PLANT SCIENCE BULLETIN

The Botanical Society of America: The Society for ALL Plant Biologists

WINTER 2009 VOLUME 55 NUMBER 4

Erratum....142

News from the Society
- **Update Your Information!**....142
- Peer Review in Plant Science Bulletin Begins in 2010....142
- Awards for Student Presentations....145
- BSA and Climate Change....145
- The BSA and Scientific Publishing....146
- BSA Science Education News and Notes....147
  - Editor's Choice....148
  - Teaching Tools in Plant Biology....149
  - The Virtual Floral Formula....149
  - Plant Talking Points....150

Personalia
- New University of Wisconsin – Oshkosh Herbarium named after Neil A. Harriman....151

Symposia, Conferences, Meetings
- National Native Seed Conference....151

Announcements
- GO-BOTANY!....151
- Plant Ontology Consortium (POC)....153
- UH Mânoa's Lyon Arboretum receives nearly $250,000 for Hawaiian Rare Plant Program....153
- Kew's Millennium Seed Bank Partnership Collects 10% of World's Wild Plant Species
  - BBG and NYC Parks Participate....154
  - Chicago Botanic Garden collects seeds from endangered tallgrass prairie region....155

Reports and Reviews
- Climate Change Symposium: Carbon Cycling and Sequestration in the Sea by Phytoplankton and Macrophytes....156
- Growing a Green Planet: The Future of Botany Teaching....163

Books Reviewed....167

Books Received....179

Botany 2010....180

ISSN 0032-0919

THE BOTANICAL SOCIETY OF AMERICA
Leading Scientists
and
Educators
since 1893

BOTANICAL SOCIETY OF AMERICA

News from the Society

This issue brings 2009 to a close and sets the stage for an exciting 2010 for all botanists. This year the annual meeting is returning to New England for what promises to be a stimulating week of field trips and sessions. Beginning with Volume 56, *Plant Science Bulletin* will see a major content change as it becomes a vehicle for peer-reviewed publications of articles, essays, and reviews of general interest to the Society. See "Peer Review in Plant Science Bulletin Begins in 2010" below for additional information. The success of this venture depends on your contributions. In that spirit you can begin by **UPDATING YOUR INFORMATION**!

While we look ahead to Botany 2010 in Providence, the articles in this issue feature symposia presenters from our last two meetings. From Snowbird in 2009 we have a summary of the Climate Change Symposium sponsored by the Physiological and Ecological Sections. Unlike most of what we hear in the media, this is from the perspective of aquatic plants in the marine ecosystem. From Vancouver in 2008 we have an optimistic challenge for the future of botany teaching from a Teaching Section-sponsored symposium. This is a "breath of fresh air" from one of our younger members.

-the Editor

Erratum

The following phases were inadvertantly added to the book review by Brogan et al. in the previous issue, PSB 55(3):126, top of column 2. They should be deleted.

"the balance between competitive and faculitative interactions (Chapter 4) and how research on facilitation contributes to an understanding of a diverse range of topics in community ecology (Chapter 6). Most importantly, Callaway presents"

Update Your Information!

Whether or not you have recently submitted an article to the *American Journal of Botany*, please go to the *AJB* editorial manager web page to "UPDATE MY INFORMATION"

http://www.editorialmanager.com/ajb/.

This will assist associate editors for the *American Journal of Botany* and, beginning in the new year, the *Plant Science Bulletin* to identify appropriate reviewers for manuscripts submitted.

Peer Review in Plant Science Bulletin Begins in 2010

(Note, for submissions prior to 1 April, 2010, please contact the editor (psb@botany.org) before using the on-line submission system described below.)

The **Plant Science Bulletin** (Print: ISSN 0032-0919, Electronic: ISSN 1537-9752) is a quarterly publication of the BSA containing news and information from the Society, information on upcoming meetings, courses, field trips, news of colleagues, and professional opportunities. It provides a means of advertising items or materials wanted. It also publishes original, previously unpublished, peer-reviewed articles on innovative teaching approaches and methods, both formal and informal, the history of botany, and economic botany and serves as a peer-reviewed forum for essays discussing issues of concern to Society members such as environmental policy. Book reviews of current botanical literature also are juried. Papers not suitable for publication in the *American Journal of Botany* because they are

PLANT SCIENCE BULLETIN

ISSN 0032-0919

Published quarterly by Botanical Society of America, Inc., 4475 Castleman Avenue, St. Louis, MO 63166-0299. The yearly subscription rate of $15 is included in the membership dues of the Botanical Society of America, Inc. Periodical postage paid at St. Louis, MO and additional mailing office.

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

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

purely descriptive, natural history, or broad surveys, may be appropriate for the *Plant Science Bulletin*.

News, information and announcements should be submitted directly to the editor, preferably in MS Word or WordPerfect format, at psb@botany.org. Contributed and invited articles or essays and book reviews should be submitted to *Plant Science Bulletin* on the *American Journal of Botany* website at http://www.editorialmanager.com/ajb/ - - click on *Plant Science Bulletin*. The latest version of the instructions for authors will always be available online.

Plant Science Bulletin **publishes four types of manuscripts:**

1. Research Articles
Research articles must include either quantitative or qualitative methods of analysis and be grounded in a theoretical framework. Research articles on botanical education must include an assessment component. For a description of assessment methods see: Sundberg, M.D. 2002. Assessing Student Learning. *Cell Biology Education* 1:11-15. http://www.lifescied.org/cgi/reprint/1/1/11

2. Descriptive Articles
Descriptive articles must have a clear focus and be grounded in a botanical problem. They will usually include specific examples, for example "How To…" articles in botanical instruction or special projects or special exhibits at gardens or arboreta.

Both research and descriptive articles will generally have the format of a typical research manuscript. The article should be grounded by a clear description of goals and expected outcomes and references made to appropriate literature. Although traditional section headings may be employed, Introduction, Materials and Methods, Results, and Discussion, more descriptive section headings should be used if appropriate.

3. Essays
Essays may focus on any area of general botanical interest and are usually within the context of personal experience and/or provide specific examples. The essay should be presented in a scholarly manner citing references and appropriate resources related to the topic.

4. Book Reviews
The main function of the book review is "to acquaint readers with worthwhile books and to inform the readers of those books' strengths and limitations." Specific guidelines for book reviews are on the BSA website under "Instructions for Reviewers" http://www.botany.org/plantsciencebulletin/InstructionsForReviewers.pdf and "A Strategy for Reviewing Books for Journals" http://www.botany.org/plantsciencebulletin/files/psb-1994-40-3.php#bookreview.

Review Policy and Procedure
Manuscripts are reviewed by scholars with expertise in the field as assigned by the editor or members of the Editorial Committee.

Manuscripts may be returned without review if the English needs significant improvement. Authors have the opportunity to make one revision addressing the criticisms and concerns of the reviewers and Editorial Committee.

Correspondence and notifications regarding manuscripts will be through e-mail. All reviewer comments, author revisions, and copyediting before production will be done electronically using *AJB* Editorial Manager (http://ajb.edmgr.com).

Final acceptance of a manuscript is contingent upon strict compliance with *Plant Science Bulletin* requirements.

Manuscript Preparation
Style (citations, abbreviations, etc.) should follow the guidelines for manuscript preparation for the *American Journal of Botany*.

A cover letter, an author agreement form, a manuscript file, and separate files for figures should be uploaded at http://ajb.edmgr.com.

For manuscript files MS Word (.doc) format is preferred; WordPerfect (.wpd), Rich Text Format (.rtf), are acceptable for review.

The Editorial Manager online submission system automatically inserts line numbers to facilitate review comments, so line numbers are not required in the manuscript file.

Double-space and left justify the margin of the entire manuscript, including Literature Cited, Appendices, Figure Legends, and Tables, using continuous pagination.

Leave at least a 2.5-cm margin on all sides. Number pages in upper right corner.

Number figures and tables in the order discussed in the text.

Manuscript Content
1. Title Page
Center boldfaced title written with sentence-style capitalization, followed by superscript 1 (for footnote 1, to appear on footnote page). Latin binomials in a title should be followed by the name of the family in parentheses.

Below the title, list authors: each author's first name, middle initial, surname. On the next line, give affiliation and unabbreviated address. If authors have different affiliations and addresses, add a superscript number after each author's name to indicate the footnoted address. Include another footnote superscript number to indicate the author for correspondence.

2. Footnote Page
Include the following footnote:
[1]Manuscript received _______; revision accepted _______.

Place brief acknowledgments, if desired, as a separate paragraph, using the following style: "The author(s) thank(s)…". For brevity, do not use first names. Include grant acknowledgments here.
Other footnotes (e.g., e-mail for correspondence) are permitted: match footnote numbers with those on the title page.

3. Abstract Page (Research and descriptive articles only)
The abstract is 150 words or less, written in a single paragraph. Please include in the first sentence how the paper is of interest to the **broad botanical** readership. Include the paper's premise (why you did this work), methods, content, and significance. Provide a list of 3–10 "Key words." Capitalize proper nouns, place in alphabetical order, and separate by semicolons.

4. Text
In the first paragraph of the introduction, include the theoretical or conceptual basis for your work in a context accessible to a diverse botanical readership. Text following the introduction should be in sections following a section heading. Center main headings and capitalize all letters - - for instance, MATERIALS AND METHODS.

Indent subheadings at the start of a paragraph; capitalize only the first word and proper nouns and adjectives.

Second-level headings—(boldface italic followed by an em dash)

Third-level headings—(italic followed by an em dash)

If statistical analyses are used, include statistical values either in the text or within tables. Include the statistic value, degrees of freedom, and p-value for each result reported (e.g., for a t-test report "t = 32.41, df = 1, P = 0.03"; for an ANOVA report "$F_{5, 23}$ =26.45, P<0.001" [note two df -values as subscripts with F]). Use P for significance, p for probability.

Common Latin words (e.g., in vivo, sensu lato) are not italicized.

Footnotes are not used in the text although endnotes may be appropriate for some articles and essays. Endnotes should be numbered successively in the text and included in a section before the Literature Cited.

Literature Cited, Tables, Appendices, Figure Legends and Figures should follow the guidelines specified for *AJB*.

Cover/Rebuttal Letter
Include a cover letter that describes the questions addressed or hypotheses tested, the major contribution of your paper to your discipline, and how this contribution is of interest to a broad audience. List any papers on related topics by any of the authors that have been published within the past year or that are in review or in press. For a revision, include a rebuttal letter detailing your

response to all the review comments.

