must make a science out of education and science education research. More research must be done on how people learn and we urgently need more research on teaching science as inquiry. So who will do this research? We need to develop a new tradition of cooperation between scientists, science educators and teachers. And we should consider opportunities for postdoctoral

students. According to Alberts there are currently about 40,000 science post-docs in the U.S. and about 1/3 of them may consider secondary education if certain conditions are met. Of course, he admits that it would be a poison pill for a doctoral student or post-doc to express such an interest to a major professor. This is an attitude that we can and should change, he said.

Finally Alberts mentioned a new initiative at the Academies, the Teacher Advisory Council, which consists only of K-12 teachers with at least a 50% appointment teaching math or science. Already two outcomes have been identified: 1) Scientists must be educated to learn to respect teachers and to discover the true opportunities and problems science teachers face in the schools and 2) Teachers are empowered through interactions with scientists. Partnering of scientists and teachers is a powerful tool for making the changes required to affect greater public scientific literacy.

-Editor

Plenary Address
The All Species Initiative and the
Future of Life
Edward O. Wilson

Organismal biology is a calling to a lifetime of excitement, began E.O. Wilson in his address to Botany 2003, noting that he began his career only about 13 blocks from the convention center where we were meeting. Furthermore, he predicted that we are on the cusp of a renaissance in taxonomic study. During the 18th century taxonomy was concerned primarily with naming and classifying; in the 19th century understanding the genealogy of species was the primary goal; the modern synthesis of the 20th century helped to explain the mechanism of speciation; but in the 21st century we will be able to provide a complete account of the earth's biodiversity in a project on the scale of the Human Genome Project.

It is time to reassess the importance of taxonomy - it is not as "old fashioned" as thought by our molecular colleagues. Unfortunately, while there are approximately 6000 active taxonomists in the world today, a number not significantly different from what it was in the 50's according to Wilson, the percent of biologists active in taxonomic investigations has dropped precipitously with the

rapid growth of other fields. According to Wilson it is important that we recognize taxonomy not just as a tool for other disciplines, but as an important discipline in and of itself. Why is this so? The obvious answer is that we know so very little about the number of species living on earth. Our gap in knowledge is huge, especially when you move away from the furry and feathered creatures. The microbes in particular are a "dark hole" of biology.

But, according to Wilson, there are more reasons than this to further the Linnean enterprise. Among these are the need for taxonomic inventories for effective conservation, for bioprospecting, for biological impact studies and for analyzing ecosystem assembly. A more complete taxonomy is prerequisite to reconstructing the tree of life. But most important is the "unsurpassable adventure of explaining the unknown world." Fewer than 1% of known species have been studied beyond diagnostic anatomy and exosystem preference. "Molecular biologists don't know how thin is the information they stand on."

While the goal of a complete census of biodiversity may seem naively ambitious, Wilson suggests that it is now a possibility because of the power of computing. He predicts that within 10-20 years we will have on-line expert system keys and data bases to permit rapid field identification. These will include high quality images, "e-types," to permit instant feature matching (he noted the project of the New York Botanical Garden as a model of this possibility). Collected data on new species, including descriptions and e-types, could be uploaded and instantly available to other researchers anywhere in the world. Once the census is complete, the second step will be genomic studies, particularly of viruses, bacteria, and fungi. He predicts that microbial systematics and microbial ecology will become dominant fields as we move from the nano- to the pico-level.

Wilson argued that the accelerating destruction of ecosystems and the extinction of species makes it essential to move on the All Species Initiative now. While NSF has begun funding some of the necessary components, a major problem is that the world economy has stagnated and support, especially from private foundations, is lagging. What can we do in academe? We must work to increase the prestige of taxonomic studies, including providing better financial support, in order to attract new young students to the field. This is especially critical for students from the 3rd world. Then, says Wilson, we must argue the position that systematics, like evolution, is a concept that unites the levels of biological thought — down to the molecular and up to the ecosystem. Furthermore, a better

understanding of systematics is essential to maintaining biodiversity and understanding evolutionary biology.

-Editor

Dr. Wilson agreed to respond briefly to some questions for the *Plant Science Bulletin* - -

Editor: The first question from the audience concerned defining "species." How would you define it in terms of the "All Species Survey" for use with plants, fungi, and particularly microbes?

EOW: The definition of species is a deep epistemological problem, and of course also a daunting practical issue. However, rather than regarding it as an impediment to the global biodiversity map, it should be thought a challenge and an opportunity for advance. Working tentatively with the best criteria available according to taxon, whether reproductive isolation or genetic difference, and keeping them standard, even as we test and debate them, we can expect to hit upon the best criteria when further along in the all-species effort.

Editor: Another question had to do with training new students. Given the general decline in taxonomic offerings at our colleges and universities, how do you think potential funding for the "All Species Survey" could most effectively be distributed to train the generation of systematists who would accomplish the task?

EOW: As funding flows into global exploratory systematics, as it undoubtedly will as the importance of the subject is more widely realized, jobs and training support will be created in academia, museums, and various biological research organizations. This is the "Field of Dreams" argument, in which I believe: If you build it, they will come. First, from the depleted ranks of systematists and taxon experts, then from others, including the young people who see the prospects of career and adventure.

Editor: What specific role do you see for professional societies, such as the Botanical Society of America, in implementing the All Species Survey?

EOW: I would see as immediately useful status reports to BSA members on the global effort, which can be readily assembled from organizations that are actively involved in the all-species initiatives, including the Global Biodiversity Information Facility in Copenhagen, NatureServe in Arlington, VA, and the All-Species Foundation in San Francisco. An occasional progress report would inform especially non-systematics BSA members of what is happening, and also give a sense of goals

envisioned and the technologies coming into play to reach them. Local all-species inventories, I might add, are a great educational method for colleges and universities.

Best wishes,

Edward O. Wilson

**President Elect's Address
A Tale of Two Liverworts:
Organismal Biology as an Essential
Link between Molecular Biology
and Earth Systems Studies**

**Linda E. Graham
Professor of Botany and the Gaylord
Nelson Institute of Environmental
Studies**

In modern biology, molecular and ecosystem approaches are advancing dramatically, offering tremendous potential for humans to comprehend themselves and their place in nature. Investing scientific resources in these areas is essential. This shouldn't have to mean that support for productive research at the organismal level must necessarily decline precipitously. But it has. All of us have observed shifts in institutional investment in faculty positions, collections, and building programs that de-emphasize organismal approaches. In his plenary address at this conference, Professor E.O. Wilson was eloquent in defense of organismal biology and vertical studies that link organisms with their environmental roles as well as the molecular and cellular features that underpin them. I will argue the particular point that organismal biology is an essential link between molecular and system approaches, increasing the utility of all of these approaches. I will illustrate this point by a tale of two liverworts (and yes, there is a literary allusion!).

Why liverworts? The value of vertical studies could be illustrated with a variety of organisms, oceanic cyanobacteria and coccolithophorids, or salt marsh plants, just to name a few. One reason for choosing liverworts is that while they are quite beautiful (as illustrated on the Southern Illinois University website "Land Plants Online"), they engender but little recognition by the general public. As many of you know, it can be difficult to interest undergraduates

in these plants. For one thing their colloquial name is a real turn off—recalling on the one hand a widely disliked food and on the other, an undesirable skin condition. I'm not sure how much it helps to explain the medieval Doctrine of Signatures and that the term "wort" is an old term meaning "herb!"

The main reason for choosing liverworts is my research interest in early events in the history of land plant evolution. Molecular systematic studies and fossil evidence indicate that liverworts are a very early-divergent group of modern plants. Their study is therefore likely to tell us something about the first plants became adapted to land, a topic of great interest to most botanists.

Liverworts have several distinctive land plant (embryophyte) features not found in even their closest green algal relatives, the aquatic charophyceans. These include an embryo & sporophyte, which, though quite small, plays the same reproductive role as oak trees and rice plants—spore production and dispersal. And liverworts have tough sporopollenin-walled spores, capable of surviving dispersal in air, an essential adaptation to life on land. Recently, Popper and Fry (2003) reported that liverworts, like all other land plant groups, have xyloglucans in their primary cell walls, while such materials are sparse or absent from related green algae. And an impressive body of liverwort sperm cell biology, illustrated by Zane Carothers' pioneering work and Karen Renzaglia's more recent anatomical studies, also shows features in common with other land plants.

The characters in my tale of two liverworts are *Marchantia*, the only liverwort that many biology students ever see, and the much less well-known *Blasia*. *Marchantia*, with relatively complex structure and reproduction, has become a liverwort model genetic system. Complete mitochondrial and chloroplast genomic sequences are known, and a BAC library project, which will illuminate the nuclear genome, is underway. *Blasia*, though much less well studied at the molecular level, is nevertheless of great interest because molecular systematics suggests that it is particularly early-divergent, and thus may model structural, reproductive, and physiological characters of very early plants. By comparing *Blasia* and *Marchantia*, we can know much more about the great revolution in Earth's ecosystems begun by early land plants than we can by focusing on just one liverwort. This is analogous to the method used by Dickens, in setting his classic story in both London and Paris, to more effectively illuminate the social conditions and human dilemmas relevant to the French Revolution.

Blasia is an excellent colonizer, growing on moist rocks or soil worldwide. But its body is rather delicate,

one to a few cells thick, and it lacks the defensive terpenoid-containing oil bodies more typical of liverwort cells. So *Blasia* tends to be evanescent. But it is easily "recalled to life," thanks not only to spores, but also two types of asexual propagules known as gemmae. The short-lived stellate gemmae propagate the species during favorable growth conditions. But neither they nor the gametophytes that grow from them are able to survive harsh conditions. Such tissues are unlikely to survive long enough to fossilize, under most circumstances. *Blasia*'s ephemeral body may help explain why fossils of intact earliest plants have not yet been found, even though the spore record elucidated by Jane Gray and others suggests that land plants were abundant and widely distributed as long as 460 million years ago. Their tissues were not generally resistant to decay and other degradative processes.

A second type of oval-shaped gemmae produced by *Blasia*, and first studied in detail by Jeff Duckett and Roberto Ligrone, can survive harsh conditions. Our lab studies have found that these oval gemmae are so tough that they retain their shape and cell wall structure even after having been boiled in concentrated acid for 20 min, a procedure that plant spore walls, but few other biological materials can survive. These gemmae owe their resistance to cell wall components that have properties consistent with phenolic polymers—such as specific autofluorescence. The gemmae cell walls glow when exposed to UV and violet light, indicating capacity to absorb UV, a feature that may protect cell DNA from radiation damage. Such resistant materials should fossilize well, and indeed there are some similar, though enigmatic remains in the fossil record. These results suggest that very early land plants might have used similar materials to aid survival in their stressful new habitat.

Our studies of close green algal relatives suggest that earliest land plants inherited from them the ability to produce resistant cell wall phenolic compounds in a highly regulated process, then used these materials in new ways on land. For example, liverwort sporangial epidermal cells commonly produce similar wall polymers, which likely help protect spores from UV, desiccation, and microbial attack while they develop. Ongoing genomic projects that include green algal relatives and bryophytes offer the prospect of comprehending the molecular basis of the earliest stages in the evolution of plant phenolic polymers.

Additional studies in our lab have revealed that resistant (probably phenolic) cell wall polymers are even more abundant in the later-divergent *Marchantia*. These compounds are particularly abundant in cells of *Marchantia*'s lower epidermis,

which includes numerous unicellular rhizoids produced by tip growth of certain epidermal cells (in a manner similar to higher plant root hair elongation). The undersurface tissues of *Marchantia* play several important, and sometimes surprising roles in which resistant wall polymers are likely adaptive. For example, nitrogen-fixing cyanobacteria live entangled among *Marchantia*'s rhizoids where they likely aid in the liverwort's nitrogen nutrition. *Marchantia* is one of relatively few liverworts known to commonly have cyanobacterial associates. Other substrate microbes—such as decay agents—in the absence of resistant cell wall polymers would have more deleterious effects on the liverwort.

We have found that *Marchantia*'s lower epidermis and rhizoids of several types are extremely resistant to decay (and also a high-temperature, acid treatment designed to test extreme resistance to hydrolytic attack), probably because the cell walls are armored with tough, autofluorescent materials like those previously described in *Blasia* and related green algae. Scanning EM studies by Martha Cook and other analyses of rotten and acid-treated remains have revealed striking similarities with some puzzling Silurian-Devonian fossils previously thought to be the remains of a group of 'extinct plants whose bodies were composed of tubes covered with a cellular layer.' I've argued that some of those fossils are actually the resistant lower epidermal remains and/or clumps of rhizoids of *Marchantia*-like liverworts. Evidence for this hypothesis includes the fact that holes in *Marchantia* epidermal remains (where rhizoids have broken off) are patterned very similarly to pores in certain fossil cell scraps described by Pat Gensel and others.

Marchantia's resistant lower epidermis and rhizoids have another surprising function; they form the core of the stalks of gametangiophores, those tiny palm tree-shaped structures from whose undersides the sporophytes grow. The stalks enable those sporophytes to gain better access to wind currents for spore dispersal. Their development involves an intriguing change from prostrate to axial growth that likely involves transition in plant tissue-level response to the gravitational field. This is yet another example of a fundamental plant process that should prove amenable to molecular genetic analysis, thanks to a growing genomic knowledge of *Marchantia*.

Marchantia and other bryophytes also provide examples of the role of organismal information in ecosystem studies. The decay-resistant tissues of bryophytes that I've emphasized are likely relevant to a fascinating paleobiogeochemical phenomenon, namely the dramatic Paleozoic atmospheric carbon dioxide drawdown described by Berner and others. Knowledge of such past

events is regarded as key to developing ways to understand and predict modern carbon cycles. While the rise of vascular plants is typically linked with the most dramatic portion of this ancient decline, geochemical data from older deposits suggest that substantial decline in the CO₂ content of Earth's atmosphere had begun to occur well before the rise of vascular plants, as argued by Jane Gray and Art Boucot in a recent paper. The spore fossil record strongly indicates presence of a widespread flora of bryophyte-like plants during this period. Could pre-vascular, bryophyte-like early plants have contributed to the early stages of this drawdown event?

In order to investigate this possibility, we measured the amount of acid hydrolysis-resistant carbon produced by three early-divergent mosses that today occupy hydric (*Sphagnum*), mesic (*Polytrichum*), & high UV xeric (*Andreaea*) regions of Earth. The amounts were surprisingly high—from 25% of dry biomass in the case of peatmosses to an incredible 85% in the case of the granite moss *Andreaea*. We then used this data—together with published productivity and cover data for modern representatives—to estimate the amount of carbon that could have been sequestered by moss-like early land plants, then buried, thereby reducing atmospheric CO₂ level. We calculated that even if only a tiny fraction (1%) of this resistant carbon were actually buried, significant decrease in atmospheric CO₂ could have resulted (Graham, et al., in press). Given our discovery that vegetative parts of liverworts such as *Marchantia* also produce resistant carbon, it will be interesting to experimentally determine if ancient liverwort-like plants could have impacted Earth's atmosphere even before moss-like plants arose. Such information is not only valuable in understanding planetary carbon cycle evolution, but may also be helpful when future astroengineers use plants to modify the atmospheres of other planets for human habitation. Because bryophytes are particularly resistant to radiation, desiccation, and other stresses—a consequence of their ancestors' early struggles to survive in a harsh terrestrial environment—they have been identified as prime candidates for use in terraforming operations.

I hope that the tale I've told tonight will help raise the general level of respect for liverworts. But I also hope that it may stimulate renewed interest in the contributions of organismal studies as crucial to the most effective use of molecular and ecosystem level information. Perhaps we should foster approaches that not only respect traditional organismal structure, reproduction, and physiological studies but also effectively link them both up and down the hierarchy of biological organization.

New Officers for 2003-04

Allison Snow has been selected as the President-Elect (2003-06, in a three-year presidential succession) and **David Spooner** has been selected as Secretary (2003-06).

Pamela Diggle was selected as Council Representative for a two year term (2003-05) at the BSA Council meeting.

Many thanks to our out-going Past President **Judy Jernstedt** and Secretary **Jennifer Richards** for their hard work during these past three years!!

It has been a pleasure serving as your president for the last year, but all good times come to an end, and mine concluded at the BSA Annual Banquet. At the appointed hour, after the Address of the President-Elect, Linda Graham succeeded me as President. I will continue to serve the Society as Past President for the following year, taking on a different slate of responsibilities. There have been many challenges and many changes. In parting, I would like to thank you for placing your trust in me by allowing me to serve. – **Scott Russell**, Past President.