Author Agreement Form

Upon initial submission of a manuscript, the corresponding author must fill out an author agreement form and either upload an electronic version at the online submission site or mail or fax a hard copy to the Editorial Office in St. Louis, Missouri (*American Journal of Botany*, P.O. Box 299, St. Louis, MO 63166-0299, USA; 1-314-577-9515). The author agreement form is available online at http://www.botany.org/ajb/AJB_Author_Agreement_Form.doc; on the Editorial Manager website at the "Attach Files" screen; and from the Editorial Office.

Awards for Student Presentations

(from the Annual Meeting)

Genetics Section Graduate Student Research Awards

Stein V. Servick, Department of Botany, University of Florida (PhD student)

Ashley Kuenzi, Department of Biological Sciences, University of Cincinnati (MS Student)

Emanuel D. Rudolph Award (Historical Section)

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

This year's award goes to **Mauricio Bonifacino**, Universidad De La República, Montevideo, Uruguay, for his presentation: "Cassini the 5th, Master of Compositae: insight into his life and work." Co-authors: Harold Robinson, Vicki A. Funk, Walter Lack, Gerhard Wagenitz, Christian Feuillet and Nicholas Hind.

Developmental & Structural Section Best Student Poster Award

Kerri Mocko, Miami University, for his poster, "Contrasting leaf shapes of Pelargonium species vary in extent of solar tracking." Co-authors: Cynthia Jones and Adrienne Nicotra

BSA and Climate Change

Scientific Organizations Reaffirm Concensus on Climate Change

Letter Signed by Leading Scientific Societies Sent to Senators

WASHINGTON, DC - The American Institute of Biological Sciences (AIBS) and other leading scientific organizations have reaffirmed the scientific consensus that climate change is occurring and is primarily caused by human activities.

In a statement sent to all U.S. Senators on October 21, 2009, the leaders of 18 scientific organizations stated that "rigorous scientific research" demonstrates that the greenhouse gases emitted by human activities are the "primary driver" of climate change. "These conclusions are based on multiple independent lines of evidence, and contrary assertions are inconsistent with an objective assessment of the vast body of peer-reviewed science," the scientists wrote.

Dr. May Berenbaum, President of AIBS, signed the letter on behalf of the society. "The evidence that human activities contribute to global climate change is compellingly consistent and clear; constructive human activities to stem or reverse these changes are now urgently needed," she said.

The letter called attention to the impacts of climate change on human society, the economy, and the environment. The "broad impacts" of climate change include sea level rise, greater threats of extreme weather events, and increased risk of regional water scarcity, wildfires, and the disturbance of biological systems throughout the United States.

"Climate change is surging through and rending Earth's biodiversity," said Dr. William Y. Brown, President of the Natural Science Collections Alliance. "If we do not stem the tide of our own greenhouse gases now, we simply invite and magnify future harm and cost."

"[T]o avoid the most severe impacts of climate change, emissions of greenhouse gases must be dramatically reduced," the letter stated. "In addition, adaptation will be necessary to address those impacts that are already unavoidable."

The impact of climate change on natural resources and biological systems will be profound.

"Climate change is real, and plants know it. Plants that could once grow only south of central Ohio can now grow north of Detroit," said Dr. Kent Holsinger, President of the Botanical Society of America. "Warmer temperatures also lead to earlier flowering, which can disrupt pollinator interactions leading to declines of both plants and pollinators." The consequences will be significant for our food supply, which depends upon plants and their pollinators.

Dr. Brian D. Kloeppel, President of the Organization of Biological Field Stations, warned: "Climate change will continue to have dramatic impacts on both temperate and boreal forests as rising temperatures increase carbon dioxide efflux from forest soils. The resulting feedback on the distribution and productivity of these forest ecosystems as water resources fluctuate could be dramatic."

The scientific organizations that sent the letter represent the breadth of the scientific community. Collectively, these organizations serve more than 10 million scientists. Ten AIBS member organizations have already signed the statement. To read the complete statement, please visit Climate_Science_Letter_final_10.21.2009.pdf.

The BSA and Scientific Publishing

August 18, 2009

The Honorable Senator Joe Lieberman
One Constitution Plaza
7th Floor
Hartford, CT 06103

Dear Senator Lieberman:

We write as President of the Botanical Society of America and as Editor of the *American Journal of Botany*. The Botanical Society of America is a non-profit 501(c)(3) scientific organization incorporated in the State of Connecticut with nearly 3200 members, and the *American Journal of Botany* is its professional journal (recently named one of the 10 most influential science journals of the 20th century by the Special Libraries Association). As a non-profit society dedicated to promoting the science of botany, we share your commitment to ensuring the widest possible access to science and scientific information. Nonetheless, we are deeply concerned about the **Federal Research Public Access Act. S. 1373**, which would require that final manuscripts of federally-funded, peer-reviewed, private sector journal articles be made available in federally owned or federally approved public repositories no later than six months after publication.

We applaud the goal of enhancing public access to science, and we agree that science and scientific information play a vital role in our society. Unfortunately, our experience indicates that this bill will not enhance public access to science. As currently written, this bill threatens the livelihood of many non-profit, scientific society publishers. If these publishers cease to function, the public will have less access to science, not more, and the curricula of schools, colleges, and universities will suffer.

Concerns:

- An informal "straw poll" of college and university librarians indicated that **most libraries would cancel journal subscriptions if the time to free access was 6 months or less.** The same informal straw poll indicated that most libraries would retain subscriptions to important journals if the time to free access was 12 months or more.

- Income from institutional subscriptions is the primary revenue source for most non-profit, scientific society publishers. **If most libraries cancel subscriptions, the journals will cease to operate, and public access to science will be imbedded.**

- Many non-profit, scientific society publishers use subscription income to support educational programs within their scientific disciplines. **If most libraries cancel subscriptions to their journals, societies will be forced to reduce support for education both in colleges and universities and through outreach to K-12 classrooms.**

By mandating free access to federally funded journal articles no more than six months after publication, S. 1373 jeopardizes public access to science. It threatens the livelihood of 501(c)(3) non-profits and will limit their ability to enhance the training of future generations of scientists.

We share your commitment to broad public access to science. Indeed, we have already adopted policies that advance this objective: (1) We allow authors *to* disseminate their work to other scientists or correspondents by email immediately upon publication. (2) We allow authors to post copies of papers published in the *American Journal of Botany* on personal or institutional websites immediately upon publication. (3) We make all papers published in the *American Journal of Botany* available without charge from the journal website 12 months after publication.

We encourage you to work with leaders of the scientific community to identify ways in which the federal government can best advance our shared goal, the broadest possible access to science and scientific information.

Sincerely yours,
Kent E. Holsinger, President, Botanical Society of America
Judy Jernstedt, Editor, *American Journal of Botany*

"Botany I rank with the most valuable sciences"
-Thomas Jefferson

BSA Science Education News and Notes

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

PlantingScience* — *BSA-led student research and science mentoring program

"I am a very scientific minded guy with new ideas everyday. I am always interested in how things work and how they are put together. I am not a very plant oriented studented and I never thought about planting anything in my life. ***I rest my future of plants in your hands."*** — high school student in fall 2009 online session

Those words of a student introducing himself to his online mentor (emphasis added, otherwise un-edited) are an indication of the difference your interactions can make.

The Fall 2009 PlantingScience Online Mentored Inquiry Session kicked off Oct. 1. What an exciting session so far!

With 10 scientific societies now part of the BSA-led program, it is an impressive response to Dr. Bruce Albert's 2003 call for scientists to meaningfully engage with K-12 education to address science literacy. Our thanks to the 300+ scientists from the Botanical Society of America, American Society of Plant Biologists, American Society of Agronomy, American Society of Plant Taxonomy, American Fern Society, American Bryological and Lichenological Society, American Phytopathological Society, Ecology Society of America, and the Society for Economic Botany.

Additional thanks to the PlantingScience Master Plant Science Team for their extra mentoring efforts. Congratulations to graduate students/post-doctoral researchers sponsored by BSA (**Tatiana Arias, Kevin Badik, Alona Banai, Michele Brower, Asha Bruing, Tamrya d'Artenay, Nick deBoer, Charlotte Germain-Aubrey, Kate Hertweck, Sean Hoban, Bridget Jacobs, Eric Jones, Laura Lagomarsino, Jason Lando, Kathryn March, David Matlaga, Tania Price, Patrica Ryberg, Maggie Sporck, Laura Super, Lindsey Tuominen, Genevieve Walden, Nicole Ward**)!

Congratulations to the graduate students sponsored by the American Society of Plant Biologists (**Rob Baker, Brunie Burgos, Kelly Gillespie, Lisa Kanizay, William Perez, Amber Robertson Smith, Josh Rosow**)!

By the time the online session ends in November we expect: 6 middle schools and 10 high schools investigating seed germination; 2 high schools investigating photosynthesis; 1 middle school and 1 high school field-testing the new pollination module; and 9 high schools field testing the *Brassica* and *Arabidopsis* strands of the new genetics module.

And we'll start the fun over again in the spring session, which will run Feb.-Mar.

Plant IT Careers, Cases, and Collaborations

The Plant IT collaboration among the Botanical Society of America, BioQUEST Curriculum Consortium and Texas A&M University is in is final year of funding, with our final Summer Institutes for Teachers and Students coming in July 2010. We look forward to providing teachers from around the country with opportunities to experience teaching and learning with plant investigative cases. Bioinformatics and forensics involving cotton fibers will be areas of focus this summer. Visit the website (myPlantIT.org) for investigative case resources from the first two years on remote sensing, pollen, seeds, and ethnobotany.

We'll again host high school students from Texas in a residential Summer Career Camp, who will work with the Summer Institute Teachers on the investigative cases the teachers develop, take field-trips to laboratories, and learn about science careers and college life. Providing information about careers in botany has long been part of the BSA priorities. Plant IT Careers, Cases, and Collaborations has been the first opportunity the BSA has had to work directly with pre-college students on a significant scale.

So, what do students think about plant careers? Good news! Student surveys in year one indicated some learning gains in basic plant biology and increased awareness of the variety of plant-related careers. 8 of the 26 students attending last summer also attended the year before — so we must be doing something right!

Want to hear for yourself some of what students gained from the experience? Listen to the interviews with plant scientists Dr. Micky Eubanks and Dr. Lori Hinze conducted by a student participant posted on the project blog http://myplantit.org/blog/

Science Education Bits and Bobs

The Coming Biology Revolution — A report by the Board of Life Sciences outlines challenges in food,

energy, environment, and health facing our society today and makes recommendations for harnessing the potential of biology and our nation's life scientists to address these. *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution* is available at the National Academies Press website:
http://www.nap.edu/catalog.php?record_id=12764

Advanced Placement Program begins Curriculum Revisions with Biology — In response to National Research Council recommendations, the College Board is making major changes to the suite of college-level science courses offered to high school students. The new AP Biology Curriculum will focus around four big ideas and seven science practices that biology students should be able to apply. New inquiry-based labs will be introduced annually to ease the transition to full implementation in 2013. See the September 18 and 25 issues of *Science* for new feature and Education Forum coverage. Read an un-edited draft of the revision on the College Board website.
http://www.sciencemag.org/cgi/content/full/325/5947/1488

http://www.sciencemag.org/cgi/reprint/325/5948/1627.pdf

http://apcentral.collegeboard.com/abiocfDRAFT

New NSTA Communities: Plants in the Classroom — The National Science Teachers Association has joined the wave of social networking among professional groups by providing opportunities for education communities to self-organize on the NSTA website. Beverly Brown initiated a "Plants in the Classroom" Community. Let's see how the community develops.
http://www.nsta.org/communities/?lid=hp

New NABT Outreach Coordinator/Informal Educator Member Section — You might be familiar with the 2-Year College and 4-Year College and University sections of the National Association of Biology Teachers. A new section is geared for individuals engaged in outreach and informal education, and a special outreach session, featuring presentations by NSF and NIH program officers and informal breakout groups, will be held Nov. 11 from 1-4 pm during this year's NABT meeting in Denver.
http://www.nabt2009.org/websites/conference/index.php?p=236

Now Available Online: Journal of Geoscience Education — Beginning with the September Issue, The Journal of Geoscience Education, supported by membership to the National Association of Geoscience Teachers, is now available online. The website offers free pdf downloads and the possibility of posting comments.
http://www.journalofgeoscienceeducation.org

Editor's Choice.

Botany in Science Education Journals

Gregory, Ryan, T. and Cameron A. J. Ellis. 2009. Conceptions of Evolution among Science Graduate Students. *BioScience* 59: 792-799. This study of graduate students at four science colleges at a mid-sized Canadian University revealed 70% of the graduate students identified evolution as an established scientific fact and reported mixed results of student understanding of mechanisms and patterns.

If you're interested in keeping up with evolution education publications, see also:
Dolan, E. 2009. Recent Research in Science Teaching and Learning. CBE Life Sci. 8: 162-164.
http://www.lifescied.org/current.dtl

Teaching Issues and Experiments in Ecology Vol. 6 featured evolution articles
http://tiee.ecoed.net/vol/v6/toc.html

And don't miss the rare free access offered by Springer until the end of 2009! Evolution: Education and Outreach
http://www.springerlink.com/content/120878/

Neff, Michael, M. Lori Sanderson, and Dan Tedor. 2009. Light-mediated Germination in Lettuce Seeds: Resurrection of a Classic Plant Physiology Lab Exercise. *American Biology Teacher* 71:

Johnson, N.C. V. Bala Chaudhary, Jason D. Hoeskema, John C. Moore, Anne Pringle, James A. Umbanhowar, and Gail W. T. Wilson. 2009.

Mysterious Mycorrhizae? A Field Trip and Classroom Experiment to Demystify the Symbioses Formed Between Plants and Fungi. *American Biology Teacher* 71:

Quinn, C., Mark E. Burback, Gina S. Matkin, and Kevin Flores. 2009. Critical Thinking for Natural Resource, Agricultural, and Environmental Ethics Education. *JNRLSE* 38: 221-227.

The authors review the literature and discuss considerations for preparing university students for natural resources and agriculture professions to apply critical thinking skills to complicated ethical challenges.

Hague, Steve S. 2009. Case Study: Transgenic Crop Controversy in Costa Rica. *JNRLSE* 38: 204-208.

This case-study is intended for undergraduates to consider arguments and counter-arguments of the GMO debate within the context of transgenic cotton grown in Costa Rica.

Munsell, John, Rachel Hamilton, and Adam K. Downing. 2009. Prospective Scope of Forest Management Education at James Madison's Montipelier. *JNRLSE* 38: 198-203.

An effort to integrate forest management education in to heritage tourism is described, with particular emphasis on impact to engage constituents.

Harms, Kristyn James King, and Charles Francis. 2009. Behavioral Changes Based on a Course in Agroecology: A Mixed Methods Study. *JNRLSE* 38: 183-194.

Students and instructors in an Agroecology course and a control course were studied to identify conditions for an experiential environment conducive to behavior change.
View all titles in JNRLSE Volume 38 at http://www.jnrlse.org/issues

Bond, Michael. 2009. Risk School. *Nature*461(7268):1189-7792.

The public's understanding of science depends on two things: their ability to understand factual information and their cultural background. As scientists and teachers we tend to focus on the former assuming that if we present "the facts" in a VERY CLEAR way, everyone will understand. HA! This brief article makes clear why we have such an uphill battle.

Teaching Tools in Plant Biology

The American Society of Plant Biologists has annunced the launch of "Teaching Tools in Plant Biology" in its high-impact journal The Plant Cell. Teaching tools is a monthly, online-only feature of the journal that offers regularly updated sets of teaching materials on important themes in plant biology. Each Teaching Tool includes a short esay introducing the topic, a PowerPoint lecture with notes, and suggested further readings. Tools wil be "off-the-shelf" modules but easily customizable by the instructor.

Teaching Tool # 1
Why Study Plants
see
http://www.plantcell.org/
(The first 6 Tools are free; starting in April, 2010, they will be available only to The Plant Cell subscribers)

The Virtual Floral Formula

Geoff Burrows
School of Agricultural and Wine Sciences
Charles Sturt University
Wagga Wagga, Australia.

gburrows@csu.edu.au

The study of flower structure is a standard component of almost all first year university botany and biology subjects. A knowledge of flower structure is important in understanding:
- how flowers facilitate the exchange of genetic information,
- different pollination syndromes,
- the development of fruits and seeds and the classification of fruit types,
- plant breeding, and
- how to identify plants using keys and Floras.

While important, floral structure is often studied in a single laboratory session, based on a small number of specimens, the choice of which may be constrained by seasonal factors. Students may be examined on this material several weeks after the class, with no effective ways of reviewing the information.

I have designed an interactive website called 'The Virtual Floral Formula'. See:

http://www.csu.edu.au/herbarium/

and then click on 'The Virtual Floral Formula'.

Users can select from 12 flowers, and for each flower scroll through a selection of images that show all the main structural features. They can then progressively assemble a floral formula for the flower from 13 drop-down menus (Fig. 1). When satisfied with their answer the 'Submit' button is clicked, after which the answer is compared and contrasted with the official answer and any differences are highlighted (Fig. 2). The images are now described and/or labelled (Fig. 2), allowing for any floral formulae discrepancies to be investigated.

As best as I can tell this is a unique resource, with nothing like it on the web for independent learning about flower structure and floral formulae. I suspect this application could be usefully used as a supporting resource in many first year university biology or botany subjects.

I would welcome comments or suggestions.

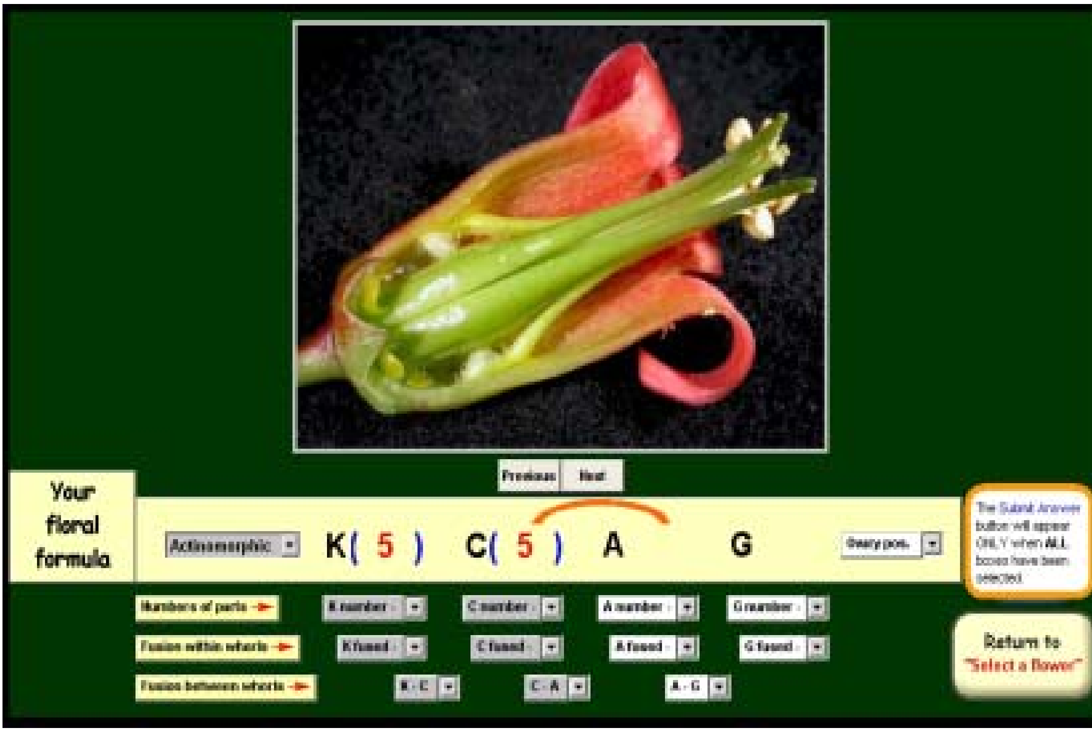
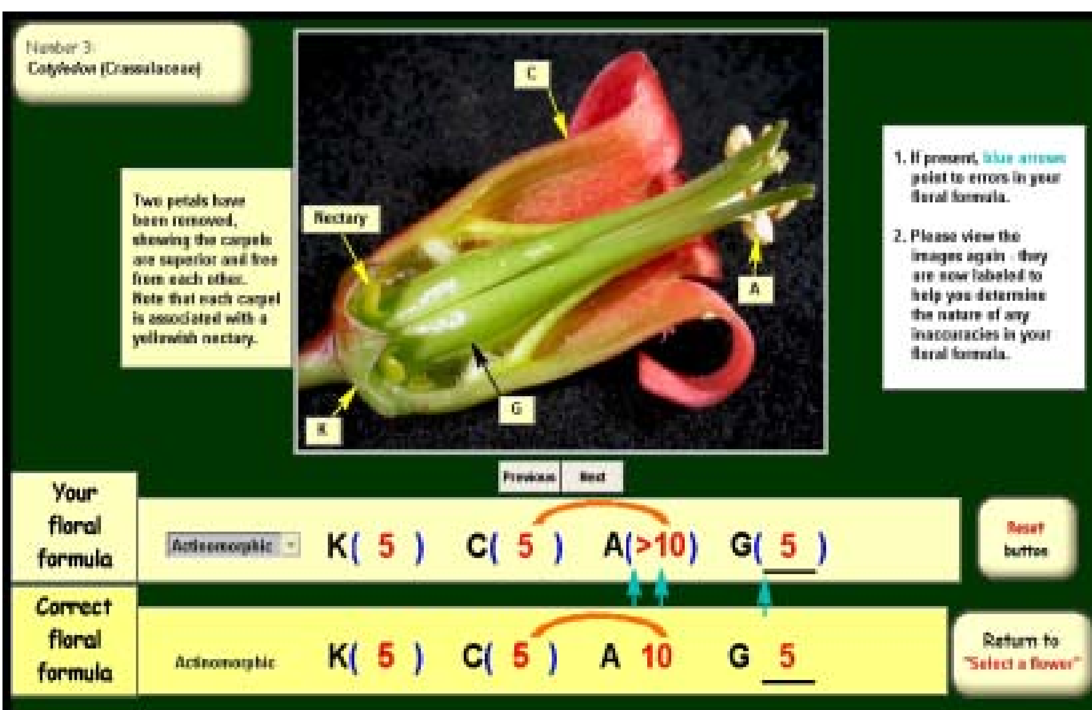