Dr. Judy Jernstedt from the University of California Davis has accepted a request by the BSA executive committee and will become the next Editor-in-Chief of the *American Journal of Botany*. Congratulations! Dr. Jernstedt will assume the role in January of 2005. She will begin work this autumn with Dr. Karl Niklas (current Editor-in-Chief) to begin the change-over process.

BSA Honors and Awards

A. Botanical Society of America Merit Awards

These awards are made to persons judged to have made outstanding contributions to botanical science. The first awards were made in 1956 at the 50th anniversary of the Botanical Society, and one or more have been presented each year since that time. This year we will present 4 Merit Awards.

The first goes to **Dr. Jack B. Fisher**, Fairchild Tropical Garden. The 30 years of contributions made to botany by Dr. Fisher have been broad, deep, original, and patient. He has carefully combined anatomical, developmental, physiological, and ecological

considerations, to show how tropical plants grow and adapt. He has made critical contributions to our understanding of water transport in lianas and fundamental discoveries on the developmental basis of tropical tree geometry. In the same way that he has waited patiently for tree seedlings to mature and yield their anatomical secrets, he has worked for 20 years to forge alliances between Fairchild Botanical Garden and institutions of higher learning to promote education of the next generation of comparative botanists. Dr. Fisher has benefited botany through his research and his thoughtful outreach and he richly deserves recognition through a BSA Merit Award for these admirable accomplishments.

The second award goes to **Spencer C.H. Barrett**, University of Toronto, for his myriad contributions to reproductive biology, plant breeding systems and aquatic ecology. He established heterostyly as a model system in reproduction, contributed to understanding of the evolutionary modification of floral development, genetic structure of populations, the role of incompatibility in the breeding systems of natural populations, the evolution of dioecy and the influence of gender ratio in determining plant breeding systems. In addition to his service as Associate Editor and Book Review Editor of the *American Journal of Botany*, he mentored a generation of plant biologists, including 2 Master's students, 9 Ph.D. students and 6 postdoctoral associates who have occupied faculty positions.

The third Merit Award winner is **Leslie G. Hickok**, University of Tennessee. Dr. Hickok has made a career out of defying the odds and generating surprises. While others were intimidated by the high chromosome numbers of ferns, he showed that valuable insights into polyploidy and speciation could be obtained by studying their cytogenetics. While the mainstream focused attention on *Arabidopsis* as a plant model system, Hickok promoted the unique properties of the fern *Ceratopteris*. His pioneering work on selection and mutation using this model demonstrated the power of a system that separated gametophytic and sporophytic life stages. More recently, he has succeeded in marrying his deep commitment to advancing botanical knowledge and his desire to provide meaningful, enriching experiences for biology students. Through his insight and perseverance, he transformed *Ceratopteris* into **C-fern**, and now over 60,000 students per year are learning about plant genetics using this inexpensive but effective teaching system. Dr. Hickok is a distinguished scholar whose research and teaching efforts at all levels from K-12 to international seminars can be characterized as groundbreaking, inspirational, dedicated, and unselfish. For his outstanding contributions and longstanding

generosity, the BSA is pleased to present a Merit Award to Dr. Leslie G. Hickok.

Our final Merit Awardee is **Jeffrey D. Palmer**, University of Indiana. Dr. Palmer has excelled in his contributions to botanical science. His astonishing research productivity has resulted in over 200 scientific papers, many of them published in the most prestigious scientific journals. Dr. Palmer has fundamentally transformed the scientific landscape we now operate in through his legendary contributions to phylogenetics and gene and genome evolution. He has arguably been the most influential person in the development of the field of molecular systematics of plants and has been directly responsible for the paradigm shift in our current views of evolutionary relationships among eukaryotes, including higher plants. Other major contributions from his laboratory include the characterization and evolution of introns and plant mitochondrial genomes, the evolution of plastid genes in non-photosynthetic plants, and the origin and evolution of chloroplasts. The list of the graduate students and post-docs trained in his laboratory reads like a who's who of botanical science. His collaborative approach and willingness to share data has built a sense of community among plant molecular phylogenetics workers unparalleled in other fields of organismal biology. At the same time, Dr. Palmer has generously served as department chair at Indiana University as well as on review panels and editorial boards and has promoted outreach through his many public presentations. For his innovative and productive scientific contributions, Dr. Palmer has received many awards, among them the Wilhelmine Key Award from the American Genetic Association, election to the American Academy of Arts and Sciences and the U.S. National Academy of Sciences, and an ISI Highly Cited Award for the top 15 most cited plant and animal scientists. In honor of his extraordinary accomplishments, the BSA is proud to present him with a Merit Award.

B. The Gleason Award

Each year The New York Botanical Garden presents the Henry Allan Gleason Award for an outstanding publication in the field of plant taxonomy, plant ecology, or plant geography. The Gleason award for 2003 is presented to Dr. Stephen J. Botti and Dr. Walter Sydoriak for their book, *An Illustrated Flora of Yosemite National Park* published by the Yosemite Association, Yosemite National Park, CA. This publication combines excellence in both plant taxonomy and plant ecology, successfully bringing these two areas together in its focus on the conservation and use by the public at large.

C. Darbaker Prize

This prize is given for meritorious work in the study of microscopic algae. This year's award is given to Dr. John C. "Jack" Meeks, UC-Davis. The award recognizes his excellent work sequencing the genome of the important cyanobacterium, *Nostoc*, and his extensive studies on the *Nostoc*/*Anthoceros* symbiosis.

D. Lawrence Memorial Award

The Lawrence Memorial Fund was established at the Hunt Institute for Botanical Documentation, Carnegie Mellon University, to commemorate the life and achievements of its founding director, Dr. George H. M. Lawrence. Proceeds from the Fund are used to make an annual Award in the amount of \$2000 to a doctoral candidate to support travel for dissertation research in systematic botany or horticulture, or the history of the plant sciences.

The Lawrence Memorial Award for 2003 goes to Ms. Sarah Edwards, a student of Dr. Michael Heinrich at the University of London. For her dissertation research, Ms. Edwards has undertaken a study of the medical ethnobotany, from plant systematics to indigenous taxonomy, of the Wic and Kugu peoples of the Cape York Peninsula. The proceeds of the Award will support her travel in Australia for field work. Since Ms. Edwards is presently in the field and not able to be here to accept in person, she will receive the Award materials by mail.

E. Karling Graduate Student Research Awards

The Karling Awards support graduate student research and are made on the basis of research proposals and letters of recommendations. This year we gave out 11 awards. Recipients are

Mario Blanco,
Kuo-Fang Chung
Laurie Cosaul
Laurelin Evanhoe,
Susan Grose,
Shawn Krosnick,
Jeffrey Morawetz,
Julieta Rosell
Jackeline Salazar,
Tyler Smith,
Jay Walker

F. Section Awards: A.J. Sharp Award (Bryological and Lichenological Section)

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

This year's A.J. Sharp Award goes to **Dorothybelle Poli, University of Maryland**, for her paper "Auxin regulation of axial growth in bryophyte sporophytes: Its potential significance for the evolution of early land plants." Her co-authors were Mark Jacobs and Todd Cooke.

Katharine Esau Award (Developmental and Structural Section)

This award was established in 1985 with a gift from Dr. Esau and is augmented by ongoing contributions from Section members. It is given to the graduate student who presents the outstanding paper in developmental and structural botany at the annual meeting. This year's award goes to **Wanda Kelly** from the University of Maryland, College Park, for her paper "Geometrical relationships specifying the phyllotactic pattern of aquatic plants." Her co-author was Todd Cooke.

Ecological Section Awards (Ecology Section)

The Ecological Section Award for the best student presentation in the Ecological Section sessions goes to **Jenise Snyder from Florida International University**, for her paper "Spikulet phenology and floral compatibility of sawgrass, *Cladium jamaicense* (Cyperaceae) in the south Florida Everglades". Her co-author was Jennifer Richards.

The Ecological Section Award for the best student poster goes to Christina Coleman, Auburn University for her poster "Herbivore defense as an explanation for hyperaccumulation: Relative heavy metal toxicity to diamond back moth (*Plutella xylostella*). Her co-author was Robert Boyd.

Margaret Menzel Award (Genetics Section)

The Margaret Menzel Award is present by the Genetics Section for the outstanding paper presented in the contributed papers sessions of the annual meetings. This year's award goes to **Linda Jennings, University of British Columbia**, for her paper "Genetic, morphological and ecological variation within and between two Southern Utah endemics, *Townsendia aprica* and *T. jonesii* var.

lutea (Asteraceae). Her co-author was Jeanette Whitton.

The Genetics Section Poster Award is given for the best student poster at the annual meetings. This year's award is given to Liu Xianan, University of Illinois, for the poster "Differential expression of genes regulated in response to abiotic-stress in sunflower." Co-authors were Ginger Swire-Clark and Vance Baird.

Moseley Award (Paleobotanical and Developmental and Structural Sections)

The Maynard F. Moseley Award was established in 1995 to honor a career of dedicated teaching, scholarship, and service to the furtherance of the botanical sciences. Dr. Moseley, known to his students as "Dr. Mo", died this Jan. 16 in Santa Barbara, CA, where he had been a professor since 1949. He was widely recognized for his enthusiasm for and dedication to teaching and his students, as well as for his research using floral and wood anatomy to understand the systematics and evolution of angiosperm taxa, especially waterlilies. (PSB, Spring, 2003).

The award is given to the best student paper, presented in either the Paleobotanical or Developmental and Structural sessions, that advances our understanding of plant structure in an evolutionary context.

This year's award goes to **Stefan Little** from University of Alberta, Edmonton, for his paper "Permineralized fruits of Lauraceae from the Middle Eocene Princeton chert, British Columbia." Stefan's co-author is Ruth Stockey.

Isabel C. Cookson Award (Paleobotanical Section)

The 2003 Isabel Cookson Award, recognizing the best student paper presented in the Paleobotanical Section, is awarded to **Michael Dunn** of Ohio University, Athens, for his paper entitled "The Fayetteville Flora of Arkansas, USA: An Upper Mississippian (**middle Chesterian/lower Namurian A**) plant fossil assemblage with permineralized and compression remains."

Edgar T. Wherry Award (Pteridological Section and the American Fern Society)

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

floristics and patterns of evolution in ferns. This year's award goes to **Michael Barker** from Miami University, Oxford, for his paper "Microlepidopteran soral mimics in the Caribbean." The paper was co-authored by Shane Shaw, James Hickey, and John Rawlins.

George R. Cooley Award (Systematics Section/American Society of Plant Taxonomists)

This award is given annually by the American Society of Plant Taxonomists for the best contributed paper in plant systematics presented at the annual meeting. This year's award goes to Lucia Lohmann, University of Missouri-St. Louis, for her paper "A new generic classification for Bignoniaceae (Bignoniaceae)."

Bessey Award (Teaching Section)

This award recognizes outstanding contributions to botanical instruction. The award was presented to **Joseph Novak, University of West Florida, Pensacola**, during the Education and Outreach Forum this past weekend.

News from the Sections

THE IMPORTANCE OF HERBARIA

Herbaria, dried pressed plant specimens and their associated collections data and library materials, are remarkable and irreplaceable sources of information about plants and the world they inhabit. They provide the comparative material that is essential for studies in taxonomy, systematics, ecology, anatomy, morphology, conservation biology, biodiversity, ethnobotany, and paleobiology, as well as being used for teaching and by the public. They are a veritable gold mine of information. There are more than 60 million specimens in 628 herbaria in the USA, and 7 million specimens in 110 herbaria in Canada (Funk & Moran 2000). Nearly 5 million are held at the US National Herbarium housed at the National Museum of Natural History, Smithsonian Institution, and, just for the record, about 500,000 are in the Compositae.

Recent articles have highlighted the problems that are being faced by state and university natural history collections, including herbaria. Two are sitting on my desk right now from *Nature* (Dalton, 2003) and *BioScience* (Gropp, 2003). These and other articles make it clear that natural history collections are being targeted unfairly in the current budget crisis in states and universities. From Los

Angeles to Iowa to Virginia, natural history collections are being closed or given away and the staff either re-assigned or fired. All of this has a negative impact on our ability to train systematists (Gropp 2003) and causes much concern over the fate of organismal biology.

In honor of the opening of the new herbarium at LSU in 2002, I prepared a list of uses for herbaria. With the help of many colleagues (especially Tom Wendt, TEX) I enlarged the list and it was published in the *Plant Press*, the Botany newsletter at the Smithsonian. Perhaps it is time to take another look at the list.

Herbaria can be used to:

1. discover or confirm the identity of a plant or determine that it is new to science (taxonomy);
2. document the concepts of the specialists who have studied the specimens in the past (taxonomy);
3. provide locality data for planning field trips (taxonomy, systematics, teaching);
4. provide data for floristic studies (taxonomy);
5. serve as a repository of new collections (taxonomy and systematics);
6. provide data for revisions and monographs (systematics);
7. verify plant Latin names (nomenclature);
8. serve as a secure repository for "type" specimens (taxonomy);
9. provide infrastructure for obtaining loans etc. of research material (taxonomy and systematics);
10. facilitate and promote the exchange of new material among institutions (taxonomy);
11. allow for the documentation of flowering and fruiting times and juvenile forms of plants (taxonomy, systematics, ecology, phenology);
12. provide the basis for an illustration of a plant (taxonomy and general publishing);
13. provide pollen for taxonomic, systematic, and pollination studies as well as allergy studies (taxonomy, systematics, pollination ecology, insect ecology, and medical studies);
14. provide samples for the identification of plants eaten by animals (animal ecology);
15. document which plants grew where through time (invasive species, climate change, habitat destruction, etc.);
16. document what plants grew with what other plants (ecology);
17. document the morphology and anatomy of individuals of a particular species in different locations (environmental variation);
18. provide material for microscopic observations (anatomy and morphology);
19. serve as a repository for voucher specimens (ecology, environmental impact studies, etc.);
20. provide material for DNA analysis (systematics, evolution, genetics);

21. provide material for chemical analysis (pollution documentation; bio-prospecting, for coralline algae - determining past ocean temperatures and chemical concentration);
22. provide material for teaching (botany, taxonomy, field botany, plant communities);
23. provide information for studies of expeditions and explorers (history of science);
24. provide the label data necessary for accurate data-basing of specimens (biodiversity and conservation biology, biogeography);
25. serve as a reference library for the identification of parts of plants found in archeology digs (paleoethnobotany);
26. provide space and context for accompanying library and other bibliographic resources (library sciences, general research, taxonomy, etc.);
27. serve as an archive for related material (field notebooks, letters, reprints, etc.)
28. provide information on common names and local uses of plants (ethnobotany, economic botany);
29. provide samples for the identification of plants that may be significant to criminal investigations (forensics);
30. serve as a means of locating rare or possibly extinct species via recollecting areas listed on label data (Conservation Biology, Environmental impact statements, endangered species, etc.);
31. serve as an educational tool for the public (garden clubs, school groups, etc.);
and
32. provide a focal point for botanical interactions of all types (lectures, club meetings, etc.).

At the US National Herbarium, in order to make maximum use of our substantial resources, we have the following goals: additional compacterization of collections to increase storage space, processing of the backlog of unmounted specimens so all material is available, photographing the type images so our most important specimens will be available on the web, and data-basing the specimen label information so it also can be made available on line. I am sure other herbaria have similar goals, we must all work together to stress the importance of herbaria and preserve our collections for the future. If anyone wishes to add to this list please contact me.

Vicki Funk
US National Herbarium
Smithsonian Institution MRC166
P.O. Box 37012
Washington D.C. 20013-7012 USA
Funk.vicki@nsmnh.si.edu

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Plant Biologists Reaching Out: Planning and Delivering Teacher Workshops

D. Timothy Gerber, University of Wisconsin - LaCrosse and David W. Kramer, Ohio State University at Mansfield have collected and assembled useful information and advice for botanists who are dedicated to meeting one of the many challenges of *Botany for the Next Millennium*: "Societies, faculties, and/or individuals should promote effective botanical education of K-12 by: ...sponsoring retraining workshops for K-12 teachers." They offered a workshop with this title at the Forum of Botany 2003 in Mobile.