Figure 1 above; Figure 2 below.



Plant Talking Points

(www.botany.org/PlantTalkingPoints)

This classroom tool on the BSA web page was recently featured in the Science Teachers GRAB BAG section of the National Science Teachers Association NSTA Reports Newsletter. If you're not familiar with it, take a look - - then consider writing up and submitting one of your favorite botanical Talking Points to add to the BSA collection!

Personalia

New University of Wisconsin – Oshkosh Herbarium named after Neil A. Harriman

University of Wisconsin Oshkosh Chancellor Richard H. Wells presents yellow-button mums to Professor Emeritus Neil Harriman at a dedication ceremony for the University's herbarium on Sept. 9. Dr. Harriman founded the 3,700-square-foot facility in 1964, and in honor of his service, the herbarium, located in Halsey Science Center, henceforth will be called the Neil A. Harriman Herbarium. (University of Wisconsin Oshkosh photo)

Symposia, Conferences, Meetings

National Native Seed Conference

Plant Materials Development, Production, and Use in Restoration

Snowbird Utah, May 17-21, 2010

The Native Seed Conference invites all seed professionals, resource managers, scientists, citizens, and students of North American conservation.

This national meeting will bring together the latest research and developments from public agencies and the private seed industry.

Plant Materials Development
-- Recent and on-going developments

Seed Production

Seed Zones & Genetic Concerns
- The latest science and research findings through common garden studies and trials
- Policy roundup: what do the agencies want?
- Climate change: how should this shape our practices?

Seed Use: Lessons Learned
- Hear first-hand accounts of successes and mistakes
  - -Shrublands
  - -Highways
  - -Prairies
  - -Forests
  - -Deserts

Workshop: Government Procurement Procedures
- Learn how the U.S. government buys seed, how specifications are made

For updates and information: www.nativeseed.info

Contact: Rob Fiegener, Institute for Applied Ecology
rob@appliedeco.org
(541) 753-3099 x 201

Announcements

GO-BOTANY!

Framingham, MA - What if you could walk into the woods, see an interesting plant, pull out your cell phone, connect to the internet, identify the species, and access a wealth of information about it? The National Science Foundation (NSF) felt the concept was very interesting and has just awarded a four-year grant totaling $2.49 million to New England Wild Flower Society for Go-Botany: Integrated Tools to Advance Botanical Learning.

Go-Botany is a multi-faceted project, including the creation of an online state of the art plant identification key for all New England flora. It will build upon the upcoming New England Wild Flower Society publication, New England Flora, the first comprehensive botanical reference of the region's plant taxa to be published in the last 25 years.

Who are the audiences for Go-Botany?

The targeted audiences span a continuum from beginners without previous knowledge to students with considerable previous exposure to local plants.

The educational products associated with Go-Botany will be distributed nationally to educational organizations and will serve as a model for training in botany.

What are the goals of the project?

*Stimulate interest among teachers regarding native and naturalized plants of the New England Region;

*Connect students to plant resources as well as grassroots plant conservation;

*Provide basic skills to beginning botany students;

*Improve informal botany education;

*Provide schools the ability to customize teaching resources for botany;

*Provide the framework for institutions across the U.S. to create comprehensive and user-friendly field-accessible guides to plants.

One direct impact of Go-Botany will be to increase the level of public interest in botany and plant identification among youth and adults in our region. This impact will be measured by:

*Attraction and engagement levels by visitors to the Go-Botany website;

*Numbers and types of museum and website visitors who, post-visit, are stimulated to further explore botanical resources;

*The number and sophistication of website interactions by individuals who use the Online New England Flora;

*The number of customized My Plants personal web pages that are built by users; and

*Increases in involvement of beginners and amateurs with hands-on, field-based citizen science.

A second impact will be increased abilities of informal science educators in New England and beyond to use plants in teaching activities, as measured by:

*Interest and attendance at Go-Botany's botanically-focused professional development workshops;

*Frequency of educators' use of the Go-Botany website;

*Sophistication of botanical content in teaching activities and student projects;

*Successful use of mobile web-connectivity by ISE educators and their students to obtain botanical information while in the field; and

*Successful creation and use of customized field guides by a variety of nature centers and informal science programs.

The website will employ three separate types of keys, so that users will be able to access information compiled from multiple sources to identify a plant to the taxon level (usually species level) using the key best suited to their ability. Once the user works through a key, they will arrive at a "Taxon Page," which will contain color photographs, maps, links to other sources, and a wide range of additional information about the plant. The three distinct keys will be built in the style of an Application Program Interface (API) so that other institutions can plug the tool into their systems for plant identification. The importance of building an easy-to-use, well-designed user interface (UI) cannot be overemphasized. A UI that provides users with a rich set of tools such as easily accessible illustrations, images, and definitions of botanical terms will facilitate self-directed and group exploration, discovery and integration of botanical knowledge in an informal science/education setting. The UI will also display Taxon Page information in an easily-browsed format, with expandable topic tabs, enlargeable photos, external links to other resources, and internal links to closely related species. The UI will facilitate a user's own research by supporting queries and allowing results to be tabulated and saved.

The senior staff team, researching the taxa and building the computer models, is comprised of William Brumback (Conservation Director at New England Wild Flower Society), Dr. Elizabeth Farnsworth (Author, Ecologist, and Educator, MA), Arthur Haines (New England Wild Flower Society Research Botanist), and Sidharth Koul (New England Wild Flower Society Programmer Analyst). Key partners for research, development, and testing include the Yale Peabody Museum of Natural History, New Haven, CT; the Montshire Museum of Science, Norwich, VT; and the Chewonki Foundation, Wiscasset, ME.

"We are extremely pleased with this $2.49 million grant from the National Science Foundation," stated Debbi Edelstein, New England Wild Flower Society Executive Director. "Building an interactive field guide designed to teach botany opens the world of scientific inquiry to a generation that favors the richness and immediacy of online learning. The online flora will serve to increase the number of citizen scientists and to enhance their knowledge by making comprehensive visual and scientific information about New England taxa readily available. It will also begin the work within the botany community to create a national online flora, usable throughout America on portable handheld devices. It will free important scientific knowledge from the constraints of heavy books and enable youths and adults to move into the field and discover the world of botany."

"With the online Go-Botany, New England Wild Flower Society moves the exciting world of botany into the 21st century and makes botanical knowledge accessible, which is key to the survival of plants in this age of global warming. At a time when fewer people are relating to the natural world, this tool will enable New Englanders to better understand and appreciate the green world around them. When you begin to learn the plants you see every day, your interest in conservation naturally follows," stated William Brumback, Go-Botany Project Director and New England Wild Flower Society Conservation Director.

"New England Wild Flower Society is proud that the National Science Foundation has recognized our leadership in science education with the largest grant the Society has ever received," stated Board of Trustees Chair Frances H. Clark. "This four-year grant will enable us to develop and test teaching techniques using innovative technology with plant, education, and citizen science communities. Our exciting and dynamic Go-Botany will increase the public's knowledge of plants and their habitats and grow a community of people who care for and conserve our vital native flora for future generations."

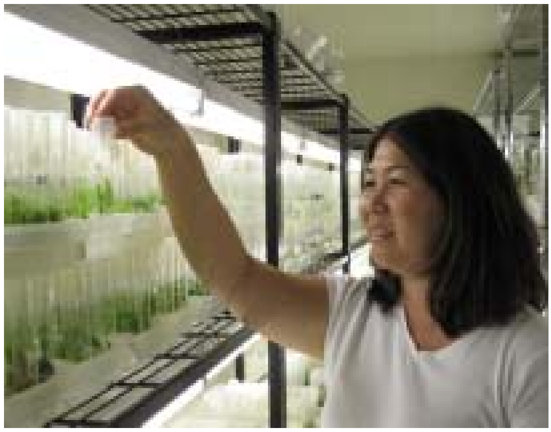
Plant Ontology Consortium (POC)

The main objective of the Plant Ontology Consortium (POC) is to develop, curate and share controlled vocabularies (ontologies) that describe plant structures and growth and developmental stages, providing a semantic framework for meaningful cross-species queries across databases. The Plant Ontology (PO) has been developed and maintained with the primary goal to facilitate and accommodate functional annotation efforts in plant databases and by the plant research community at large. As a part of the POC project, participating databases such as TAIR, NASC, Gramene and MaizeGDB have been using PO to describe expression patterns of genes and phenotypes of mutants and natural variants. The Plant Ontology Consortium (POC) is funded by the National Science Foundation.

contact: http:www.plantontology.org

UH Mânoa's Lyon Arboretum receives nearly $250,000 for Hawaiian Rare Plant Program

The University of Hawai'i at Mânoa's Lyon Arboretum has been awarded a $248,952 National Leadership Grant from the Institute of Museum and Library Services in Washington, D.C., for research on rescue, recovery and storage of Hawai'i's most critically endangered native plants.



Nellie Sugii observing the health of a cloned tissue culture specimen of the endangered species ***Cyanea dunbariae.***

The total project budget, with Lyon Arboretum's contribution and matching funds, is $422,927.
"To have such a grant awarded to the Lyon Arboretum is a true testament to the value of the statewide and national significance of the work our staff conducts on endangered plants," says Director Christopher Dunn.

Proposed activities for the three-year project will address issues that have the greatest impact on plants in *in vitro* culture and seed storage, and the management of *ex-situ* (off-site) collections. The probability of successfully establishing *in vitro* cultures is directly related to the collection process and handling of field collected plant material.

Staff members engaged in the grant include Dunn, Nellie Sugii, Alvin Yoshinaga, Cindy Nose, Kalani Matsumuru and Tim Kroessig.

Kew's Millennium Seed Bank Partnership Collects 10% of World's Wild Plant Species

BBG and NYC Parks Participate

The New York City Department of Parks & Recreation and Brooklyn Botanic Garden announced that they have contributed to the seed banking of ten percent of the world's wild plant species through participation in the worldwide Millennium Seed Bank project (MSB), based at the United Kingdom's Royal Botanic Garden, Kew (RBG). MSB officials announced the ten percent achievement—a major milestone for global biodiversity conservation efforts- at Kew's Millennium Seed Bank facility in Wakehurst Place, England.

"Through our historic partnership with Brooklyn Botanic Garden and Royal Botanic Gardens, Kew, we have identified and collected the seeds of 75 important and declining local plant species from the greater New York City area for safe storage and as a hedge against their possible loss from nature," said New York City Parks commissioner Adrian Benepe.

Brooklyn Botanic Garden president Scot Medbury said, "Brooklyn Botanic Garden is proud to contribute its expertise in the native flora of the New York City metropolitan area, in partnership with the New York City Department of Parks & Recreation and Royal Botanic Garden, Kew, to this extraordinary effort. The progress made by the Millennium Seed Bank and its worldwide partners speaks to the great global movement to ensure the future of biodiversity in our rapidly urbanizing world. BBG will continue to comprehensively study the vegetation of New York City and its environs, deepening the understanding of the city's plant life and by extension providing a blueprint for conservation efforts."

In 2006, the New York City Department of Parks & Recreation—through its Greenbelt Native Plant Center (GNPC) on Staten Island—and Brooklyn Botanic Garden (BBG) were invited by RBG to join as local partners in its global effort to bank the seeds of the world's flora. The GNPC/BBG effort is distinguished by being the only urban partner of the worldwide Millennium Seed Bank partnership.

GNPC and BBG agreed to make conservation-quality seed collections of 75 locally important and declining species from the greater NYC area. These species have been collected from wild populations within the five boroughs and from neighboring counties, utilizing internationally accepted standards for capturing maximum genetic diversity. BBG scientists and GNPC staff selected local species from regionally rare plant associations and from plant communities whose ranges are contracting, largely due to urban and suburban development and the encroachment of nonnative invasive species. Selected plant communities include Oak–Tulip Tree Forest, Red Cedar Rocky Summit, Maritime Heathland, and Dwarf Pine Plains. Populations of the selected species were then located by using current and historical plant location data from BBG's New York Metropolitan Flora Project and by field scouting.

According to Dr. Paul Smith, head of Kew's MSB partnership, "The Millennium Seed Bank is not a doomsday vault where seeds are stored under lock and key—our mission is to use these seeds to support conservation and improve people's lives. Most of the collections are available for research, and over a third have a known use to people. This is very much what the next phase of the Millennium Seed Bank partnership is all about."

MSB seeds will be made available to organizations involved in researching and delivering the sustainable functions of plants (for example, drought-resistant crop and forage species, medicinal speciejesss, and energy-rich species) and in the restoration of damaged vegetation.

GNPC's and BBG's involvement in the Millennium Seed Bank has yielded several benefits that will also have a lasting positive impact on local and regional efforts to conserve native flora. The seed-banking facilities at the GNPC were renovated with funds provided by RBG/MSBP to meet international standards, allowing Parks to expand and enhance its ongoing efforts of the past decade to preserve local biodiversity by seed banking and propagating rare and declining plants in New York City. In addition to the MSB collections, the GNPC seed bank now contains more than 1,400 accessions from over 400 plant species from the five boroughs and the region. In addition, the new seed-storage facility has enabled GNPC to assist other regional efforts to collect and bank local seed. The GNPC is now in the process of formulating plans to organize itself as the Mid-Atlantic Regional Seed Bank—a seed repository for restoration and management projects throughout the region.

The ten percent target was set in 2000 when the Millennium Seed Bank partnership was formed, and though this accomplishment is being celebrated today, a new target looms—collecting and banking a quarter of the world's plants by 2020. For more information about the Millennium Seed Bank and today's announcement, visit www.kew.org/press.

About BBG's New York Metropolitan Flora Project
Launched in 1990, the New York Metropolitan Flora project (NYMF) is a multiyear effort to document the

flora in all counties within a 50-mile radius of New York City, including all of Long Island, southeastern New York State, northern New Jersey, and Fairfield County, Connecticut. NYMF serves as a vital reference for those involved in environmental efforts such as preserving rare plants, planning parks and greenways, repairing degraded habitats, and designing home gardens in which native plant communities are preserved or restored.

Chicago Botanic Garden collects seeds from endangered tallgrass prairie region

Kew's Millennium Seed Bank Partnership (MSBP) today announced it has reached it's goal of collecting, banking and conserving 10% of the world wild plant species. The Chicago Botanic Garden collected and contributed 10,000 seeds from 1,500 species found in the tallgrass prairie region-which covers the Midwest and Great Plains. The Dixon National Tallgrass Prairie Seed Bank, is located at the Plant Science Conservation Center at the Garden. Due to habitat fragmentation, the tallgrass prairie has been reduced to less than 0.01% of its former range, making it one of the world's most threatened habitats—and scientists at the Garden predict that climate change may further endanger this habitat.

The goal of this project is global in scope. The Dixon National Tallgrass Prairie Seed Bank, in association with the national Seeds of Success (SOS) program, is part of an international seed conservation initiative collectively known as the Millennium Seed Bank Partnership (MSBP), originally developed by the Royal Botanic Gardens, Kew, in England. In 2000 the global program set a goal to bank 10% of the world's flora by 2010 for long-term storage and conservation.

Seed banking—conserving and storing species away from their original habitats—enables plants to escape threats imposed by destructive habitat changes, including urbanization, climate change, invasive species, over harvest and pollution. This method guards against species' disappearance in the wild and is an important way botanic gardens are helping to conserve plant diversity.

Between 2003 and the end of 2010, the Chicago Botanic Garden committed to collect seeds from 1,500 native species across the Midwest, with an emphasis on tallgrass prairies species.

"I think of the seed bank as a refuge in a bottle. Once, plant species might have found refuge from such changes on a distant mountaintop—now they will find it in a freezer. I believe this is the most important long-term conservation project currently underway at the Chicago Botanic Garden," said Dr. Pati Vitt, Curator of the Dixon National Tallgrass Prairie Seed Bank. "Climate change has occurred naturally over the millennia, and most organisms proved capable of either adapting or migrating in the face of such environmental change. The changes that we are seeing now, however, are occurring too rapidly for many species to adapt, and given the patchwork of natural areas interspersed with human development, it may be very difficult for many species to migrate."

Every seed is a living potential plant, and once dried and frozen, they can remain viable for 200 years or more. For every 1% reduction in seed moisture content, the lifespan of a seed is doubled, making seed collection an efficient and cost effective way to conserve the diversity of plant species for generations to come.

Additionally, the Chicago Botanic Garden is planning on expanding the original MSBP goal, which banks one population per species, to become a repository for multiple populations of each of our target collection species. Initially focused on collecting species of high restoration importance from each of the eco-regions that comprise the tallgrass prairie system, the seed bank will then be a valuable restoration collection for conservation purposes and as a resource for a wide community of scientists and land managers. The Chicago Botanic Garden hopes to collect over 100 million seeds from 2,500 native species in the next ten years.

With the recent opening of the Daniel F. and Ada L. Rice Plant Conservation Science Center, the Garden's staff of over 200 full-time scientists, research assistants and students provide leadership on solutions for plant conservation problems caused by climate change, habitat loss and fragmentation, invasive species and pollution.

"The Reproductive Biology Lab, Geographic Information Systems facility, and Seed Bank will all be right next to each other," says Dr. Vitt. "So all aspects of seed production, collection, storage and curation will be integrated and expanded."

The Chicago Botanic Garden's Dixon National Tallgrass Prairie Seed Bank collects in 14 states across the Midwest and the northern Great Plains including Minnesota, Wisconsin, North Dakota, Michigan and Iowa. For more information on the Garden's Dixon National Tallgrass Prairie Seed Bank, visit http://cbgseedbank.org or call (847) 835-6861.

"It will be years before we run out of storage capacity for the seeds," said Dr. Vitt.

Reports and Reviews

Climate Change Symposium: Carbon Cycling and Sequestration in the Sea by Phytoplankton and Macrophytes.

AnitraThorghaug[1], John Raven[2], Erica Young[3], Linda Franklin[4]. Botanical Society of America, Snowbird Utah, July 29, 2009

1. Yale University, School of Forestry and Environmental Studies, New Haven, Ct.; 2. University of Dundee, Dundee, Scotland; 3. University of Wisconsin, Milwaukee; 4 .Smithsonian Environmental Research Center, Edgewood, MD.

The Utah meeting of the Botanical Society of America (July 29, 2009) was the site of a dialogue concerning carbon dioxide cycling by marine plants. This included potential problems and solutions for carbon sequestration in marine biota. Our conclusions included how marine plants will be and are being affected by increasing levels of carbon dioxide dissolved in the oceans and seas. The oceans presently contain differing concentrations of both plants and carbon as well as a wide variety of plant phyla. Various genera respond very differently to carbon dioxide in seawater (based on experimental values of plant responses). Within the plants' limits, most responses are proportional -to the varying concentration of carbon. The central to far North Atlantic Ocean currently has the highest concentration of oceanic carbon dioxide (Fig. 1).