What they have learned from personal experience after several years of presenting teacher workshops at their universities is organized into three modules available on the WWW. The online modules have links to other Internet resources. The first module, *Premises for Action* [http://www.mansfield.ohio-state.edu/~dkramer/BSA_Wkshp_Premises.htm] lists several factors contributing to poor performance of US students on science achievement tests and on statewide proficiency tests. This module is designed to motivate professional botanists to become involved in correcting the situation and lists several facets of the problem that need to be addressed.

Action Alternatives: What Can We Do? discusses a variety of approaches that professional botanists can take to address the problems. This includes everything from "Nothing!" to designing and presenting teacher workshops [http://www.mansfield.ohio-state.edu/~dkramer/BSA_Wkshp_Alternatives.htm]

Assuming the choice will be to offer a teacher workshop, the largest module is a list of procedural steps one should follow to design an effective workshop. *Planning the Teacher Workshop* [http://www.mansfield.ohio-state.edu/~dkramer/BSA_Wkshp_Planning.htm] does not advocate a single model but, instead, lists several decision points that will guide the planning process. The result should be a workshop that is maximally beneficial to teachers and ultimately to their students.

The authors encourage all BSA members to visit the web site and to contact them directly if there are questions.

D. Timothy Gerber

gerber.dani@uwlax.edu

David W. Kramer

kramer.8@osu.edu

In Memoriam:

A. Orville Dahl 1910 - 2003

A. Orville Dahl received his doctorate in botanical cytology and genetics from the University of Minnesota in 1938. His graduate studies there included long-term analyses of atmospheric pollen in relation to pollinosis.



After completing his graduate work, he served as Instructor of Biology for six years at Harvard University where, in his stimulating association with Irving W. Bailey, he conducted an intensive survey of pollen morphology of the Icacinaceae. From Harvard, he returned to the University of Minnesota as Professor where, for a decade, he was Chairman of the Botany Department.

Orville held a Professorship of Botany at the University of Pennsylvania, Philadelphia from 1967 until 1978 when he was named Professor emeritus following mandatory retirement.

He was one of the pioneers in atmospheric pollen and spore studies and maintained collection stations for more than 30 years. His interest in pollen morphology, beginning in a serious way with work on the Icacinaceae, was continued with many species throughout his life. Emphasis, especially in his teaching, was on living or well-preserved microspores and their development into pollen grains. His interest was in teaching what later would be called pollen biology. He and other broadly experienced botanists and biologists, among them Johs. Iversen, Knut Faegri, Stanley Cain, A. Traverse, E.S. Barghoorn, J. William Schopf, L.R. Wilson, influenced a generation of men and women who contributed greatly to studies of pollen and spore development, many aspects of archeology, palaeoecology and hydrocarbon exploration. Micrographs of Orville's thin sections of *Tradescantia* pollen are the first transmission electron illustrations of sectioned pollen.

For many years Orville made histological and cytological observations as part of a NASA space biology program. He studied the effect of gravitation fields on *Arabidopsis* and its morphogenesis in controlled G-environments. He also studied the vascularization of the primary flowering stem under controlled G-environments.

Orville spent many summers in the Stockholm area living with special pleasure, when possible, in Vaxholm in the Stockholm Archipelago and commuting to Stockholm by boat. He was an avid horticulturist and filled our seaside garden with exotic plants. Three of the varieties of grapes that he planted have survived ten or more of our winters and now form an extensive arbor.

Orville was welcomed as a visiting scientist at Stockholm University where we worked together in the Botany Department on many long-term projects.

Orville died this year on January 21st at Lakeshore Lutheran Home, Duluth, Minnesota. He would have been 93 on April 18th. Shortly before his death he spent a good Christmas in the company of his niece Karen, her husband Dr. Thomas Holm, their three sons and their families.

Orville much appreciated the good things in life — classical music, art, good food and visiting new places. He was a generous, kindly and loyal friend, a source of inspiration and information.

- John and Joanne Rowley

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Symposia, Conferences, Meetings

The 14th Congress of The Federation of European Societies of Plant Biology Cracow, Poland 23-27 August, 2004

Secretariat:

Congress Secretariat:

The Franciszek Gorski department of Plant Physiology
Polish Academy of Sciences
Niezapominajek 21, 30-239 Cracow
POLAND

Tel: +48 12 6395144

Fax: +48 12 6395142

E-mail: fespb.congress@zfr-pan.krakow.pl
www.zfr-pan.krakow.pl/lonf/

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8. Metabolic Engineering for Plant Improvement
9. Genomics and Post-genomics
10. Bioinformatics
11. Plant Tissue Culture and Biotechnology
12. Physiology and Molecular Biology in Plant Breeding

Symposium Sows Seeds for Plant Restoration Chicago Botanic Garden Oct. 23, 2003

The School of the Chicago Botanic Garden and the Garden's Institute for Plant Conservation Biology will present the Janet Meakin Poor 2003 symposium titled "Sowing the Seeds for Change: Restoration of Plant Communities" on Oct. 23 at the Chicago Botanic Garden. The restoration of plant communities is an important contribution in the effort to conserve biodiversity. Programming, which will include several invited presentations, a contributed poster session and a panel discussion, will focus on seed ecology and the use of seeds in restoration projects. The symposium, which has been designed for both conservation researchers and practitioners, will deal with these timely issues: *How important is provenance and how far away

can one go to collect seeds?

*How should seeds be handled between collection and reintroduction?

*How does one obtain enough appropriate seed without harming natural communities?

*Should the restoration of a degraded natural site be treated differently from a site without native vegetation?

For program updates or to register, visit the Garden's Web site at www.chicagobotanic.org/symposia, or call (847) 835-8261. For information on submitting a poster proposal, contact Kayri Havens, director, Institute for Plant Conservation, at khavens@chicagobotanic.org <<mailto:khavens@chicagobotanic.org>>, or at (847) 935-8378.

Award Opportunities

HARVARD UNIVERSITY BULLARD FELLOWSHIPS IN FOREST RESEARCH

Each year Harvard University awards a limited number of Bullard Fellowships to individuals in biological, social, physical and political sciences to promote advanced study, research or integration of subjects pertaining to forested ecosystems. The fellowships, which include stipends up to \$40,000, are intended to provide individuals in mid-career with an opportunity to utilize the resources and to interact with personnel in any department within Harvard University in order to develop their own scientific and professional growth. In recent years Bullard Fellows have been associated with the Harvard Forest, Department of Organismic and Evolutionary Biology and the J. F. Kennedy School of Government and have worked in areas of ecology, forest management, policy and conservation. Fellowships are available for periods ranging from six months to one year and can begin at any time in the year. Applications from international scientists, women and minorities are encouraged. Fellowships are not intended for graduate students or recent post-doctoral candidates. Information and application instructions are available on the Harvard Forest web site (<http://harvardforest.fas.harvard.edu>). For additional information contact: Committee on the Charles Bullard Fund for Forest Research, Harvard University, Harvard Forest, P. O. Box 68, Petersham, MA 01366 USA or email (hfapps@fas.harvard.edu). Annual deadline for applications is February 1.

KATHERINE ESAU POSTDOCTORAL FELLOWSHIP

UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

Applications and nominations are invited for the Katherine Esau Postdoctoral Fellowship in Plant Biology, which will be awarded to an outstanding young scientist interested in structural aspects of plants at the level of tissues, organs and whole plants. Included would be studies in which plant structure is integrated with development, evolution and/or function. Modern approaches to important questions in plant anatomy and morphology are encouraged. Preference will be given to candidates who have completed their Ph.D. within the past 5 years. The Esau Fellowship will be awarded for a period of two years to enable the successful candidate to work under the mentorship of a University of California, Davis faculty member. The Esau Fellowship stipend is \$35,000 per year plus benefits and includes a \$5,000 per year research allocation.

Applications should include the identification of an appropriate faculty mentor(s), a complete curriculum vitae, graduate and undergraduate transcripts, reprints of published works, a proposal of the research that would be carried out under this program (limited to 5 single-spaced pages, 12-point font, 1-inch margins) and a statement of the relevance of the proposed research to the planned career in plant structure and development, evolution and/or function. Applicants are required to provide three letters of reference and a letter of commitment of laboratory space and ancillary support from the proposed UC Davis faculty mentor(s). International candidates are welcome to apply. Preference will be given to candidates who received their Ph.D. from an institution other than UC Davis and who have not already spent time on this campus.

Please send a hard (paper) copy of your completed application to Professor Judy Jernstedt, Chair, Faculty Advisory Committee, Esau Fellowship Program, Department of Agronomy and Range Science, University of California, Davis, One Shields Avenue, Davis, CA 95616. (FAX: [530] 752-4361). Inquiries may be made by e-mail to the chair (jjernstedt@ucdavis.edu). Web site (<http://www.dbs.ucdavis.edu/fellowships/esau>).

Fellowships will be awarded on an annual basis. The next deadline for this program will be November 1, 2003.

The University of California is an equal opportunity employer.

Books Reviewed In this issue:

Bryological

Gathering Moss: The Natural and Cultural History of Mosses. Kimmerer, Robin Wall
- John Z. Kiss 100

Ecological

The Cerrados of Brazil: Ecology and Natural History of a Neotropical Savanna. Oliveira, Paulo S.
and Robert J. Marquis (eds) - Noel Pavolic 100

Columnar Cacti and Their Mutualists. Evolution, Ecology and Conservation. Fleming, H.
& Valiente-Baunet, A. (eds) - Roberto Kiesling 101

Invasive Exotic Species in the Sonoran Region. Tellman, Barbara (ed) - Webster, Grady 103

Economic Botany

Biology of Vanda Miss Joaquim. Sin, Hew Choy, Yam Tim Wing and Joseph Arditti.
- Peggy Dominy 105

Dye Plants and Dyeing. Cannon, John and Margaret. - Elizabeth Harris 106

Feast Your Eyes: The Unexpected Beauty of Vegetable Gardens. Pennington, Susan J.
- Robynn Shannon 107

Magnolia: The Genus Magnolia. Sarker, Stayajit D. and Yuji Maruyama (eds).
- Nina Baghai-Riding 108

The New Daylily Handbook. Gatlin, Frances L with James R. Brennan (eds). - Joanne Sharpe 109

Palms Won't Grow Here and Other Myths. Ferancko, David A. - Scott Ruhren 109

Plant Resins: Chemistry, Evolution, Ecology, and Ethnobotany. Langenheim, Jean H.
- Dorothea Bedigian 110

Thyme, The Genus Thymus. Stahl-Biskup, Elizabeth and Francisco Saez. - Douglas Darnowski 112

Tillage for Sustainable Cropping. Gajri, P.R., Arora, V.K. and Prithar, S.S. - Nina Baghai-Riding 113

Genetics

Genetically Modified Crops: Assessing Safety. Atherton, Keith T. - Johanne Brunet 114

Physiology

Molecular Plant Biology, Vol 1. Gilmartin, Philip M. and Chris Bowler. - Peggy Dominy 115

Plant Growth and Development Hormones and Environment. Srivastavam, Lalit M.
- Douglas Darnowski 115

Plant Physiology, 3rd Ed. Taiz, Lincoln and Eduardo Zeiger. - Timothy C. Morton 116

Plant Tissue Culture, 100 Years Since Gottlieb Haberland. Laimer, M., W. Rucker (eds)
- Joseph Arditti 117

Systematics

Willows: The Genus Salix. Newsholme, Christopher. - Danilo D. Fernando 119

Teaching

The Names of Plants, 3rd ed. Gledhill, David. - Douglas Darnowski 120

Gathering Moss: The Natural and Cultural History of Mosses. Kimmerer, Robin Wall. 2003. ISBN 0-87071-499-6. (Paper US\$17.95) 176 pp. Oregon State University Press, 101 Waldo Hall, Corvallis, Oregon, 97331-6407. It is nice to know that other plants still exist in this era of *Arabidopsis*. One can get this feeling from reading *Gathering Moss*, which written by a professional bryologist who is a college faculty member. The book is a series of linked essays on the beauty, cultural, and natural history of mosses. The author has a great way of combining her professional and personal lives in these essays. This is a book for those of us who are passionate about the subjects and organisms that we study.

Mosses are seemingly inconspicuous and can be easily overlooked, but not once you have read *Gathering Moss*. The author also does a great job in teaching some essential facts of the physiological ecology and other aspects of the biology of mosses in these essays. For instance, the advantages of being small and life in the boundary layer are discussed in one of the chapters. We learn about the remarkable ability of mosses to survive desiccation as the author eloquently tells us: "...even after all of these years, I still delight in the ritual of adding the water, drop by drop, and watching with the microscope as the shoots revive."

Kimmerer also stresses ecological aspects of moss biology and the important role of mosses in various ecosystems. She tells us that one gram of moss from the forest floor can be the host for as many as 150,000 protists, 132,000 tardigrades, and 200 insect larvae in the essay entitled "In the forest of the water bear." The author also outlines the destruction of moss communities due to their popularity for horticultural uses by harvesters who completely decimate luxurious carpets of "old growth" moss in Oregon.

One of my favorite stories is the subject of the last essay entitled "Straw into gold." This is about the moss *Schistostega* that lives in lake shoreline caves. This moss survives with only a few minutes of sunshine each day that it obtains near sunset. "Just for a moment, in the pause before the earth rotates us again into night, the cave is flooded with light. The near nothingness of *Schistostega* erupts in a shower of sparkles..."

One anecdote (not in the book) that the author would appreciate is the recent story of the moss *Ceratodon* that was grown on the space shuttle *Columbia* during the ill-fated mission that ended in February 2003. Despite the fiery disintegration of the space shuttle over Texas, the moss experiment of Fred Sack and Volker Kern (Ohio State University) somehow survived the fall back to Earth. Partial

cultures of the moss that were fixed in space could still be seen in the recovered containers, and the two scientists may be able to obtain some data from the experiment. As this story and this book tell us, thought they may be overlooked, mosses are hearty and vigorous plants indeed. - John Z. Kiss, Botany Department, Miami University, Oxford, OH 45056.

The Cerrados of Brazil: Ecology and Natural History of a Neotropical Savanna. Paulo S. Oliveira and Robert J. Marquis, eds. 2002. ISBN 0-231-12042-7 (Paper \$37.50) 398 pp. Columbia University Press, 61 W 62nd St., New York, NY 10023. - Ecologists have been interested in the environmental and habitat heterogeneity of savannas and their dynamics for a long time. This excellent book is the first in English to focus entirely on the Brazilian cerrados biome, a 2 million square kilometer area (22% of the country) encompassing campo limpo (grassland), campo sajo (some shrubs and trees), cerrado (savanna) and cerrado (woodland). Cerrado is a portugese word meaning 'half closed' or 'dense' probably referring to the difficulty of traversing the more wooded portions of the vegetation gradient on horseback.

Why focus on the cerrados? This region is one of 25 identified world centers for biodiversity and is believed to be the most species rich tropical savanna system in the world. Beta diversity of the vegetation is quite high. In Brazil, the Amazon and Atlantic Forest regions have greater diversity. In the 1970's the rate of cerrados destruction exceeded the rate for Amazonian rainforest. Today, humans have modified 80% of this species rich biome. This alteration is principally due to cattle ranching and the expansion of corn, soybean, and cotton agriculture. Economic policy has fostered the growth of agriculture and modern farming technology has converted cerrados land of low fertility and high acidity into the most important agricultural region in Brazil.

The editors have created a comprehensive and error free book with well-integrated contributions by the authors. I only found one error on page 107 where 'interstate' is misspelled. There are good black and white photographs to give the reader an idea of the soils, vegetation, ant foraging, and pollinator systems. Most chapters have good tables and well reproduced figures. Not being familiar with most of the political boundaries of Brazil, I wished that Figure 6.1 had appeared or was referenced earlier in the text. Unfortunately, the dark fill that highlights the cerrados biome obscures the state labels and boundaries within the region: this problem also occurs in Figure 6.4.

The book is divided into five sections, excluding the introduction: 1) Historical framework and the abiotic environment (soil, palynology, fire, and human impacts), 2) the plant community (physiognomy, understory, population dynamics, fire effects and ecophysiology), 3) the animal community (lepidoptera, herptofauna, birds and mammals), 4) insect-plant interactions (ants-plants-herbivores, plants and their herbivores, pollinators and pollination biology) and 5) the conservation of the cerrados. Oliveira and Marquis introduce the book by first presenting an analysis of the scientific literature demonstrating the exponential increase in cerrado publications. They introduce the structure of the book and the cerrado vegetation nomenclature. Chapter 5 concerning the vegetation physiognomy ties all the chapters together by characterizing and names vegetation along the cerrado continuum. Most authors discuss further research needs.

Important factors in the distribution of cerrados include seasonal rainfall, poor soil fertility, drainage, fire regime, and climatic fluctuations of the Quaternary. We learn how the creation of hard iron nodules called ironstone or petroplinthite, varying in size from sand to cobble, reduce erosion and gullyng at the periphery of plateaus; therefore, it stabilizes the geomorphic landscape. Many cerrado soils are high in Al and many cerrado species accumulate considerable concentrations of this element in their leaves. Some woody species have been shown to grow poorly in the absence of Al! Palynological studies indicate that the cerrado was present prior to the Quaternary, and experienced fire prior to the influence of man, and waxed and waned with climatic fluctuations. It was interesting to learn that legumes comprise the largest plant family in the cerrados and that the largest genus is *Chamaecrista*. African grasses are the principle invasive plants, because they have been widely introduced to improve pasture. The chapters about animals document the underestimation of biodiversity of the groups and that some of this diversity is dependent on the mosaic of gallery and mesophytic forests within the cerrados. Perhaps most interesting and fascinating, for the ecologist, are the three chapters that highlight biotic interactions between insects and the plants. The field is ripe for more cross comparisons between African and Australian tropical savannas.

Clearly each author's discussion of research needs illustrates that much research still needs to be done in the cerrados. Despite the imperilment of the cerrados, I was struck by how much remains compared to regions like Midwestern savannas. Nevertheless, in the presence of the human economy, time is probably short, which is why this book was written. The reader wonders how

successful the Brazilian government has been to achieve the goal of protecting 10% of this biome by 2002? The editors and authors have succeeded in their hope to write a book that will aid and foster future cerrados research. Makes me want to learn Portuguese and head south to the cerrados plateaus! Noel B. Pavlovic, U.S. Geological Survey, Lake Michigan Ecological Research Station, 1100 N. Mineral Springs Rd., Porter, IN 46304.

Columnar Cacti and Their Mutualists. Evolution, Ecology and Conservation. Fleming, H. & Valiente-Banuet, A. (eds.) 2002. University Arizona Press. Tucson. XIII + 370 pp. with the collaboration of 29 authors. Co-evolution of plants and animals is one of the most thrilling aspects of modern biology, and the different contributions of this volume cover this for the columnar cactus and vertebrates. It is a compilation of original papers, or updated ones from a conference held in late June, 1998, at Tehuacan City, Puebla, Mexico. The book is organized in 3 parts: I. Geology and Evolution; II. Anatomy and Physiology; and III. Population and Community Ecology and Conservation.

Starting the Part I, T.R. van Devender gives a general dynamic view of the environment and geological history of the Mexican and SW USA deserts, and the consequent floristic changes, as well as the relationships of those floras with others regions.

The collaboration of 5 authors produced the next chapter with a cladistic analysis of the phytogeography of the Mexican cactus tribe Pachycereae, resulting in two solid conclusions: its origin is southern Mexico and the genus *Stenocereus* is the basal group.

Another phylogenetic analysis, based on chloroplast DNA is presented by R. Wallace. This study considers all the columnar cacti, both South and North American, and confirms the previous conclusion of Mauseth and others about the S-American origin of the family and the derivation of the Pachycereus and Leptocereae tribes from one of the two primary clades of columnar cacti.

Of special interest was the cladistic analysis of T. Terrazas and S. L. Cornejo combining morphological, anatomical, and chemical data. To mention only the 2 mayor conclusions, *Stenocereus* appears as a monophyletic clade defined by "distinctive silica bodies in the dermal tissue"; and Pachycereus, as normally defined, is paraphyletic.

The phylogeny of "Cactophilic" bats is treated by Simmons and Wetterer. On the one hand they conclude a dependence of many columnar cactus on bat pollination and seeds dispersal. On the other, bats are basically opportunistic using nectar, pollen and fruits as part (sometimes a very important part) of their diet. At least 18 bats species are known to have developed mutualistic relationships with cacti, and "cactophily" evolved a minimum of 13 different times and include morphological adaptations, according to the authors.

In the last chapter of Part I, four authors analyze the "Genetic diversity of Columnar Cacti", based on isoenzyme electrophoresis, a technique poorly applied in cacti because of the (more illusory than real) difficulty in extracting enzymes from the mucilage. Authors conclude that the 9 species studied have high levels of genetic diversity and insect-pollinated ones have more genetic variation than bat pollinated species.

Part II of the volume starts with an interesting study of the Evolutionary Trends in 40 Columnar Cacti under domestication or from wild populations in southwestern Mexico. One case, *Stenocereus stellatus*, is thoroughly analyzed. It exists as a wild plant, but also is cultivated and managed, resulting in significant morphological differences and also partial pollen incompatibility. The study it is also useful in providing a better understanding of domestication processes of some cacti and other plants.

The "Growth Form Variations in Columnar Cacti" is analyzed by M. L. Cody, who correlated branching patterns with environmental factors, especially canopy and temperature. For instance, subcanopy columnar cacti differ in branching from emergents of the same species and pollinators may be different in both cases.

The chapter of P.S. Nobel on "Physiological Ecology of Columnar Cacti" demonstrates that low temperatures are the main limiting factor for these plants' distribution, but morphological attributes (apical pubescence, shade of the spines, stem diameter), can help in some degree to survive severe cold. High temperatures are tolerated very well by these plants (up to 70° C or more, temperatures unprecedented in vascular plants because enzymatic denaturation!) The chapter is absolutely didactic and several other aspects are covered (water relations, crassulacean-acid metabolism, etc.).

The "Pollination Biology of Sonoran Desert Columnar Cactus" by Fleming, analyzes the importance of vertebrates (bats) and insects (moth

and bees) in fruit set, in relation to time of anthesis, geographical distribution, gene flow, competition for pollinators, self-compatibility, and hermaphroditism vs. different forms of dioecy, among other interesting items.

The "Biotic Interactions and Population Dynamics" i.e. the interactions of these columnar cacti with animals such as bats or birds and insects, and with plants (nurse plants, its benefit and competition, extra and infraspecific) are analyzed with mathematical models in Chapter 11, where 7 authors collaborate. The process affecting seeds dispersal, seedling, juvenile and adults are considered.

The relationship between columnar cacti and their main pollinators and seed dispersers in Andinian enclaves of Colombia and Venezuela are summarized in Chapter 12. The authors also describe adaptative strategies of floral and fruit features, and the roles of bats and birds in seed dispersion.

"Columnar cactus and the Diets of Nectar – Feeding bats" considers the composition of diet in several groups of bats with high to low specialization in cactus pollen and nectar, or who feed only sporadically on cacti. Coincidence in seasonal geographic distribution of some bats with cactus flowering time is noticeable. Coincidental distribution of cacti and agaves results in bat mutualism with both vegetal groups.

Fleming and Nassar examine the "Population Biology of a Particular Bat: *Leptonycteris curasaoe*" and come to very interesting conclusions, such as the temporal coincidence of the peaks of flowering and fruiting with the annual birds migrations, and also the long distance migrations of male or/and female bats that daily fly up to 30 km from their roosts for foraging.

"Why are columnar Cactus Associated with Nurse Plants?" is the question-title of a chapter answered by Sosa and Fleming. They conclude that for the studied species, columnar cacti and nurse plant associations differ for slopes or flat lands. Under the canopy of the nurse plant, cactus seeds and seedlings escape from predators and find protection from drought and temperature extremes. According to their data, the last factor is the most important one.

Four authors write about "Cacti in the dry Formations of Colombia," where they describe the floristic and physiognomic composition of the vegetation of the dry formations, and provide a tentative list of 60 cactus species in 20 genera based on the literature

and their own research.

The “Conservation of Nectar Feeding Bats” is treated by M. Santos and H. T. Arita, who conclude that this group is more vulnerable than other chiropterans because of their close mutualistic association with plants, their dietary specialization, their restricted geographical range and their small body size. Colombia, Venezuela, Brazil and Peru are the countries with the greatest species richness of these bats, some of which are endemics in areas under accelerated human modification.

If there is any general criticism it is the scarcity of photos or line-draws of the organisms studied that would help the reader who is not familiar with group. This would be particularly useful in chapter 8 to illustrate the diverse patterns of forms. Simple diagrammatic schemes to show the variations in columnar cactus branching would be sufficient. The graphics and maps are clear, except for Fig. 2-3 where the floristic provinces of Mexico are illustrated by gray tones. Finally, it is unclear if birds and insects have less importance in pollination, or if the few references to them indicates the lack of a specialist in these groups.

We must congratulate the editors for the selection of the subjects treated, and the quality of the chapters. The pollination of cacti by bats, and their foraging for cactus nectar and fruits, relating with migrations, and also the relationship between cactus and nurse plants serve as examples for the study of other cactus groups. The book is restricted almost exclusively to the Tribe Pachycereae and concentrates heavily on North American columnar cacti. It will serve as a model for other groups and other areas. It is a book written at university level, but is readable for the serious cactus enthusiast, with mostly clear charts, maps and graphics. – Roberto Kiesling, Instituto de Botánica Darwinion, *Academia Nacional de Ciencias Exactas, Físicas y Naturales Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)*, Argentina.



Invasive Exotic Species in the Sonoran Region. Barbara Tellman (ed.). 2002. ISBN 0-8165-2178-6 (cloth), US\$45.00. 424 pp. The University of Arizona Press and the Arizona-Sonora Desert Museum, Tucson. – In addition to its revolutionary effects (both good and bad) on human societies, the “globalization” begun in the late 20th century has had significant environmental effects—many of them negative. It is now well known that the hegemony of industrial capitalism, despite its potential benefits for hunger and disease control in underdeveloped countries, has produced unanticipated environmental effects, including not only deforestation and loss of biodiversity, but also a rising tide of exotic species of plants and animals over the face of most of the planet (outside of the polar regions). In the United States, monitoring of the interplay between native plant species and invaders has become more intensive, with botanists in universities and governmental agencies tracking the decline of many rare species and the concomitant upsurge of exotics. In California, many vernal pool plants have become rare or extinct, partly as a result of clearing for agriculture, but also due to competition from introduced Eurasian weeds, especially annual grasses. In the California flora, as summarized in the *Jepson Manual* (1993), more than 1,000 species out of 5,862 are identified as aliens—a proportion of greater than 17%, which appears to be steadily increasing. An undesirable consequence of the massive interchange of plants and animals among continents is the increasing homogenization of the world’s biota, accompanied by disturbing signs of genetic erosion.

Concern about the environmental effects of invasive plants and animals goes back to the early history of the United States. In a review from a recent symposium at the Missouri Botanical Garden, Richard Mack cites evidence that in New England a number of European plant species were becoming naturalized 15 years after the Pilgrims landed at Plymouth! In 1811 the controversial botanist Rafinesque published a list of 300 weedy species, which was progressively expanded by later botanists. There is a general consensus among students of the effects of invasive species that serious research on the problem was initiated in response to the ground-breaking book in 1958 by Charles Elton: *The Ecology of Invasions by Plants and Animals*.

Books and reports about weeds are becoming more sophisticated, and government agencies (both state and federal) have become very proactive. Practically every state in the United States has at least one manual on weed identification or eradication, and websites on exotics have proliferated strikingly. There are also books of a

more general scope that consider the impact of non-indigenous species on native plants and animals, of which *Invasive Exotic Species in the Sonoran Region* is a recent example.

In contrast to the situation in the United States, publications about invasive species in Mexico are sparse. The literature on most tropical floras suggests that invasion by exotic species is a relatively minor problem. For example, in the essays in *Seasonally Dry Tropical Forests* (Bullock, Mooney, and Medina, 1995), it is noted that tropical dry forests have been severely impacted by clearing for agriculture, but scarcely any mention is made of problems from exotic species. Invasions appear to be most severe on tropical islands, of which the most notorious is Hawaii (Mooney and Drake, *Ecological Invasions of North America and Hawaii*, 1986).

Sonora is a largely arid Mexican state with a subtropical moist to desertic climate that might be expected to resemble Arizona in its proportion of introduced species. *Invasive Exotic Species in the Sonoran Region* presents the results of a symposium held in 1998 at the Arizona-Sonora Desert Museum in Tucson by a concerned group of naturalists, conservationists, and resource managers. The agenda of the symposium and the book reflects the provocative document *State of the Sonoran Biome*, by Gary Nabhan and Andrew Holdsworth, that appeared just a few months earlier. That report enumerated a number of factors that were (and are) responsible for the increasing threats to biodiversity in the Sonoran Desert biome: urbanization, exploitation of water resources, livestock grazing, mining, and invasive species. However, it is clear from the focus of *Invasive Exotic Species in the Sonoran Region* that the ecological impact of introduced (exotic) species is a particular concern.

The chapters of this book are grouped into three sections: exotic species in the Sonoran Desert; discussions of different taxa or ecological groups of plants and animals; and problems of controlling exotic species. The essays in the various chapters cover the field of the nature of exotic species in the Sonoran region, and their impacts. Preceding the 19 chapters in the three sections is a preface by Gary Nabhan and a brief introduction by the Editor, Barbara Tellman, that offers some interesting statistics: the proportion of plant species of exotic organisms in the Sonoran Desert (49% vs. 51% for animal groups) is less than in the United States as a whole (62%), and the percentage of exotic species in all major taxonomic groups (except fish) is much lower in the Sonoran Desert, especially in plants. It must be noted, however, that neither Tellman,

Stephen McLaughlin, nor most other contributors to the volume often do not distinguish rigorously between the the various terms used: alien, exotic, naturalized, and invasive.

The list of contributors includes a many of the investigators currently active in studies of ecology and biodiversity in the Sonoran Desert, although it is rather light on contributions by Mexican researchers. Although both plant and animal exotic species are considered, most contributions are primarily botanical. Steven McLaughlin provides an interesting essay on the floristic composition of the Sonoran Desert with special regard to the percentage of exotic plant species in the current flora. It is no surprise that the data show the grass family (Poaceae) to be the dominant group, with nearly 200 exotic species in the western U.S. and 73 in the Sonoran Desert province. It is notable that species of Mediterranean origin are dominant in biomass in the Sonoran region (even though fewer in species than European or Eurasian weeds). Wilson, Leigh, and Felger list 62 established non-native plant species according to life form (mostly annuals but some hemicyptophytes). West and Nabhan survey the impact of exotic plant species on the Midriff Islands in the Gulf of California and the adjoining Sonoran Coast, identifying 17 species of particular concern and 38 others that have the potential of becoming serious invaders. It is notable that they identify buffelgrass (*Pennisetum ciliare*) as the greatest threat, as this is the theme of an entire chapter by Búrquez-Montijo, Miller, and Martínez-Yrizar. Their map indicates that buffelgrass has spread over most of the mainland Sonoran Desert and is most dominant in irrigated districts; it is the perfect exemplar of a transforming invader. Jane and Carl Bock in their chapter discuss a considerable number of other invasive grasses—especially species of lovegrass (*Eragrostis*). Todd Esque and Cedil Schwalbe, in reviewing the physical and biological effects of alien invasions, finger red brome grass (*Bromus rubens*) as a particular villain in the upland Sonoran Desert grasslands because of its provision of fuel for wildfires.

Juliet Stromberg and Matt Chew review the impacts of exotics on the riparian ecosystems in the Sonoran Desert, they are not quite as negative in their attitude towards saltcedar (*Tamarix ramosissima* and other species) as some other writers. They note that human disturbance of natural flooding (by dam and canal construction) has so modified the habitat to favor establishment of exotics that extermination campaigns against saltcedar are not sufficient to restore riparian vegetation to its original state. Saltcedar invasion is reviewed by Lawrence Steens and Tina Ayers in their analysis of exotics in the Grand Canyon, and they take a live-and-let-live

attitude towards the thickets of *Tamarix*; they do not find it reduces biodiversity, and imply that we should resign ourselves to living with it. There is some evidence that salt cedar thickets are not biological deserts, as some native birds use them for nesting. The question of trying to extirpate exotic species can be complicated, as noted by Shapiro (in *Diversity & Distributions* vol. 8, 2002), who finds that in the Central Valley of California a number of native butterflies have adjusted to introduced plants such as fennel (*Foeniculum*), which is usually regarded as an undesirable weed.