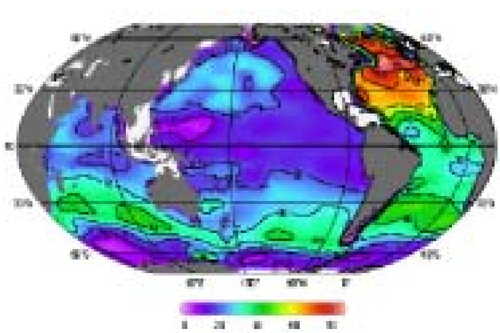


Figure 1 Measured **dissolved** carbon dioxide in the world's oceans. From NOAA 2004 . Notice descrepancies between the hotspots of oceanic carbon dioxide herein and atmospheric carbon dioxide from Figure 2.

This is where both accumulations of excess carbon input from industrial, transport, and mining processes (Figs. 2,3) as well as from the oceanic loss of heat and carbon exhalation occur. Lesser, still important, areas of carbon dioxide concentration include the southern Atlantic, the southern Indian, and the southern Pacific oceans (both with east-west bands). A site in the northwest Arabian Sea appear to contain the second highest concentrations of inorganic carbon (Figure 1). These areas of accumulation are the most likely to show plant responses to anthropogenically increased CO_2. Although the NOAA (2005) and other results indicate that the largest portion of carbon dioxide is in the upper 10% of the oceans, the atmospheric distribution of carbon dioxide differs considerably in location from the oceanic concentration. The discussions of oceanic processes of absorbing and distributing carbon dioxide included both the solubility pump, with the thermocline circulation, and the biological pump, comprised of plant distribution and plant physiological processes.

Raven discussed the differential CO_2 solubility in seawater as a function of temperature and salinity and equilibrates with the other components of the inorganic system ((H_2CO_3, HCO_3^- and CO_3^{2-} , as well as H^+/OH^-) and how the components of the inorganic chemical equilibrium enters cells and are used (as CO_2) in photosynthesis. Thorhaug discussed the profiles of carbon dioxide in the atmosphere and oceans (Figures 1 & 2) as influenced by the thermohaline circulation found though out the deeper ocean (Figure 4) with its role in coincidence with the release of CO_2 to and the uptake of CO_2 from the atmosphere (Figure 4) as well as the transfer of heat. The thermohaline circulation is related to the

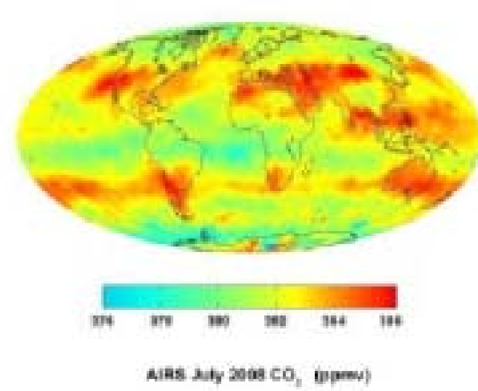


Figure 2. AIRS 7/08 large scale patterns measured CO2 transported around Earth by ATMOSPHERIC circulation NASA, showing in red the large scale patterns of atmospheric CO_2 concentrations indicating large scale differences among regions especially in the northern and southern terrestrial areas. The origin of accumulations over the undeveloped areas in the southern oceans is not clear at present.

CO_2 patterns found in the South Pacific and South Indian Ocean as well as the far north Atlantic Ocean. The biological carbonate pump (near-shore for mangroves, marshes, seagrasses, and macroalgae, and near-shore and open ocean for the phytoplankton) was discussed by Young and by Thorhaug in their presentations of phytoplankton and macro-plant responses and their transport carbon from the surface euphotic zone to the ocean's interior and sediment especially in shallow waters coastal waters and estuaries, but also in, and upper 200 m of the oceans and seas. It was emphasized that the open ocean regions only support photosynthetic production in the surface -200 m due to light limitations in deeper zones. Thorhaug pointed out that the Atlantic, Pacific & Indian Oceans had taken up 118 billion metric tons of CO_2 human sources 1800-1994, which is said by NOAA to be one third of oceans' long-term potential. The ocean has removed 48 percent of the **excess** atmospheric CO_2 over 200 y. One half of this anthropogenic CO_2 can be found in the upper 10 percent of the ocean where the plants are able to live. Discussions by Thorhaug included where carbon enters the oceans and is currently stored (including sediment, coral, phytoplankton, macroalgae, shoreline higher plants shoots and roots), and that a great deal entered in geological times when continents (especially India) scudded across ocean floor releasing carbonate sediments).

The Problem of Acidification of the Ocean - John Raven

Continuing ocean acidification occurs as a result of anthropogenic CO_2 release to the atmosphere with about a quarter dissolving in the ocean, increasing

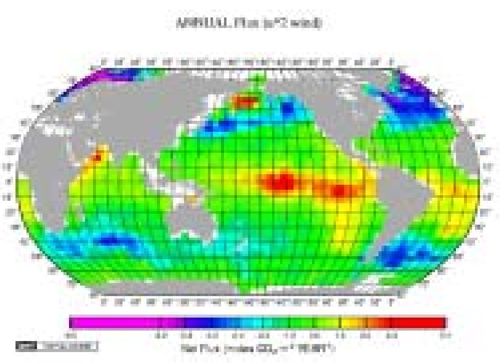


Figure 3 Air-sea fluxes CO_2/y. "Red" indicates release from ocean waters to atmosphere. The "blue" and "pink" indicate uptake whereas the "red, orange and yellow" indicate exhalation by the oceans. Note similarities with thermohaline current giving off heat in Figure 4 .(*Takahashi et al. 1999*)

the CO_2 and H_2CO_3 concentrations, increasing the HCO_3^- concentration relatively less (but more in absolute terms), and decreasing the CO_3^{2-} concentration. Growth of many non-calcified marine photosynthetic organisms is saturated by the present concentration of inorganic carbon species in the surface ocean. Other non-calcified photosynthetic organisms such as some phytoplankton species and a number of macroalgae and seagrasses, with a less effective or no CO_2 concentrating mechanism, show increased growth when more CO_2 is added to present-day seawater.

For calcified photosynthetic organisms (e.g. coccolithophores, and symbiotic foraminifera and corals) there is the additional complication that in many cases calcification, and thus growth, is decreased when carbon dioxide is supplied at greater than the present levels. With the additional complication of warming of the surface ocean with less deep mixing, and so a smaller input of nutrients regenerated in the deep ocean, it is difficult to predict the outcome of global environmental change for marine primary productivity, though species composition will change and there may be a decrease in the oceanic ecosystem services provided by photosynthetic organisms. Fertilization of iron- and of nitrogen-limited areas of the ocean with the respective limiting nutrient has been proposed and, for iron, tested as a means of bioremediation of both ocean acidification and increased atmospheric CO_2. However, major remediation is unlikely to occur, and there could be undesirable side effects.

John Raven emphasized in the calcium carbonate cycling in the sea that increasing carbon dioxide will create two effects in plants: changes in characteristics of plant physiological processes such as photosynthesis and enzyme functioning and significant oceanic fractionation of location of CO_2. Significant variation in sea-surface CO_2 concentration is already and will continue to be a potential result with CO_2 more soluble in cold water. CO_2 taken up near poles, released in equatorial upwellings as deep, CO_2-rich water comes to the surface and warms due to the oceanic Solubility Pump. Simultaneously the Biological Pump potentially will create CO_2 assimilated by organisms, with some biomass sequestered into sediment (particularly by Green, Red and brown algae and by the sequestering higher marine plants), while in most biologically processes carbon is mineralised back to CO_2, or dissolved organics of which much will come to the surface in upwellings. Additionally, there are temporal variations in inorganic carbon and pH in surface ocean seen as significant variation in sea-surface CO_2 concentration as a result of Diel (biological) and seasonal (biology, temperature) variations. Report of decadal variations, based on ä11B in coral aragonite as a proxy for the pH at which the deposition occurred (although there are some problems with the methodology). Still disputed are natural variations with over-ride effects of anthropogenic CO_2 in poorly flushed coastal waters.

Continuing effects of anthropogenic CO_2 emissions into the atmosphere include the following oceanic effects: 1.) increasing anthropogenic CO_2 emissions will continue to increase surface [CO_2], [HCO_3-] and [total inorganic C], and decrease pH and [$CO_3$2-] ; 2.) Increasing effects of the added CO_2 deeper in the ocean; 3.) Significant biological of shoaling of the saturation horizons of the main form of biologically precipitated $CaCO_3$ until the surface ocean becomes under saturated (by 2050 at high latitudes) ; 4.) Increasing anthropogenic CO_2 emissions will continue to increase surface [CO_2], [HCO_3-] and [total inorganic C], and decrease pH and [$CO_3$2-]; 5.)In the long term (1 -10 kyr) the increasingly CO_2-enriched waters will dissolve carbonates, increase dissolved alkalinity at depth and ultimately return higher-alkalinity water to the surface; 6.) Surface pH and [$CO_3$2-] increase:

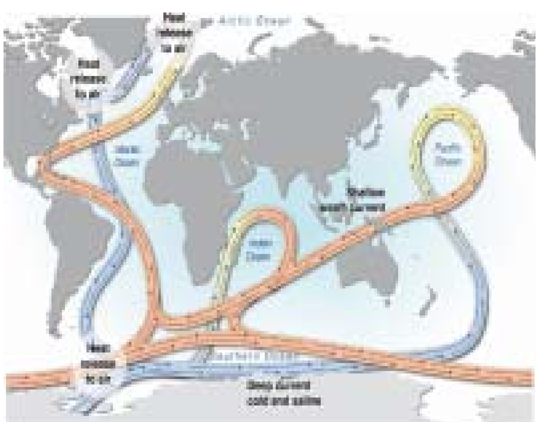


Figure 4. The deep and surface circulation of the oceans with release of heat and gases thermohaline circulation. Note similarities between point of heat release to air and degassing in Figure 3

surface waters once more supersaturated with calcite, then aragonite. Occurring within the physiology of plants will be the following: 1.) Many marine photosynthetic organisms will become saturated with inorganic carbon for cell doubling time, despite Rubisco kinetics; 2.) Presence of inorganic carbon concentrating mechanisms, based on active transport across membranes; 3.) Same outcome as from C_4 plant's photosynthesis on land – but evidence supporting C_4 photosynthesis in phytoplankton needs careful analysis (work on *Thalassiosira pseudonana* and *T. weissflogii).* The main emphasis on ocean acidification in the media has been on the effects on organisms with $CaCO_3$ skeletons, although most marine $CaCO_3$ precipitation involves photosynthetic organisms. Note that planktonic coccolithophores have calcite, as do unicellular primary producers. Planktonic and benthic: foraminifera have calcite as do other unicellular grazers and, when symbiotic with algae as in corals, primary producers have calcite (only photosynthetic in warmer waters).