Animal exotics in the Sonora Desert are not as dramatically apparent as buffelgrass and saltcedar, and their number is smaller, so they are treated in fewer chapters and pages than plants. Barbara Tellman identifies honeybees (*Apis mellifera*), English sparrows (*Passer domesticus*), starlings (*Sturnus vulgaris*), rainbow trout (*Salmo gairdneri*), brook Trout (*Salmo trutta*), and bullfrogs (*Rana catesbeiana*) as playing leading roles. Eric Mellink, in a review of invasive vertebrates on the Midriff Islands, pinpoints mammals—especially rodents and cats—as dangerous predators on native vertebrates; surprisingly, goats do not appear to be such a problem as they are on Pacific Ocean islands such as Guadalupe and San Clemente. Phillip Rosen and Cecil Schwalbe indicate that on the mainland feral cats are the most destructive predators in terrestrial ecosystems, and bullfrogs and crayfish in aquatic systems. They suggest that survival prospects of the threatened Chiricahua leopard frog (*Rana yavapaiensis*) would be improved by reducing or limiting stockponds where bullfrogs mainly thrive.

The final section of the book addresses the problems of the exotic species management. Joel Floyd describes the activities of the USDA Plant Protection and Quarantine section, and notes that enforcement of quarantine laws is complicated by the complexity of jurisdictions between state, federal, and international agencies. Barbara Tellman reviews the variety of methods used to control invasive species, including chemical applications, physical removal, controlled fires, and biological controls. Juli Gould and Jack Deloach discuss biological control of invasive exotics, of which St. John's Wort (*Hypericum perforatum*) is the classical example. These authors address some of the problems in biological control, such as inadequate monitoring, and the possibility of "collateral damage" when nontarget species are attacked. They provide a survey of four sample cases, including puncturevine (*Tribulus terrestris*), saltcedar (*Tamarix ramossissima*), giant Salvinia (*Salvia molesta*), and giant reed (*Arundo donax*); control of puncturevine by Eurasiatic species of weevils has

been largely effective. Intensive research on saltcedar has begun only recently (since 1985), and results are said to be promising, but at present physical removal of the plants is the major strategy being used. Biological control of giant reed has scarcely begun. The most startling case is giant *Salvinia*, which was only discovered in the Lower Colorado River in 1999, but is already a serious problem; apparently, however, weevils that have been used in Australia may prove effective. In his final summary, Jeff Lovich suggests that a Sonoran Desert Weed Council could be set up along the guidelines of the California Exotic Pest Plant Council (CalEPPCS).

This book is documented with a glossary and appendices on relevant laws, as well as checklists of the exotic introduced species of plants and animals in the Sonoran Region. It does not include much historical information or theoretical ecology, but does provide detailed descriptions of some of the invasive species, their effects on the arid Sonoran ecosystems, and the so far indecisive methods used to control their spread. It provides an overall view of the problems involving invading species in the Sonoran desert, and calls attention to the fact that we do not yet have a parallel treatment documenting the effects of invasion by exotics on the Chihuahuan Desert ecosystem.—Grady L. Webster, Herbarium, University of California, Davis CA 95616.

Biology of Vanda Miss Joaquim. Sin, Hew Choy, Yam Tim Wing and Joseph Arditti. 2002. ISBN 9971-69-251-1 (paper US\$67.50est), 259 pp., Singapore University Press, Yusof Ishak House, 31 Lower Kent Ridge Road, Singapore 119078. *Vanda Miss Joaquim* is an orchid. It also happens to be the national flower of Singapore. The **Biology of Vanda Miss Joaquim** is not only a horticultural study, but also a cultural study of this plant. In their preface, the authors declare they "celebrate its beauty, recall its history, explain its biological complexity" in almost reverent tones.

Vanda Miss Joaquim is a hybrid, the oldest and sole natural hybrid between *Vanda hookerana* and *Vanda teres*. It was a "foundling", discovered by Miss Agnes Joaquim in her Singapore garden one morning in 1893. Believing she had stumbled across a new species, she took it to the Director of the Singapore Botanic Gardens. There, it was confirmed to be a new species and named for her. Thus, starts the story, study and cultural influence of this exotic plant.

The authors begin their book with a chapter on orchid basics, for those not particularly familiar with the family and the many genera. Here the authors discuss habitat, growth, propagation, roots and, of course, the flowers. Many line drawings, black and white photos, and microscopic illustrations accompany this chapter and continue throughout the rest of the book. Though labeled “basic”, this chapter is aimed at the research botanist.

Chapter two is devoted to the discovery and subsequent history of this orchid. Truly, the authors dug deep into Singapore archives to recount the personalities and social milieu surrounding this *Vanda*. Illustrations showing snippets of newspaper reports surrounding the establishment of the *Vanda* Miss Joachim as the national flower in 1981 and postcards of the era of its discovery add considerable richness to the story, but also suggesting the depth of national pride. The evidence that this flower has become an integral part of the Singaporean identity is found in its pervasive presence on currency and coinage, textile design, as welcome leis to visitors, jewelry design, and a plethora of souvenirs.

The following five chapters deal with the extensive physiology, cytogenesis, breeding, propagation and cultivation of *Vanda* Miss Joaquim, the real biology of this plant. There is a middle section of beautiful color photos. After several pages of cited references, indicating extensive research, Appendix 1, and the subsequent Appendix 2, appear to be from a lecture or paper on “Miss Agnes Joaquim: A Singaporean with Armenian Roots” by Abraham Der Krikorian, Professor Emeritus, Department of Biochemistry and Cell Biology, SUNY at Stony Brook. These sections give attention to Miss Joaquim, variously described as kind, gentle and shy, her family, her Armenian heritage, Christian faith specifically and the Armenians in Singapore in general. These sections, which offer a fascinating insight into the person, place and time, are just tagged on to the end of the book. One might wonder at the suitability of such a section in what otherwise is a research-level book on plant biology. Throughout the book the authors express themselves with almost deferential language in regards to this flower and so it is excusable that their obvious enthusiasm for the plant is extended to Miss Joaquim herself.

It could be argued that chapters 1 and 2 along with the appendices are superfluous to the biological study of *Vanda* Miss Joaquim. The overview of *Orchidaceae* in the first chapter tends to be redundant of the more specific discussions on *Vanda* Miss Joaquim in chapters 3-7. Chapter 2 dealing with its cultural history and, the appendices comprising biographical and supplementary information on its discoverer are more accurately

enrichment material. It certainly gives an interesting dimension to this remarkable plant. It might have been more cohesive if chapter 2 had been grouped with the appendices. This book is appropriate for the botanist researcher and orchid enthusiast. I would be suitable for library collections supporting botanical research programs, including academic, botanical special collections and public libraries with an active gardening demographic. - Peggy Dominy, Sciences Librarian, Hagerty Library, 33rd & Market Sts., Drexel University, Philadelphia, PA, 19104

Dye plants and Dyeing. John and Margaret Cannon. 2003. ISBN 0-88192-572-1; 128 pp. Timber Press Inc., Portland, OR. A guide to the most commonly used dye plants including an introduction covering dyeing basics. The authors of this volume are botanists who wish to present more background botanical and historical to the craft of dyeing with plant material. This book is meant for two audiences: either a dyer interested in learning more about dye plants, their history and use or a botanist interested in dyeing. The plants chosen for inclusion are for the most part the traditional old-world (western) dye plants such as *Rubia tinctoria* (madder), *Isatis tinctoria* (woad), *Lawsonia inermis* (henna) and their brethren but some new world plants such as *Maclura pomifera* (osage orange) and *Phytolacca americana* (pokeweed) are also included. In all, 47 different plants are described. Each entry is covered in two pages; text is on the left describing the plant, historical aspects of its use as a dye as well as instructions for dyeing. On the facing page is a colored pencil drawing from life or dried specimens. The illustrations by Gretel Dalby-Quenet are fairly accurate depictions of the plants under consideration and include useful sample hues of the colors obtained from each dyestuff under different conditions (water vs. alcohol extraction and comparison of the various possible mordants) as produced by the authors (although the samples depicted do not always encompass the full range of possible colors obtainable). For those craftspeople interested in dyeing beyond the one-time experimental effort this is not a stand-alone guide but does make a useful addition to the dyer's library. For those botanists interested in the economic uses of plants, this is a volume with excellent coverage of western dye plants. Elizabeth Harris, Ohio State University.

Feast Your Eyes: The unexpected beauty of vegetable gardens, by Susan J. Pennington. This book is not what I expected (I pictured sort of a glossy, coffee table version of a seed catalog, with voluptuous vegetables spilling from the pages). This author is not what I expected (I expected, well, a *gardener* at least, maybe even a professional horticulturist or landscape designer, a Gertrude Jeckyll of vegetables).

Susan J. Pennington is, by her own admission, no horticulturist or even gardener. She is, first and foremost, a scholar. In *Feast Your Eyes* she has combined her background and expertise in archaeology with the vast resources of the Smithsonian Institution's museums and libraries to produce this delightful, richly-illustrated book in which the cultural history of vegetable gardens is told for the first time. If you're looking for a guide to designing your vegetable garden, this book is not it (though several books of that sort are listed in the "Selected Bibliography"); Pennington makes it clear in the introductory pages that she has written a "how-come" book rather than a "how-to" book.

Pennington wrote *Feast Your Eyes* while Enid A. Haupt Fellow in Horticulture at the Smithsonian Institution. In 1992, the Garden Club of American (GCA) donated its extensive slide library to the Smithsonian, and that acquisition became the inspiration for the American Garden Legacy Series of exhibitions organized by the Smithsonian Institution Traveling Exhibition Service. As Haupt Fellow, Pennington took on both the second exhibition in the series (as curator) and the companion book.

In *Feast Your Eyes* Pennington became the first author to explore the aesthetics of vegetable gardens, tracing their cultural history across cultures as well as through time. And not only the aesthetics of vegetable gardens, but also the aesthetics of the vegetables themselves. An entire chapter is devoted to "The Vegetable Still Life" (17th century to present), another to brief "biographies" of ornamental vegetables.

The remaining six chapters and the epilogue are about gardens, in the Aztec empire of Montezuma, Louis XIV's France, and Ming dynasty China, through English and American landscape gardening of the 18th and 19th centuries, to the war garden movement of World War I and victory garden movement of World War II, and finally to the vegetable gardening renaissance that began in the 1970's.

Two things make this book remarkable. First is the convergence of Pennington's interests and the Smithsonian's resources. Most of the figures in the

book are from the donated GCA slide collection, but many others come from other Smithsonian collections, housed in the Freer Gallery of Art, the Smithsonian American Art Museum, the National Museum of American History, the Horticultural Branch Library, and the Horticultural Services Division. Still other images are from the Smithsonian's "neighbors": the National Gallery of Art, the National Archives and Records Administration, and the Library of Congress. Pennington agrees that she could not have written this book anywhere other than the Smithsonian.

The other remarkable thing about *Feast Your Eyes* is how such a readable and accessible book could at the same time be so scholarly. Pennington's research is carefully documented, with 240 endnotes in just eight chapters and an epilogue. Pennington says she had to insist on being allowed to include endnotes, and insist she did. Why were the endnotes so important to her? Because *Feast Your Eyes* is the first place primary literature on the aesthetics of vegetable gardens has been synthesized. Although the intended audience is visitors to the traveling exhibit of the same name, the book is so readable and so, well, *interesting*, it will surely have broad appeal. Amateur gardeners, professional and armchair landscape designers, ethnobotanists, and cultural historians alike will be captivated by Pennington's account of the changing perceptions of vegetable gardens.

As mentioned above, *Feast Your Eyes* is a companion book to a Smithsonian traveling exhibition of the same name. As such, it suffers from a certain lack of cohesiveness, each chapter having been written as a stand-alone module from which exhibition text could most readily be adapted. For example, one gets the feeling that the chapter on vegetable still lifes has just been plopped into the middle of a fascinating historical account. Nor is it clear why the section on the Aztec "floating" gardens is cast as the epilogue rather than as a ninth chapter.

My remaining criticism is trivial: I wish the book had a subject index. The index of plant names and index of proper names might carry many readers as far as they wish to go, but what if one wants to know what the book has to say about drift planting? – Robynn Shannon,

Magnolia: The Genus Magnolia. Satyajit D. Sarker and Yuji Maruyama (eds.), 2002. ISBN 0-415-28494 (hardcover \$120) 187 pp. Taylor and Francis Group, 11 New Fetter Lane, London.- Plants represent a large storehouse of pharmaceutical drugs. Medicinal plants, used to treat illnesses and ailments, date back prior to the first century A.D. especially in the Far East and among Native American cultures. Herbal and traditional medicines have gained popularity in recent years and the market for medicinal plants has become an ever-growing, big business. Dietary supplements from plants are in health food stores and pharmacies. Commercially important plants such as *Ginkgo*, *Ephedra*, the Brazil nut, and St. John's wort have attracted considerable attention. Several species of *Magnolia* are used in traditional Chinese and Japanese medicine and are known to combat headaches, chronic hepatitis, asthma, typhoid, malaria, and cancer.

The book 'Magnolia' addresses the value of the genus *Magnolia* in Chinese-Japanese herbal medicine. It represents a compilation of more than twenty-five years of biological activities obtained from various magnoliaceous plants. Past and new investigations that promote how various compounds are used to treat allergies, nervous tension, and insomnia and the progress of science associated with herbal medicine are included. Most of the attention is given to biphenol compounds in bark such as magnolol and honokiol. Both compounds are important cardiovascular agents and serve as sedatives on the central nervous system. Isolated compounds from leaves, flower buds, and wood including alkaloids, coumarins, flavonoids, lignans, neolignans, phenylpropanes, terpenoids, and other essential oils also are elucidated. The authors note throughout the text that many of the cited compounds are contained in more than one species or one geographical area, aiding in their availability and marketability. For example, *M. grandiflora* (southern Magnolia) produces many classes of compounds. Some species, however, predominately produce alkaloids, whereas some others produce mainly lignans/neolignans.

The book is divided into six chapters. Each chapter is an individual paper with a list of published references. Eighteen authors, mostly from China, Japan and the United Kingdom, contributed to this book. Compounds discussed throughout the text are illustrated, referenced to appropriate plant parts, and evaluated as to their clinical effectiveness. The first chapter introduces basic morphological characteristics, pollination strategies, and important chemical constituents that pertain to the genus *Magnolia*. Chapter 2 reviews the traditional understanding of *Magnolia* bark in China and Japan as well as its healing qualities in today's clinical

practice. A major strength of this chapter is the summary of Kampo prescriptions containing *Magnolia* bark that date back to 200 A.D. The third chapter provides a critical discussion of some phytochemical aspects of *Magnolia*. A lengthy table containing 255 different secondary metabolites isolated from 40 different species of *Magnolia* and chemical illustrations of these compounds are presented. This chapter also describes variations in the amount and composition of classes of compounds such as alkaloids, essential oils, and flavonoids according to the age of the plant, general habitat, and geographic location.

Chapter 4 is a lengthy overview on how pharmacological compounds from *Magnolia* are used to treat health problems associated with cardiovascular system, allergies, kidney disorders, stroke, and asthma. Much of the discussion focuses on laboratory tests conducted on rats and mice cells. Lethal dosage, days of treatment, side effects and Magnolia-prescribed Kampo medicines are reviewed. In addition, improved preparation and quality control of crude drugs from Magnolia are suggested.

Quality control and quality assessment of honokiol and magnolol in Magnolia bark and its preparation are the focus of the fifth chapter. Advantages and disadvantages of using various laboratory practices are addressed such as gas chromatography, Fourier transform infrared spectroscopy, and high performance liquid chromatography. Comparisons are made using extracts from bark versus leaves in the specifications.

The final chapter briefly addresses the paleobotanical record of *Magnolia* and how some of these modern-day species are being threatened with extinction due to habitat fragmentation. Present geographical distributions and how to commercially cultivate, propagate and plant various species of *Magnolia* are well documented. An understanding of culture techniques for these species will optimize our success with the numerous bioactive compounds that are important to the pharmaceutical and medical industries.

This book lacks color pictures and plates. It is intended for specialists interested in plant biochemical compounds and herbal medicine. Upper-division undergraduate and graduate courses that focus on herbal remedies and pharmacology would benefit from this text. Casual readers, however, probably will not delight in a cover-to-cover reading of this book because of difficult biochemical and medical terminology. – Nina L. Baghai-Riding, Department of Biology and Environmental Science, Delta State University, Cleveland, MS 38733.

The New Daylily Handbook. Gatlin, Frances L. with Brennan, James R. [Editors]. 2002. ISBN 0-9631072-3-2 320 pages. American Hemerocallis Society, Inc. Daylilies occur in great profusion in gardens throughout the country because they are easy to care for and because of the large variety of flower shapes and colors. The Handbook contains 22 chapters on a wide variety of topics ranging from the early history of their discovery in China, Japan and Korea to a detailed description of the cellular basis for the development of tetraploid cultivars.

This book is described as “an updated anthology, based on the classic 1968 Horticultural Society Daylily Handbook”. Because the editors regarded the earlier volume to be a classic they made every effort possible to include the material written in 1968 as it was then published. A large number of the original handbooks were apparently destroyed in a fire and those which remained were treasured by those who owned them. This respect for the past resulted in an italicized admonition to the reader: “It will be necessary to pay attention to dates”. I enjoy the many cultivars of daylilies available from a local breeder (Barth Daylilies, Alna Maine), but am not a member of the American Hemerocallis Society. Therefore the approach taken in the book—former editor’s preface, current editor’s preface, former author’s chapters annotated with “endnotes” by the current editors and new chapters on new topics was a bit confusing, even though I did try very hard to pay attention to dates!

In spite of the odd method of presentation, I found there to be a great deal of solid material in the various chapters to interest the botanist, the horticulturalist and the gardener. Two chapters were particularly complete and scholarly and would be of interest to any botanist. Shing-yu Hu’s 1968 chapter on the taxonomy of the 23 original species of daylily included a key, detailed descriptions and illustrations; the endnotes described the two additional species that had been named since the chapter was written. Paul D. Voth, Robert A. Griesbach and John R. Yeager wrote a very detailed chapter on the developmental anatomy and physiology in Daylily in 1968 from which I learned some fascinating facts about the contractile roots of the plant and how they influence the ecology of the plant. Since every possible organ of the plant has been manipulated in breeding daylilies, this very in-depth description of all of the plant parts and the various character states provide a solid basis for observing the resulting cultivars. In 2002 the editors updated the embryo development information and pigment biosynthetic pathways with more recent research findings, though the brevity of the endnotes is quite a contrast to the completeness of the 1968 information.

Because of the explosion in the number of cultivars of daylilies from 14,000 in 1968 to 52,000 in 2002 it is impossible to show very many of them. However the editors have included color photos of several of the original species as well as cultivars of more unusual forms such as miniatures, spiders, and doubles. A number of awards such as the Stout medal are made each year by the American Hemerocallis Society. The Lenington All-American award is given to daylily cultivars which have been bred to survive over a wide geographic area and a series of photos of the winners from 1970 to 2001 give a good sampling of the characteristics of the more popular cultivars. In addition, results of surveys of the favorites of 21 daylily growers from around the country were included in an appendix. Much daylily breeding has been done by amateurs and there is considerable information in this book about how to breed daylilies, how to register them and how to show them. For the gardener there are chapters of their use in the landscape and how to use daylilies in flower arrangements.

This book would appeal to anyone who has more than a passing interest in daylilies. There are research opportunities mentioned for the serious botanist, particularly in the molecular biology area. Since daylilies are a fairly simple flower with a lot of variety in obvious characteristics, they would make a good subject for exposing undergraduates to many botanical concepts. The book chronicles the history of the success of horticultural efforts made by amateurs as well as professionals and there is a glossary of daylily terminology for those who find some of the chapters more challenging than others. It succeeds very well as a handbook in that it contains answers to a many of the questions one would ask when buying and growing daylilies. It should be in any horticultural and botanical garden library. —Joanne Sharpe, Coastal Maine Botanical Gardens, Boothbay Maine

Palms Won’t Grow Here and Other Myths. Francko, David A. 2003. ISBN 0-88192-575-6 (cloth US\$27.95) 308 pp. Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527. — As stated in the title, the author sets out to dispel assumptions about where plants can grow. Mixing the science of gardening with climatology, case studies and personal experience, and an amusing, down-to-earth writing style, Francko could convert the skeptics. This is a book that goes against some long-held traditions. However, as acknowledged by Francko, the ideas overall are not new but the treatment of the topic is up to date. The

focus of this book is testing and dealing with plant hardiness in general, more than just cold hardiness. Other factors discussed include the timing and duration of cold weather, exposure (location within the landscape), stem versus root hardiness, acclimation, dormancy and plant life form. In addition many of the transplanted species may experience heat and drought which may be harsher than native climates.

Palms Won't Grow Here and Other Myths: Warm-climate Plants for Cooler Areas, as the subtitle suggests is aimed at gardeners, in particular the adventurous gardeners eager to grow tropical species in cooler climates. This is a gardening book with a rationale and strategy – the first third of the book – that challenges preconceived notions about hardiness and distribution. The center spread of color photographs and approximately last half of the book (Part II) covers the candidate species by groups: Cold-Hardy Palms, Broadleaved Evergreen Trees and Shrubs, Crape Myrtles and Other Deciduous Trees and Shrubs and Bamboos, Bananas, Yuccas, Cacti and Other Exotic Temperate Plants. Even the most passionate gardener could be inspired by many of the species presented. Admittedly, gardeners “do not want their yard to look weird” but a thoughtful incorporation of these species with attention to design offers an alternative to the suburban dogma of a perfectly manicured lawn bordered by yews and hemlocks trimmed into tight geometric shapes. Plants as “design elements” is not familiar territory for many botanists. The author is encouraging, almost nurturing the reader at times... “Choose the right plants, site them properly, plant them with attention to their needs and care for them until they are well established...” Hey, I could do this!

Could scientific gardens/gardeners be more successful? Are microclimates a subconscious reality of most gardeners' lives? Probably the answer is “yes” to both of these questions. If you are tired of the palate of species or not content to work with native species in your garden this book may be your guide to tropical gardening in temperate locales. Be warned that the author focus on his Ohio environment with an occasional mention of other temperate regions.

Occasionally I was confused by the rationale for inclusion of certain species in this book as well as the original species-specific distributions. *Opuntia* sp. (prickly pear cactus) is stated to be a species ranging from Colorado through Mexico yet it is a relatively common native in the dunes and pine barrens of the Northeast. *Ilex opaca* (American holly) *Polystichium acrostichoides* (Christmas fern), both identified as natives of the eastern United

States are suggested to enhance the design of the tropical-theme gardens. However, the inclusion of these species clouds the intriguing central theme of the book: transplanted warm climate plants.

There is an ongoing debate within the worlds of botany and horticulture regarding the choice, trade and spread of potentially invasive species. Perhaps my assessment will be viewed as too purist by the gardening audience, but with the evidence against Japanese barberry (suggested for planting in this book too!), purple loosestrife and kudzu, to name a few, there is more room for caution. The author acknowledges an occasional potential for invasiveness. Consider *Arundo donax* (giant reed), “...can be invasive, but it is very tropical looking and works well with palms, bamboos, and crape myrtles.” For most species suggested for cultivation in this book no further guidance regarding invasiveness is given. Of course Francko's book is not unique in suggesting cultivation of gorgeous introduced species; check your Sunday paper for colorful advertisements for affordable, fast growing *Hibiscus* sp., *Liriope* sp., *Paulownia tomentosa* etc.

This book continues Timber Press' reputation as a publisher of broad-interest nature books with usefulness and appeal beyond the intended audience. In fact, I realized that people interested in invasive plants and plant biogeography could learn a lot from *Palms Won't Grow Here and Other Myths*. If you are sentimental for southern species (Southern magnolia, crape myrtle, oleander etc.), Francko's book offers some alternative ideas regarding survival and potential distribution of introduced species. Though unintended are warnings here too? – Scott Ruhren, Department of Biological Sciences, Ranger Hall, University of Rhode Island, Kingston, RI 02881. (ruhren@etal.uri.edu)

Plant Resins: Chemistry, Evolution, Ecology, and Ethnobotany. Langenheim, Jean H. 2003. ISBN 0-88192-574-8 (Cloth US\$49.95) 586 pp. Timber Press, Inc. The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, OR 97204. One of the satisfactions of working in the discipline called Economic Botany is investigating the variety of subjects it encompasses. It is a pleasure to explore the plant world contained in Jean Langenheim's masterpiece, *Plant Resins*. From ancient amber adornments to irritating poison ivy, plant resins have been intimately connected with humans since the Old Stone Age. Their power can be audacious, provocatively penetrating boudoirs and bedding as 'bachour,' vapors of sandalwood and 'eagle wood,' 'aloe wood' or 'gharu,' the resinous product

produced by fungal infection of *Aquilaria agallocha* do throughout the Arabian Peninsula, Bahrain and northern Sudan. Or it can be sanctifying; serving the spirit, as frankincense and myrrh is used in the Armenian Orthodox Church. First all four corners of the empty church and its icons are censured in a cleansing ritual, and later, during the service, the brass censurers melodically ring out as the priest distributes divine blessings to the worshipers, conveyed by fragrant clouds of thick smoke.

One special use of resin not discussed in this book is as a major component of Miwron, a unique anointing oil used in baptisms and wedding ceremonies in the Armenian Orthodox Church, prepared with a resin base. Miwron is composed of resins including aloe wood, balsam oil, frankincense, sandalwood, storax [*Liquidambar orientalis*], and leaf, flower or seed oils of basil, cardamom, carnation, chamomile, cubeb [Java pepper], galangale [the pungent aromatic rhizome produced by plants in East Asia related to ginger], hyacinth, lavender, lemon balm, narcissus, orange blossom, rose, rosemary, spearmint, sweet flag, spikenard, summer savory, thyme and violet. The mixture of 48 botanicals is blended with wine, water and oils of narcissus and olive oil. That mixture is steam-extracted for the first 3 days, then allowed to ferment on the altar for the next 40 days. A final ceremonial stirring is made with an iron sword (nizag) from Geghard and the right hand of St. Gregory the Illuminator, when the oil is consecrated.

Mysterious Silphium's contraceptive and aphrodisiac use, commemorated on 7th century BC coins from Cyrene in present-day Libya, is legendary, and its use 'for carnal pleasures' was so widespread as to drive the plant to extinction. People have found a wide range of uses for plant resins—sticky plant secretions that harden when exposed to air—as medicines, fuels, varnishes, adhesives, and perfume ingredients among many others.

For a long time, the term resin had been vaguely defined, referring to any sticky plant exudate. Jean Langenheim clarifies the first operational definition of resin, distinguishing true resins from other substances such as gum and latex. Langenheim suggests an improved definition of resins based on their age, chemical properties, the secretory mechanisms that produce them, and their ecological function.

Jean Langenheim, professor emerita and research professor of ecology and evolutionary biology at the University of California, Santa Cruz (UCSC), has been studying amber and resins for more than 40 years. Her investigations have covered every aspect of the subject, including the chemistry of resins,

their geologic history, their roles in the ecology of the plants that produce them, and their many uses throughout human history. Langenheim became interested in plant resins through her research on amber. In the early 1960s as a research fellow at Harvard University, she conducted the first chemical analyses to determine the biological sources of amber. Although people had assumed that most amber came from the resins of pines and other conifers, Langenheim found that Mexican amber came from a tropical flowering tree. This discovery led her to conduct a thorough investigation of amber through the millennia, identifying the different kinds of trees that could have produced amber throughout the geologic record.

Langenheim's 1969 paper on amber in the journal *Science* became a classic and established her as the world's leading authority on the botanical sources of amber. She went on to conduct wide-ranging studies of resin-producing trees, the chemical and anatomical mechanisms of resin production, and the role of resins in defending plants from insects and diseases. She identified tropical trees in the genus *Hymenaea*, a legume belonging to the same plant family as peas and beans, as the source of several large deposits of amber in the New World. The greatest diversity of *Hymenaea* species occurs in the Amazonian rain forest, where Langenheim did extensive fieldwork.

Comparative and interdisciplinary in scope and approach, Langenheim's work encompasses botanical, chemical, cultural, geographic and historical details of each plant. Her list of plants used for their resins is exhaustive. A timeline, presented as a simultaneous chronology, is an inventive visual representation of amber and resin use throughout world civilizations and history. This includes the amusing bottom line showing *Cannabis* use beginning 1700 BC with the Vedic legends of Shiva and Chinese medicinal use, all the way through the 1960's use by 'hippies.'

An investigation into ancient trade and use of sandalwood, agaru, frankincense and myrrh by this reviewer (Bedigian, unpublished manuscript 1996-1997) established that little information had been consolidated at that time about the great diversity of resin-producing plants, and the remarkable roles resins play for plants and people. Langenheim's book now makes a complete, scientifically meticulous modern treatment of them.

The book has three main sections: the production of resins by plants, the geologic history and ecology of resins, and the remaining half of the text is devoted to the ethnobotany of resins. That section is arranged chronologically and then by use. A distinctive quality of this encyclopedic work is the

way specifics are integrated within the headings, fluidly uniting information common to each of the taxonomically disparate groups. As a helpful feature, there are cross-references throughout the book, identifying other chapters where the subject is discussed (although including page numbers would have made these citations easier to find).

The book is bound well and richly illustrated with maps, color and black-and-white photographs of the major resin sources and some novel fossils, light and scanning electron micrographs, and delicate line drawings by UCSC alumnus Jesse Markman. Chemical structures are presented for all constituents described. Five appendices, a glossary, an extensive 68-pg bibliography with more than 1000 references, a plant index and a subject index offer further welcome information. This comprehensive and exemplary discussion of resins deserves to be dubbed "Everything you ever wanted to know about plant resins," and should appeal to a wide audience. It is priced affordably and belongs in all academic, museum and public libraries, and in the personal reference libraries of serious botanists, chemists, anthropologists, archeologists and museum curators. - Dorothea Bedigian, Research Associate, Washington University, St. Louis and Missouri Botanical Garden.

Thyme, the genus *Thymus*, edited by Elizabeth Stahl-Biskup and Francisco Saez, arrives as another offering in the Medicinal and Aromatic Plants—Industrial Profiles series from Taylor & Francis. Several of the works in that series have been reviewed already in *Plant Science Bulletin*, and Thyme is typical of the quality of that series. This volume concentrates on the plants of the genus *Thymus*, aromatic members of the Lamiaceae, probably best known from the example of *T. vulgaris*, common thyme, widely used in cooking. While there is ample information on common thyme, this book also deals with the rest of the 215 species in this genus which together have been the subject of over 2000 scientific papers, according to the authors. The members of the genus produce aromatic oils in stalked or sessile glands, so a fair portion of this book after the introductory materials concentrates on essential oil.

As found in other members of the series on Medicinal and Aromatic Plants, Thyme The genus *Thymus* opens with a chapter providing a general review of the taxonomy of the genus as well its basic botany. This material includes review of the use of thyme well before Linnaeus, and given the medical value of the members of *Thymus*, the review of early medical uses comes as no surprise. Old illustrations

pepper this first chapter. A chapter dealing with genetic polymorphisms, including polymorphisms affecting the quality of essential oils, follows, along with several chapters dealing with the chemistry of essential oils of various species of *Thymus* as well as other chemical constituents of these plants besides the essential oils. Then details of culture in the field and in vitro follow along with information on the processing of raw materials into essential oils and other products. Finally, several chapters examine the medicinal uses of products made from various *Thymus* spp.

Throughout, Thyme the genus *Thymus* is well illustrated and includes many helpful diagrams such as those detailing chemical pathways relevant for essential oils. As is typical of the series from which it comes, the writing throughout is clear and concise, though one chapter in this volume fails to maintain the general tone aimed for in most of the series. While most chapters deal with a range of species or techniques from various places where members of *Thymus* occur naturally, the chapter on culture in the field and in tissue culture deals in terms of field work almost exclusively with Swiss production, surprising given that so much material is produced in other lands, notably Spain.

Thyme the genus *Thymus* should be purchased by college and university libraries as an important book on a very commonly used genus. Parts of it, especially the introductory chapter, could even be used in introductory courses, especially those concentrating on economic or humanistic botany. Those interested in herbs may want to purchase a copy, though most of the chapters are more technical than will appeal to a general audience. – Douglas Darnowski, Washington College.



Tillage for Sustainable Cropping. Gajri, P. R., Arora, V. K., and Prihar, S. S., 2002, ISBN 1-56022-903-9 \$39.55 (soft), \$89.95 (hard) 195 pp. Haworth Press Inc., NY. Everyone knows that to maintain the world's rising population food production needs to increase. The Green Revolution, established in the 1950s, was a joint effort by Western nations to help India and other countries to feed their millions by developing and planting monocultures of genetically engineered hybrid seeds, increasing the intensity and frequency of cropping, and using large inputs of fertilizers, pesticides, and water on crops. Agriculture, however, has significant harmful impacts on resources such as soil, water, air, and biodiversity. Soil infiltration, the transport of sediment and fertilizers by surface runoff to streams and lakes, and the depletion of topsoil can occur from intensive agriculture.