Phytoplankton CO_2 Uptake and Nutrient- Limited Productivity - Erica Young

Phytoplankton in the surface oceans represent relatively small biomass compared with terrestrial ecosystems but grow over a much larger area and have much higher biomass turnover than terrestrial plants and contribute up to 40% of global photosynthesis (Falkowski, 1994) and thus play a critical role in the global carbon cycle. High phytoplankton biomass is observed in the nearshore, in coastal upwelling zones, in freshwater lakes and in many open ocean areas but phytoplankton are limited by nitrogen, phosphorus or iron limitation in large areas of the ocean.

Algae and cyanobacteria have evolved inorganic carbon concentrating mechanisms (CCMs) to compensate for CO_2 limitation in water (reviewed by Giordano *et al*. 2005). CCMs improve C fixation efficiency and involve synthesis of transmembrane transporter proteins, enzymes and expenditure of ATP for active inorganic C uptake.

Laboratory analysis suggests that in select green microalgae, diatoms, and a coccolithophorid, active inorganic C uptake and function of the CCM can either be upregulated or down regulated in response to N, P or Fe limitation, depending on the taxa (Riebesell et al. 2000, Young and Beardall 2005, Beardall *et al*. 2005, Schulz et al. 2007). However, not only are responses likely to be taxon specific but studies have covered very few taxa, so extrapolation to field conditions may be very difficult.

In situ open ocean iron fertilization experiments provide opportunities to examine the interactions between nutrient limitation and C sequestration by the open ocean phytoplankton. Open ocean regions have been shown to be iron limited (Martin and Fitzwater 1988, De Baar et al. 2005) and iron enrichment stimulates phytoplankton growth and CO_2 draw-down. More recent experiments have focused on addressing key questions including which taxa respond most readily to Fe enrichment and whether the biomass results in C transfer to the deep oceans. Cassar *et al*. (2004) showed no apparent effect of iron enrichment on inorganic C acquisition processes (as $^{13}C/^{12}C$ fractionation), More data on the physiological responses of inorganic C acquisition need to be incorporated into future in situ open ocean fertilization experiments. The scientific consensus is that iron fertilization is likely to have very doubtful ecological benefits. Despite this consensus (see also Glibert *et al.* 2007), ocean fertilization to stimulate C sequestration by phytoplankton has attracted the carbon credits trading industry.

Speculation on possible implications of rising CO_2 and global climate change for inorganic C acquisition and nutrient limitation includes the expectation in with lower oceanic pH and higher dissolved CO_2, acquisition of inorganic C may be easier for phytoplankton (Hein & Sand-Jensen 1997). However, CO_2 acquisition efficiency under present-day CO_2 levels and therefore responses to elevated CO_2 are likely to be very variable (e.g. Hein and Sand-Jensen 1997, Tortell and Morel 2002).

Anthropogenic nutrient inputs to nearshore regions can stimulate phytoplankton production (e.g. Lohrenz et al. 2008), but may result in negative ecological effects. However, global climate change, and current phenonema such as the North Atlantic Oscillation and the El Niño Southern Oscillation are likely to increase drought and desertification of continental areas including West Africa and Australia (Jickells et al. 1998; McTainsh and Strong 2007). This will result in elevated aeolian dust deposition into open ocean regions, bringing iron and other nutrients, which have been shown to stimulate phytoplankton production (Sarthou et al. 2003; Tovar-Sanchez et al. 2006; Shaw et al. 2008). Global climate change will likely affect inorganic C acquisition processes in phytoplankton through both changes in CO_2 availability and oceanic pH, and in nutrient supply to oceans. We currently need more field-based physiological studies of how phytoplankton take up and sequester CO_2 under nutrient replete and limited conditions

The Participation of Ultraviology Light in the Marine Plant CO_2 problems - Linda Franklin

Simultaneously, with the problem of the carbon dioxide build up in the oceans is the ozone and ultra violet increase in the global atmospheric shield, which is reflected in responses of marine plants. What does O_3 depletion mean for algae? Biological impact of O_3 includes damage, repair, and acclimation. Relevant to the environmental exposure of O_3 is appropriate dose (time and spectrum), and the use of biological weighting functions (BWF) to model the spectral response to natural scenarios. There are specific molecular targets of UV-B light, including nucleic acids, especially pyrimidines, in which alterations can be photo destructive forming pyrimidine dimers. The effects block DNA and RNA polymerases until repairs are made; perhaps long-term mutations are also an effect. There are also physiological targets of UV such as proteins, lipids (via a photosensitiser), porphyrins, and quinones. These appear to be altered by photo-oxidation, and cross-linking of amino acids. These effects include loss of protein content, function, or membrane integrity until repairs are made or acclimation occurs.

Do long-term mutations occur over time? We do not know. Photosynthesis as well as carbon allocation was effected, as nutrient uptake changed cell division and nitrogen fixation. Respiration, showed a great variability among species as did other measurements. Lower net primary productivity was a particular feature as was inhibition of light reactions (PSII) making lower photosynthetic efficiency. Basically, inhibition of carbon fixation (RuBisCO) occurred to lower the maximum rate. There were effects on carbon concentrating mechanisms (CCM) – TBD and in extreme cases a loss of chlorophyll, occasionally there was acclimation.Up-regulated transcription of photosynthetic genes occurred. Also found was enhanced scavenging of reactive O_2 species. As well as synthesis of UV-absorbing compounds. Mycosporine-like amino acids (MAAs) and polyphenolics (phlorotannins) resulted. There was a change in priority for synthesis of macromolecules

The Sequestration of Carbon by Restoration of Marine Macro-plants - Anitra Thorhaug

The reasoning of Hansen *et al.* 2008 to the problem of increasing global anthropogenic atmospheric carbon dioxide is that an important solution is to restore forests which will create a safety measure by decreasing atmospheric CO_2 by 60 ppm. Their assumptions are that deforestation on the planet will end in 2015 and that reforestation (and growth of these restored trees) will peak at 2030 at which time there will be yearly additions from the restored forests of 1.6GTC/y (he does not take forest fires or insect decimation into account). Thorhaug challenged this statement as the biological solution because when carbon sequestration solutions are being sought, the restoration of long-lived marine macro-plants need to be examined and these have not been calculated by Hansen *et al*.2008 as a portion of the sequestration solution. This calculation has nothing to do with the phytoplankton suggestions for sequestration and enhancement of a series of investigators. A series of experts have stated the ocean has removed 48 percent of the **excess** atmospheric CO_2 over 200 y of which a large share is found in the upper 10 percent of the ocean where the plants live. Marine macroplant restoration remains an important solution to the total global restoration and sequestration problem since: 1.) A great extent of the marine macroplants have been lost over the past 200 years therefore greatly diminishing the ocean's capacity to cycle and sequester carbon; 2.) The production (uptake of CO_2) and growth of marine plants is very high compared to terrestrial species (gross primary productivity marine coastal species is 2194 gC $m^{-2}y^{-1}$, net productivity 1151gC $m^{-2}y^{-1}$,and net global photosynthesis 3299 Tg y^{-1}); 3.) Much of the excess CO_2 is found in the upper waters of the oceans and accessible for marine plants; and 4.) There are few impediments to partial marine plant restoration around the world in terms of competition for space, or types of negative factors decimating forest restoration (fire and pests); 5.) New technologies for restoration of most of the marine macroplant species have resulted in persistence of new restored areas around the globe. (Substantial time was devoted to showing these persistent restorations). To compare the forest restoration solution to the marine macro-plants, Thorhaug calculated the present extent of four various major groups of macro-marine plants and a very conservative estimate of extent of potential restorable of the four groups: Marshes, mangroves, seagrasses and macro-algae along with extrapolating their present depositional carbon (Duarte and Ceprian (1995) , Raven (1991), Hay (1988)and includes in the table the potential depositional carbon from the restored plants. She also calculated in a highly conservative way the potential of restoring only 20% of the extent previously lost in the last half century. (This was by averaging lost habitat from experts' estimates.) The results were surprising. The extent covered by marine macro-plants is spatially one fourth of the present extent of forest cover in the world (similar in magnitude to the forest to be restored). The marine plants, particularly the macro-algae, seagrasses and marshes are some of the highest primary producers in the world. When their potential spatial extent for restoration is multiplied by their productivity they become an important and productive force to sequester carbon dioxide, from both ocean and atmospheric sources. The mangroves have long sequestration times as do the seagrasses and some of the macroalgae, all found in paleo records. The marshes no doubt also have sequestration times measured in at least decades, the other macroalgae differs from years to decades. There are many reasons for restoring these marine macroplants' services other than carbon sequestration: 1.) These are nursery habitat for the world's diminishing near shore fisheries; 2.) These are sediment stabilizers cutting down turbidity and erosion; 3.) These are a food and habitat source providing for a rich biodiversity of food webs from boreal to tropical ecosystems, which food webs reassemble after restoration first seen for seagrasses by McLaughlin *et al.* (1984). This restoration effort will have several additional services beyond sequestration, including providing employment for the young and people in poverty chiefly in the developing world (a large extent of the sites needing restoration are located in newly developing nations). The summary tables are below (Table 1 and Table 2). Data in these tables is taken from a series of investigators : Organic carbon contents estimated based on Gacia *et al.* (2002), Holmer *et al.* (2004), Kennedy *et al*. (2004), Duarte *et al*. (2005a) , sediment load buried on Milliman and Syvitski (1992), Hay(1998), and Walsh and Dieterle (1988) and extent, loss and production based on Raven(1991) , Duarte *et al*. (2005), Duarte and Ceprian (2005), Charby-Robaud and Sourna, Green & Short (2005), FAO. (2003), Gacia *et al*. (2002), Lugo (1988), Mateo *et al*. (2004), North, 1981, Paling, *et al*. (2009), Saenger (1983), Saenger (personal communications 2009), Spalding (1997),Thorhaug (1976),Thorhaug and Cruz (1989).