Tillage practices have undergone changes in time. Early agriculture practices used animal-drawn wooden or metallic tools that could only loosen the upper soil layers a few centimeters. Today, modern tractors and other tillage implements can dig soil more than a meter. The book "Tillage for Sustainable Cropping", written by three authors from India, examines various tillage systems and their impact on soil productivity and environmental quality. Soil sustainability in terms of air and water pollution, soil degradation, and the way crops respond to energy conservation, mulching, and fertilizers are discussed. This six-chapter book is well referenced and contains a useful index. The first chapter reviews demographic trends and population explosions that occurred from 1975 – 1998 in different regions of the world. Increases in irrigated areas, fertilizers, fossil fuels, and agricultural machinery are compared for developing and developed countries. Despite intensive agriculture implications, these authors portray a positive attitude as to how correct tillage approaches—the physical manipulation of soil—can be a powerful tool in enhancing crop production without having a negative impact on the environment.

Chapter two defines and discusses short and long term objectives of soil tillage. Pluses and minuses of tillage systems with residue left on and with residue removed are addressed. Common tillage practices, emphasized in environmental science textbooks, such as conservation tillage, conventional tillage, reduced till, and no till are given considerable attention. Additionally, special tillage practices are described including puddling for wetland rice, compaction of coarse-textured soils, modifying profiles of slowly permeable layered soils, and crust breaking to facilitate seedling emergence.

Two important processes that occur in soils are root growth and seedling establishment. Chapter three

focuses on the short-term effects of tillage with regards to improving soil productivity and resource conservation. Soil physical and chemical environments are emphasized with regards to various tillage practices. Important contributions of this chapter include how tillage alters the bulk density of soils, how residue cover in conservation tillage reduces evaporation and increases infiltration, and how tillage affects the concentration and distribution of macronutrients (nitrogen, phosphorous, calcium, potassium, and magnesium) and micronutrients that are essential for plant growth and development.

The fourth chapter examines crop response to conservation and conventional tillage in terms of seed germination, root growth, shoot growth, and yield as well as how tillage controls weeds. All types of soil including silt loam, sandy loam, and clay soils are analyzed in semiarid, arid, and subtropical, and tropical environments. Emphasis is given to important cash crops including wheat, corn, cotton, rice, and sorghum. Many outstanding studies are presented in this chapter such as how soil strength can change the thickness and length of roots.

The long-term effects of tillage on the quality of soil, air, and water are addressed in chapter five. One important section focuses on the emission of greenhouse gases, namely carbon dioxide, nitrogen dioxide, and methane. The authors note that no-till systems reduce carbon dioxide emissions but increase nitrogen oxide emissions. High amounts of methane are emitted in flooded rice fields and water-logged soils.

The final chapter discusses the rationalization of tillage for increasing crop production. The authors conclude that there is no tillage recipe book. Relationships among climate, soil and crop characteristics must be determined. Socioeconomic conditions, available resources and energy conservation also influence the type of tillage systems that are employed.

This book is an important reference for teachers, students, managers, horticulturists, and farmers interested in soil management and in maintaining environmental quality. Numerous tables and graphs help to emphasize important concepts throughout the text. The text could be improved by illustrating the various types of tillage practices and soil types. A glossary at the end of the book would be beneficial to explain terms such as slaking soil, broadcast application, labile component and abbreviations such as CT, NT, WUE for quick reference. - Dr. Nina L. Baghai-Riding, Associate Professor of Biology and Environmental Science Delta State University, Cleveland, MS 38733

Genetically Modified Crops: Assessing Safety.

Keith T. Atherton. Taylor & Francis, 2002. \$. ISBN 0-784-0913-0

Genetically modified crops have raised various environmental concerns and questions regarding their safety for human consumption. With respect to the environment, gene flow between modified crops and native plant populations could decrease biodiversity, modify the patterns of fungal and insect resistance in plant populations, and increase weediness in some plants. Some potential problems linked to the human consumption of genetically modified organisms include their allergenicity and the possibility of gene exchange with the human gut microflora. The emphasis of this book is assessing the safety of genetically modified crops with regards to human consumption. The environmental impact of genetically modified food crops is only addressed in some of the case studies. The chapter on virus-resistant squash is the only chapter to present a view of safety assessment in terms of both environmental impact and human consumption. In this respect the title of the book is somewhat misleading as the reader may expect safety assessment to include more of the environmental impact of genetically modified crops.

Accepting these limitations, this book provides useful information in areas less familiar to plant biologists. One chapter discusses the types of allergic reactions found in humans while another summarizes data on different types of gene exchange between genetically modified bacteria and members of the human gut microflora. The concept of substantial equivalence and its application are well described in this book. The concept of substantial equivalence represents the idea that a modified organism can be compared to an existing organism used as food in order to assess its safety. The regulatory aspects of genetically modified food crops are also discussed in some details. Reading this book will increase your general knowledge of the regulations, problems, and techniques associated with determining the safety of genetically modified crops for human consumption, and to a lesser extent for non-target organisms.

The book consists of ten chapters centered on four themes. The first two chapters introduce the history of the regulation of genetically modified food crops, the different governmental agencies involved and their respective role, in the USA and Europe respectively. Regulation of genetically modified organisms is the first theme of this book. The second theme of the book centers around methods and techniques used to assess the safety of biologically modified organisms. The third chapter introduces the concept of substantial equivalence and examples of its applications. Different

molecular and chemical techniques currently or potentially available to characterize modified crops with the goal of detecting unintended effects of transgenic food crops are described in the fourth chapter. These techniques include cDNA microarrays and chemical or toxicological profiling. Results from some of these techniques will need to be interpreted with caution, however, as molecular differences do not always indicate phenotypic differences or differences in substantial equivalence. The third theme of the book deals with some concerns associated with human consumption of genetically modified food crops. Allergenicity or the types of allergic reactions shown by humans and the proteins associated with such allergies are discussed in chapter 5 while chapter 6 discusses the biosafety of marker genes. Methods of gene exchange in prokaryotes, the factors that influence the frequency of gene exchange, and results of experiments that have examined the potential for gene exchange between genetically modified organisms and the human gut microflora are summarized in the sixth chapter. The last theme of the book is case studies. Each of the last four chapters examines a specific example of a genetically modified food crop. The seventh chapter describes the steps and data accumulated in order to determine that canola tolerant to roundup herbicide was substantially equivalent to non-modified canola. The second case study discusses Bt crops, and includes a description of the insecticidal proteins of *Bacillus thuringiensis*, their structure and modes of action, and the methods used and data accumulated to test the safety of both bacterial insecticides and Bt crops to non-target organisms (invertebrates and vertebrates). The next case study, chapter 9, discusses recombinant baculoviruses, baculoviruses with inserted insect selective toxin genes, as microbial pesticidal agents. These insect selective toxin genes were inserted into the viruses to increase the rate at which the viruses can kill their hosts. This chapter summarizes data of experiments testing the safety of these recombinant viruses for non-target organisms. The last chapter discusses all the steps and data that were required in order to obtain a non-regulated status for virus-resistant squash from the US Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS).

The book is well organized around the four themes described above. If you want to learn more about the regulations, methods, and data available to assess the safety of genetically modified organisms consumed by humans and some non-target organisms, this book will definitely educate you. If you are primarily interested in the environmental impact of genetically modified crops this book will disappoint you. - Johanne Brunet, Oregon State University



Molecular Plant Biology, vol 1. Gilmartin, Philip M., and Chris Bowler. 2002. ISBN 0-19-963876-4 (paper \$65), 274 pp., Oxford University Press, 198 Madison Avenue New York, NY 10016 U.S.A. Molecular Plant Biology is a 2 volume set, concurrently volumes 258 and 259 of the Practical Approach Series. Although not considered a 2nd edition, in the strictest sense, to the first three volumes of this series, Plant Molecular Biology—A Practical Approach, the current two volumes do follow up on some of the basic techniques and methods, first published in 1988, and incorporates the many advances since then. This review will only involve volume 1; however some statements on volume 2 will be included as gleaned from the preface.

A protocol is a set of laboratory directions to a specific laboratory method or procedure. These are usually developed in research laboratories but are not usually described in any kind of detail in the papers reporting the research. Thus, collections of laboratory methodology, written by advanced researchers, such as these are particularly useful to other researchers, who don't have to reinvent the procedure and therefore carry the research further with their own hypothesis. A good protocol should give a list of supplies and equipment requirements, and suppliers for anything that is extraordinary. The instructions should be unambiguous and in proper sequence, with any safety instructions clearly detailed. Protocols that describe the final result of a method or suggest reasons why a method might not turn out right are constructive. The protocols here appear to vary from minimalist to substantial. The list of suppliers seems to be predominately from the US and England, with only one or two from the rest of Europe and Japan.

Volume 1 is divided into three sections: Gene Identification, Gene Organization, and Library Screening and cDNA Isolation. Topics covered range from classical mutagenesis through plant transformation, T-DNA and transposon tagging methods, genomic subtraction, gene mapping, construction and screening of YAC, BAC and cosmid libraries chromosome in situ, and isolation of cDNA sequences by western and southwestern library screens, to complementation cloning. Each chapter is a hybrid, in a manner of speaking, of a discussion, reminiscent of an article, and a protocol. The discussion gives the context of the protocol. In some cases, extensive background and perspective is provided. The protocols of each chapter are set apart from the discussion text in grayed boxes. This makes it straightforward to follow the instructions without getting distracted by the rest of the chapter. Moreover, the protocols are listed separately following the table of contents, so one could quickly identify the protocol of interest, a real convenience.

The index in volume 1 covers both volumes. The index appears to be extensive with numerous see-references, tying both volumes together nicely.

Plant molecular biology is quite different from the molecular biology of animals. At this level the cellular structure and the presence of chloroplasts in plants require different techniques and laboratory procedures. Therefore, similar protocols for one would not work for the other. The high interest and intense research levels currently focused on transgenic food plants make this a timely and critical resource for research labs in both industry and academia. - Peggy Dominy, Sciences Librarian, Hagerty Library, 33rd & Market Sts., Drexel University, Philadelphia, PA, 19104

Plant Growth and Development Hormones and Environment by Lalit M. Srivastavam does an excellent job of presenting both classical and modern data on the growth and development of plants and of integrating that data. Overall, it is a serious textbook, with many informative illustrations that require the student to think about the science being discussed, bucking the trend to oversimplify what is presented to students and convert too much into cartoons.

This book presents five sections—on Some Special Aspects of Plant Growth and Development, Structure and Metabolism of Plant Hormones, Hormonal Regulation of Developmental and Physiological

Processes, Molecular Basis of Hormone Action, and Environmental Regulation of Plant Growth. In this movement from introductory details to molecular detail and then back to bigger issues driven by nurture rather than nature, *Plant Growth and Development Hormones and Environment* follows a common pattern in texts on developmental biology. For an example, see the latest edition of Gilbert's *Developmental Biology*.

Given the excellent job done by Srivastava of integrating molecular and classical data, and the clarity and logical nature of the text and illustrations, it is unfortunate that the first section on *Some Special Aspects...* begins with an almost apologetic tone with regard to plants: "...to highlight the fact that plants, while sharing many building blocks and metabolic pathways with animals, nonetheless are organized along different lines and have adopted different strategies for survival" (p.1). However, given current emphases in universities and attitudes among students, this may be necessary to pull students into the topic. All of the expected topics are covered, from our knowledge of the developmental genetics of *Arabidopsis* to the famous experiments on *Acetabularia* demonstrating nuclear control of the development of its crest. Molecular data, though given concentrated attention in the fourth section of this work, is discussed throughout the text, as when in the first section of chapters, topics in plant cell division such as the preprophase band are discussed along with more modern topics like the cyclin-dependent kinases which help to control the cell cycle. Also included are data from techniques like tissue culture—e.g. the use of somatic embryos in developmental studies is discussed, as are studies detailing the effects of applied pressure on differentiation in culture. Brassinosteroids and Jasmonates/related compounds receive the own chapters along with the classical hormones.

Of course there are occasional typographical errors and some points which might be questioned. For example, the traps of all pitcher plants are said to be derived from distal ends of leaves (p.68), which is certainly true for *Nepenthes* and *Cephalotus*. However, given some details of the development of *Sarracenia* this might be questioned, and it might be even more uncertain if the bromeliad *Brocchinia* is accepted as having pitchers—see *The Carnivorous Plants* by Juniper et al. (1989). Also, a glossary should be added to future editions of Srivastava's book.

All in all, however, *Plant Growth and Development Hormones and Environment* makes an excellent text for upper level courses in plant development and would also make an excellent part of the assigned reading for a general course on

development. Given the emphasis on hormones, even with both classical and molecular data included, it would not be sufficient for an introductory course in plant physiology—topics such as transpiration would be neglected—but could be used as supplemental reading in such a course. All college and university libraries should buy a copy. Douglas Darnowski, Washington College

Plant Physiology 3rd ed. Taiz, Lincoln and Eduardo Zeiger. 2002. ISBN 0-87893-823-0 (Cloth US\$104.95) 690 pp. Sinauer Associates, Inc. P.O. Box 407, Sunderland, MA 01375-0407. This is an outstanding work that I hope will set a new standard for textbooks. The two main authors have done a wonderful job of weaving together the writings of 23 principle contributors (enlisted to keep each chapter up to date) into a cohesive whole. Scores of others provided essays that are available online via a dedicated companion website. The net effect is to show the dynamic state of plant physiology while retaining strength and focus on central physiological themes. The addition of a dedicated companion website offers considerable flexibility to choose among various topics of interest and customize your plant physiology course.

This text is geared toward upper-division and graduate students. It lays out the basics of plant physiology while providing a sense of current research within each subject area. The book begins with two overview chapters that step the reader down from the organismal through cellular and molecular levels and present the central unifying themes of plant physiology. These themes include 1) plants are the primary producers that store chemical energy in carbohydrates by combining CO₂ & water, 2) plants are non-motile so they grow toward resources, 3) plants are structurally reinforced, 4) plants lose water continuously but have ways to avoid desiccation, and 5) plants have mechanisms for exchanging minerals and photosynthate among specialized tissues. I think it would make sense if the authors added one more theme; 6) each plant produces photosynthetic material to support its own reproduction and defends these resources using a variety of physical and chemical mechanisms.

The main body of the text is organized into three units. The first unit (four chapters) starts with a review of the importance of water then covers mechanisms for moving prodigious amounts of water plus minerals toward tissues devoted to

harvesting energy. The second unit on biochemistry and metabolism makes up ¼ of the text (seven chapters). There are three chapters on photosynthesis (light reactions, dark/carbon reactions, and physiological & ecological considerations) plus chapters on phloem translocation, energy use & storage, assimilation of mineral nutrients and finally secondary metabolites & defense. In the photosynthesis section, I would like to see a stronger link to environmental variability in light quality and the use of accessory pigments that come into play particularly when red wavelengths are absent (aquatic algae for example). This material could easily be added as an online supplement, which is the beauty of setting up a text in this fashion. The last ½ of the book (12 chapters) addresses growth and development with chapters on cell walls, development, red & blue light responses, each of the main hormones, regulation of flowering, and wraps up with stress physiology.

The text is very well illustrated and written. Line drawings are beautifully conceived and designed with effective use of color; drawings are often paired with electron micrographs or color photographs. Data charts and graphs generously support the main concepts, and these are often overlaid with line drawings for added emphasis and clarity. Chemical structures are well drawn and used throughout the text. Primary literature is cited extensively and every chapter has a lengthy bibliography based on current primary literature. This text has something for any level of student. The text itself is rigorous but this is just the first layer and the dedicated companion website <http://www.plantphys.net/> adds additional information that can be used to tailor chapters toward particular interests. In fact, two chapters are found only online (in the interest of conserving space). As the authors point out, each edition has gotten progressively larger and had the trend continued the 3rd edition would have been nearly 1000 pages. The online material is extensive. Each chapter has online sections called 'topics', 'essays', 'study questions', and additional 'suggested readings'. Topics and essays delve into greater depth on subjects that are mentioned briefly in the text and they provide added depth desirable for more advanced students. Each chapter has from 5-20 study questions that seemed appropriate as a study guide for undergraduates. The suggested readings provide access to books and review articles that would also be useful to advanced students.

This text is a monumental achievement. It makes for an intense reading experience but there was nothing in it that I didn't like and the online supplemental information can be readily updated and expanded. The 1st edition was published in

1991 at 565 pages, edition 2 in 1998 (7 years later and 792 pages) led to this edition in 2002 (4 years and 690 pages plus online supplement). I hope that the effective use of a dedicated online web site helps to alleviate the need for new editions every couple years. This text is great and could easily stand as is for several years before the 4th edition would be desirable. In the near future I would like to see the authors focus on fine tuning the web-based content and testing potential additions that might be incorporated in the 4th edition rather than turning immediately to text revision. I hope this idea catches on; Taiz & Zeiger along with Sinauer should be commended for making this leap into combined text and web-based learning. Sinauer offers additional support material for instructors in the form of a CD-ROM with all line art illustrations plus selected photographs. I highly recommend this book for any botanist. - Timothy C. Morton, Biology Department, Ursinus College, Collegeville, PA 19426

Plant Tissue Culture, 100 Years Since Gottlieb Haberland, M. Laimer, W. Rücker (eds.). 2003. ISBN 3-211-83839-2 (paperback EUR 78.00 or approximately \$80.00) 260 pp. Springer-Verlag KG, Sachsenplatz 4-6, P. O. Box 89, A-1201, Vienna, Austria. Roger J. Gautheret, who (along with Philip R. White), saw himself for many years as an "arch priest" on the subject of tissue culture (Arditti and Krikorian, 1996) wrote once that "plant tissue culture was made possible by only a few genuine discoveries [which]... did not appear suddenly, but after a long and slow journey, unpretentiously covered by pioneers" (Gautheret, 1985). According to him the earliest of these pioneers in the "prehistory" of plant tissue culture was the Frenchman Henri-Louis Duhamel du Monceau (1700-1782) who studied wound healing in trees while also writing about naval architecture (11 volumes) and science and art (18 volumes). In his book *La Physique des Arbres* (1756) Duhamel du Monceau described swelling and the appearance of buds following the removal of bark and cortex from an elm tree (Gautheret, 1985). Gautheret's suggested that this was the first observation of callus formation and "a foreword for the discovery of plant tissue culture." This suggestion is little more than Gallic chauvinism because callus formation on mature trees after wounding bears little if any resemblance to tissue culture (another example of Gautheret's Francocentric approach to the history of this subject is his refusal to credit the American orchid grower, Dr. Gavino Rotor and the German nurseryman, Hans Thomale, both now deceased, with the discovery of orchid

micropropagation despite being provided with relevant references; in a letter to JA he simply dismissed Rotor's work as not being relevant and insisted on erroneously crediting his compatriot, Dr. George Morel with the discovery despite clear evidence to the contrary).

In an earlier historical presentation Gautheret was more objective and suggested convincingly that "the history of plant tissue culture begins in 1838-1839 when M. J. Schleiden . . . and T. Schwann . . . stated the . . . cellular theory and implicitly postulated that the cell [is] totipotent" (Gautheret, 1983). Schwann even suggested that "plants may consist of cells whose capacity for independent life can be clearly demonstrated . . ." (translated from German by Gautheret, 1985). That this is so was demonstrated experimentally and considered theoretically by A. Trécul in 1853, H.Vöchting in 1878, F. Goebel in 1902, J. Sachs between 1880 and 1882, J. Wiesner in 1884 and C. Rehinger in 1893 (for a review see Arditti and Krikorian, 1996). However it was Gottlieb Friedrich Johann Haberlandt (1854-1945) who made the first attempt to culture plant cells.

Haberlandt's first attempt was to culture isolated leaf palisade and mesophyll cells of *Lanium purpureum*, stinging hairs of nettle, *Urtica dioica*, glandular hairs of *Pulmonaria*, stomatal cells of *Fuchsia magellanica* Globosa, pith cells from petioles of *Eichhornia crassipes*, and three monocotyledonous species, *Tradescantia virginiana* (stamen filament hairs), *Ornithogallum umbelatum* (stomatal cells), and *Erythronium descanis* (stomatal cells). He used Julius Sachs's version of Knop's solution (1 g potassium nitrate, 0.5 g calcium sulphate, 0.5 g magnesium sulphate, 5 g calcium phosphate and a trace of ferrous sulfate per liter; still useful at present) and added to it sucrose, glucose, glycerin, asparagine and peptone (except for the glycerin these additives are still being used). In addition, he used light (natural daylight and photoperiods during , April-June and September-November in Germany) and dark culture conditions as well as appropriate temperatures (18-24E C).

As is well known at present Haberlandt was unsuccessful. In retrospect several reasons are responsible for his failure (see excellent discussion by Krikorian and Berquam, on pp. 25-53 of this book). One was his selection of cells which were mature and highly differentiated. The second is a culture medium which was not sterile and lacked substances now known to be required by explants in vitro (many were yet to be discovered at the time). Third, Haberlandt's selection of plants was unfortunate, but he could not have known that at the time. Assertions that Haberlandt's failure was due

to the fact that "... he neglected Duhamel's results as well as Vöchting's and Rehinger's experiments . . . and [his] ignorance of the past" (Gautheret, 1985) are unjustified, have no scientific basis, seem unnecessarily harsh, and may be based more on national pride ("Duhamel's results ") than on solid science. He would have failed with most explants (Duhamel's species included) since the vast majority of tissues require richer media and do not grow in contaminated solutions. A more fortunate selection of plants, availability of plant hormones (especially IAA as suggested by Gautheret on page 106 of this book and probably also cytokinins) and a bit of luck may have perhaps led to partial success, but the fact remains that Haberlandt was a pioneer forging new directions, far ahead of his time and working without some the necessary tools which were discovered much later (for example the effects of IAA on cell division became known 31 years after his experiments).

This book celebrates the 100th anniversary of Haberlandt's paper. It can be divided in two parts. An interesting and illuminating first part (pages 1-113) which consists of a reprint (without citation information) of Haberlandt's paper (published in the *Sitzungsberichte der Mathematische-Naturwissenschaftliche Klasse der Kaiserliche Akademie der Wissenschaften Wien* volume 111, No. 1, pages 69-92) together with: 1) an excellent translation and a scholarly essay-appreciation by A. D. Krikorian and D. L. Berquam (taken from the *Botanical Review*, but without citation information), 2) a short biography of Haberlandt, 3) a retrospective on the realization of his vision (which inexplicably and disappointingly ignores seminal and very important work by Ernest Ball and Loo Shih Wei), 4) an historical overview of the culture of isolated mesophyll cells and protoplasts, and 5) yet another historical account by Gautheret; this one is fairer and more balanced.

The second half (pp. 115-260) deals with current applications of tissue culture. The chapter on micropropagation of ornamental plants errs in attributing the first description mass propagation orchids to Georges Morel in 1960 and cites his article on the subject in the *American Orchid Society Bulletin*. Actually this article is little more than a self-serving news release which contains no useful information and may even be misleading. A detailed history of orchid micropropagation is available (Arditti and Krikorian, 1996) and sets the record straight. It was obviously not consulted. Another problem with this article is that it is Eurocentric and ignores the enormous number of plants in general and orchids in particular (Hew, 1994; Ichihashi, 1997a, 1997b) which are produced in Asian micropropagation laboratories.

A chapter on in vitro conservation is telegraphic and covers only three crops (potatoes, asparagus and chrysanthemum) when many more are being cryopreserved. Again, the authors seem to have taken a primarily Eurocentric view. The chapters on natural products production is also very short and somewhat limited. It presents a table of plant-derived drugs used in western medicine and ignores a large body of work on Chinese medicinal plant resources (for a review of work which preceded publication of this book see Nalawade et al., 2003). An eight page chapter on genetic engineering and malnutrition is essentially limited to rice. Three chapters on woody plants and color illustrations conclude the book.

The title of this book is promising and enticing. However only the first part (pp. 1-103) comes close to fulfilling some of the promise, but the rest (Especially pages 115-174) is disappointing. The editing also leaves some to be desired. On the whole the book is a mixed bag. Haberlandt, tissue culture and micropropagation deserve considerably more and much better, especially at \$80 for 260 paperback which carries advertising. - Joseph Arditti, Professor Emeritus, Department of Developmental and Cell Biology, University of California, Irvine and Tim Wing Yam, Singapore Botanic Gardens, Cluny Road Singapore.

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Willows: The Genus *Salix*. Newsholme, Christopher. 2002. ISBN 0-88192-565-9 (First paperback edition). 224 pages, 65 color plates, 159 line drawings (US\$19.95). Timber Press, Inc. Portland, Oregon. This is a reprint of the 1992 hardcover edition that offers a comprehensive survey of the species, varieties and hybrids of willow for their ornamental value. There are seven chapters with line drawings interspersed within the text; color photographs make up the middle section of the book. The glossary has 157 words and there are 41 references in the bibliography. A general index completes the volume.

Chapters 1, 2 and 3 present a breadth of interesting topics on willow including origin, distribution, uses, classification, morphological characteristics, hybridization, field identification, attractive features, adaptability, propagation, spacing, planting, pruning, maintenance, intercropping, and site selection. These chapters have been written in a very easy to understand way and are not filled with a lot of jargons. Readers who are not familiar with the literatures on willow will surely find these chapters as eye opener about the plants' incredible versatility, significance and potential.

Chapters 4, 5, 6 and 7 provide alphabetical listings and morphological descriptions of the willow species, varieties and hybrids, which the author subdivided based on their suitability for large, small, rock, or sink gardens. This scheme makes sense because the size of the plant usually dictates what garden or where in a garden it is to be placed. However, the author also recognizes that some species recommended for large gardens are equally suitable for use in smaller gardens. It has also been emphasized that the ultimate size of the plant is controlled not by one factor but several including the type of species, soil, and local conditions. The presentation used in these four chapters is quite typical of a field guide, i.e., with extensive morphological descriptions, occurrences, and supplemental notes. Landscapers and gardeners will find these four chapters helpful in identification and guiding them as to what species, varieties or hybrids to plant in a particular site. Scientists will also benefit from the wealth of taxonomic descriptions, among others.

The line drawings are well done and show impressive details. The color photographs are mostly of high contrast and quality. In most part, the author achieved his goal in making this book useful to both gardeners and botanists. However, I cannot help but point out some of the inadequacies, errors, and inconsistencies in concepts and presentations. It shows that the book suffered from insufficient editorial empowerment. The following are some examples that can be dealt with in the next edition.

1. The author referred to the angiosperms as the earliest known flowering plants. The statement is not correct since the angiosperms are the only flowering plants. Two willow species were mentioned to be represented in the fossil record dating back to the Cretaceous. This is a very strong claim that needs to be substantiated or restated. As far as I am aware of, the earliest fossils credibly considered representing the genus *Salix* were from Eocene (see Cronquist, 1993). On the other hand, it is confusing if the author is referring to the angiosperms or willows as having a Cretaceous origin. 2. A table was presented that listed several primitive and advanced features of *Salix*. In spite of the many interesting information in the table, no discussion was made except to mention the subtropical origin of willow. 3. The context in which "North America" is used is erroneous. In several parts, it appears that the author was referring only to the United States as North America, whereas in other parts, it refers both to the United States and Canada. Mexico belongs to North America and this was not at all implied. 4. The diagram presented in Figure 6 was claimed to show a cross-section, but it appears more like a longitudinal view of the male and female catkins. 5. Willow is a difficult species to identify and so there are varied reports on how many species are available. A brief literature search would reveal this (Krüssmann 1986, Rehder 1990, and Judd et al. 1999 mention that there are about 500, 300 and 350 species, respectively). Newsholme claims that there are 400 species, but only describes much less than that. What is the basis or source of the 400 species? I tried counting and differentiating the species, varieties and hybrids but gave up in coming up with an accurate number because of the many inconsistencies in writing format or presentations (e.g., some synonymous taxa are presented as if they are different species, some hybrids and varieties are presented as species, common names and varieties are written in the same manner, etc.). 6. The numbering of figures of line drawings is confusing with some species lumped together in one figure and then separated by roman numerals (e.g., 8i, 8ii, 54i, 54ii, etc.). Therefore, some of these are not figures but plates. On the other hand, how many figures are there really? Also, the color illustrations were referred to as plates, but as far as I am aware of, plates are collage of figures which is not the case in this book. 7. Some of the color photographs are not shown in their correct orientation – they are either upside down (e.g., Plates 41 and 44) or turned horizontally (e.g., Plate 63). It is difficult to interpret and appreciate them the way they are laid out. 8. The caption for Plate 30 states that the red anthers subsequently turn yellow (or bright-orange anthers becoming golden-yellow in Plate 51). It is amazing to observe that some plant organs can change color, but this is not the case in willow

anthers. The yellow color is due to pollen grains which are being released through the opening of the red colored anther walls. 9. The lack of a taxonomic key definitely limits the utilization of this book. The comprehensive list of species and extensive morphological descriptions could have been highlighted with an identification key to, at least, the commonly known species. I realize that this is a difficult and an enormous task, but its contribution will be invaluable and immense. Subdividing willow species into groups and sections was a good start. 10. The number of references cited is very limited compared to what is available out there. There are many claims made in this book that should have been substantiated with references.

In spite of the shortcomings of this book, the beautiful illustrations, extensive plant descriptions, and comprehensive worldwide list of willow species, varieties and hybrids make it still the most useful reference material in the subject. Danilo D. Fernando, Department of Environmental and Forest Biology, SUNY-ESF, Syracuse, NY 13210.

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The Names of Plants, Third Edition, by David Gledhill, aims to provide an explanation of naming plants, why it is important and why naming is done in the official fashion, as well as a glossary of many common roots and epithets. While this might sound like an uninspiring topic since many readers of the Bulletin will have heard and or taught about many, many times, Gledhill does a very fine job. This third revision includes discussion of issues in naming resulting from recent advances in the non-traditional, non-Mendelian manipulation of plants.

This book opens with a chapter titled "The nature of the problem" begins to establish the importance of naming by eloquently describing where the need for names begins: "Man's highly developed constructive curiosity and his capacity for communications are

two of the attributes distinguishing him from all other animals." Gledhill maintains this type of simple but high-sounding tone throughout—a tone accessible to undergraduates but stirring to those well versed in the names of plants. This same chapter contains a concise but thorough review of important figures in the history of botany, starting with Aristotle and Theophrastus and moving to the present, touching on the value of binomials and elucidating some of the pre-Linnaean use of binomials.

In the next chapter, the author then turns to the rules of botanical nomenclature for various taxonomic levels, with sections on families, genera, and species. Throughout, copious examples illustrate the various principles of naming which are described, and the basic principles of botanical Latin are discussed. The author provides helpful tables including the various endings of botanical Latin nouns as well as carefully explaining the use of various cases in the main text. Gledhill presents examples which help to put a human face on what sounds initially like a dry field in science. "If all specific names were constructed in the arbitrary manner used by M. Adanson (1727-1806), there would have been no enquiries of the author and this book would not have been written. In fact, the etymology of plant names is a rich store of historical interest and conceals many aspects of humanity ranging from the sarcasm of some authors to the humour of others" (p.32).

This is followed by the final chapter of the main text in which the International Code of Nomenclature for Cultivated Plants is discussed along with various issues arising from new technologies. A short introduction to botanical terminology and the glossary then leads to the glossary, which forms the majority of the pages in *The Names of Plants*. The several hundred pages of the glossary, not intended to be exhaustive, nevertheless provide many helpful definitions of words from botanical Latin with explanations of their origins where useful, including Greek transliterations for some.

Who should purchase *The Names of Plants*? Certainly most if not all working botanists will find it of help, if for no other purpose than for answering those questions which are frequently asked by non-botanists about the names of plants. It would be quite appropriate reading for students in introductory courses—even in General Biology, for explaining the history and workings of scientific names which sadly remains a real mystery to so many current students. Further, all college and university libraries should have a copy in their reference collections as well as in general circulation. — Douglas Darnowski, Washington College.

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Voragen, Fons, Henk Schols and Richard Visser (eds). 2003. ISBN 1-4020-1144-X (Cloth US\$142.00) 504 pp. Kluwer Academic Publishers B.V. P.O. Box 989, 3300 AZ Dordrecht, The Netherlands.

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Botanical Society of America, Inc.
4474 Castleman Avenue
P.O. Box 299
St. Louis, MO 63166-0299

Voice: 314-577-9566
FAX: 314-577-9515
E-mail: bsa-manager@botany.org
Office hours are 7:30 am to 4:30 pm Central Time
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