AKNOWLEDGEMENTS; Thanks to the BSA Physiological Section and Ecological Sections for symposium support.

Richard Polwhele, 1798, argued that women who study plants engage in sexual activity and that "botanizing girls…do not take heed…, they will soon exchange the blush of modesty for the bronze of impudence." But not all agreed...

With bliss botanic as their bosoms heave,
[they] Still pluck forbidden fruit, with mother Eve,
For puberty in sighing florets pant,
Or point the prostitution of a plant;
Dissect its organ of unhallow'd lust,
And fondly gaze the titillating dust.

In: Richard Polwhele, 1798, *The Unsex'd Females*. (London)

Happy for England, were each female mind,
To science more, and less to pomp inclin'd
If parents, by example, prudence taught,
And from their QUEEN (Charlotte, wife of George III) the flame of virtue caught!
Skill'd in each art that serves to polish life,
Behold in HER a scientifick [sic] wife!

In: *The Lady's Poetical Magazine, or Beauties of British Poetry* 1:1-4. (1781)

In 1773 Sir Joseph Banks named *Strelitzia reginae* in honor of Queen Charlotte "as a just tribute of respect to the botanical zeal and knowledge of the present Queen of Great Britain."

Table 1 Potential area for restoration restore in the marine environment which previously supported large macrophyte and halophyte plant communities.

Type ofMarine ecosystem	Potential Restored area $10^{12}m^2$	Globe T gC x 10^{12} /y buried	Net Living restored global C CTg produced 10^{12}/y	Total new Primary production C CTg 10^{12}/y
marsh	0.14	21.14	221.9	243.04
mangrove	0.5	20.12	33.14	53.26
Seagrass	0.093	7.7	104.	111.7
macroalgae	0.28	12.44	444.36	456.80
Total marine macroplants	1.013	61.4	811.13	864.8

Table 2 Potential to restore carbon (C) by various marine plant types compared to potential to restore forests with the carbon the newly restored plant material might produce from the both therestored forest (forest and atmospheric numbers by Hansen et al (2008)) ppm of CO_2 increase with potential for marine plants and their carbon by Thorhaug, 2009.

Ecosystem Type	Area $10^{12}m^2$	NowBuried # TgC $10^{12}/m^2$ /y	Potential new area $10^{12}m^2$	Potential* change CO_2	New C NetRestored gCT10^{12}	Total Restored Burial TgC10^{12}/y
Forests	4.	100	0.13	60 ppm (Hansen et al.2008)	130	
Plankton. Deposition	332	0.18	359	unknown	0.02	0.02
Marine macroplants	1.0	373	1.01	unknown	811.13	61.4

LITERATURE CITED

Behrenfeld MJ, Westberry TK, Boss ES et al. 2009. Satellite-detected fluorescence reveals global physiology of ocean phytoplankton. *Biogeosci*. 6: 779-794.

Beardall J, Roberts S, Raven JA. 2005. Regulation of inorganic carbon acquisition by phosphorus limitation in the green alga *Chlorella emersonii*. *Canadian Journal of Botany* 83: 859-864.

Cassar N, Laws EA, Bidigare RR, Popp BN 2004. Bicarbonate uptake by Southern Ocean phytoplankton. *Global Biogeochemical Cycles* 18: GB2003.

Charby-Robaud C. and A. Sourna,1990.comparative estimation of phytoplankton and micro-phytobenthic production in the ocean. *Marine Microbiology. Food Webs* 4:31-57.

De Baar HJW, Boyd PW, Coale KH et al. 2005.Synthesis of iron fertilization experiments: in From the Iron Age to the Age of Enlightenment. *J Geophys. Res.* 110: C09S16.

De Vooys CFN ,1979Primary productivity in aquatic environments. inThe Global Carbon Cycle (Bolin *et al*. eds), pp.259-292, Wiley, Chichester 292.

del Giorgio & Williams 2005. (eds) *Respiration in Aquatic Ecosystems*. OUP, Oxford

Duarte CM and J Ceprian. 1995.The fate of marine autotrophic production: a reassessment. *Aquatic Botany* 65:159-174.

Duarte CM, Middelburg J,Caraco N. 2005. Major role of marine vegetation on the oceanic carbon cycle. *Biogeosciences* 2:1–8.

Jickells TD, Dorling S, Deuser WG, Church TM, Arimoto R, Prospero JM. 1998. Air-borne dust fluxes to a deep water sediment trap in the Sargasso Sea. *Global Biogeochemical Cycles* 12: 311-320.

Lohrenz SE, Redalje DG, Cai WJ, Acker J, Dagg M 2008. A retrospective analysis of nutrients and phytoplankton productivity in the Mississippi River plume. *Continental Shelf Research* 28: 1466-1475.

Falkowski PG. 1994. he role of phytoplankton photosynthesis in global biogeochemical cycles. *Photosynthesis Research* 39: 235-8.

FAO, 2003.Status and Trends in Mangrove Area Extent. M L Wilkie and S Fortuna eds. *Forest Resources Assessment Working Paper, 63*. FAO, Rome.Italy.

Field et al. 1998 *Science* 281: 237-240.

Gacia,E, C M Duarte. 2001. Elucidating sediment retention by seagrasses: Sediment deposition and resuspension in a Mediterranean (*P.oceanica*) meadow. *Estuar. Coast. Shelf Sci*. **52:**505–514.

Giordano M, Beardall J, Raven JA 2005. CO_2 concentrating mechanisms in algae: Mechanisms, environmental modulation, and evolution. *Annual Review of Plant Biology* 56: 99-131.

Glibert, PM, Azanza R, Burford M et al. 2008. Ocean urea fertilization for carbon credits poses high ecological risks. *Marine Pollution Bulletin* 56: 1049-1056.

Granum, et al. *Journal of Phycology* (in press).

Hansen, J, M. Sato, P. Kharecha, D. Beerling, R. Berner, V. Masson-Delmotte, M. Pagani, M. Raymo, D.L. Royer, and J.C. Zachos, Target atmospheric CO_2: Where should humanity aim? *Open Atmos. Sci. J.*, **2**, 217-231.

Hay, W. W.1998 Detrital sediment fluxes from continents to ocean. *Chem. Geol.*, 145, 287–323.

Hein M, Sand-Jensen K. 1997. CO_2 increases oceanic primary production. *Nature* 388: 51-52.

Lugo, 1988. Forested Welanads in fresh water and salt water environments. *Limnology and Oceanography*. 38(2):884-909.

Martin JH and Fitzwater SE. 1988. Iron-deficiency limits phytoplankton growth in the Northeast Pacific. *Nature* 331, 341-343.

Mc Laughlin, P.A., A. Thorhaug, S. Treat, and R.LeMaitre 1983. A restored seagrass *Thalassia* bed and its animal community. *Environ.Conserv*. 10(3):247 253.

McTainsh G. Strong C. 2007. The role of aeolian dust in ecosystems *Geomorphology* 89: 39-54.

Mateo Mateo, M. A., Cebri ´an, J., Dunton, K., and Mutchler, T. 2005 Carbon flux in seagrass ecosystems, 672 *In Seagrass Biology and Ecology*, edited by Larkum, A. W. D., Orth, R. J., and Duarte, C. M., Kluwer, 2004.

Milliman, J. D. and Syvitski, J. P.: Geomorphic/ tectonic control of sediment discharge to the ocean: the importance of small mountainous rivers, *J. Geol.*, 100, 525–544, 1992.

North, W. and K.C. Wilson 1981.A review of kelp bed management in Southern California. *World Mariculture* 14:345-359.

Paling, E.I, Fonseca, M. M. Van Katwijk, MM.VanKeulen, Fonseca, 2009 Seagrass restoration. pp. 687-713 In: *Coastal wetlands: an integrated ecosystem approach*. Perillo G, Wolanski E, Cahoon D, Brinson M (eds). Elsevier, Amsterdam.

Raven, J.1991. *Plant, Cell & Environment* 14: 779-794.

Roberts K, Granum E, Leegood RC, Raven JA. 2007. C-3 and C-4 pathways of photosynthetic carbon assimilation in marine diatoms are under genetic, not environmental, control. *Plant Physiology* 145: 230-235**.**

Roberts.*K.* 2007 *Plant Physiology* 145**:** 230-235
Romero J.,M. Perez, M.A. Mateo, E. Sala. 1994. The below ground organs of the Mediterranean

seagrass *Posidonia oceanica* as a biogeochemical sink. *Aquat. Bot.* 47:13-19.

Saenger, P., Hegerl E.J. and J.D.S., Davie**.** 1983. *Global status of mangrove ecosystems. Commission on Ecology Papers No.3*. IUCN. Gland, Switzerland. 88 pp.

Seneca, ED SW Broome, WW Woodhouse Jr. 1976. Establishing *Spartina alterniflora* Marsh in NC . *Environmental Conservation* 3:185-188.

Sarthou G. Baker AR, Blain S, Achterberg EP, Boye M, Bowie AR, Croot P, Laan P, de Baar HJW, Jickells TD, Worsfold PJ. 2003. Atmospheric iron deposition and sea-surface dissolved iron concentrations in the eastern Atlantic Ocean. *Deep Sea Res* I, 50: 1339-52.

Shaw EC, Gabric AJ, McTainsh GH. 2008. Impacts of aeolian dust deposition on phytoplankton dynamics in Queensland coastal waters. *Marine and Freshwater Research* 59: 951-962.

Smith 1981. *Science* 211: 838-840.

Spalding, M.D., Blasco, F. & Field, C.D., eds. 1997 World Mangrove Atlas. The International Society for Mangrove Ecosystems, Okinawa, Japan. 178 pp. Thorhaug, A. 1976 . Restoration of seagrasses. *Environmental Conservation.*3(4):267-283

Thorhaug, A., R. Cruz & B. Miller. 1986. Comparison of tropical to subtropical growth after restoration of three species of seagrasses. International Coral Reef Symposium. Pp.222-224. In Choate et al. (ed.) *Proc 6th Ann. Coral Reef Symp. Vol. 1*.

Walsh .JJ& D,A.Dieterle,1988. in *Scales and Global Change* (eds. Roswall et al.), pp. 287-317. Wiley, New York.

Growing a Green Planet: The Future of Botany Teaching

John Cozza, Department of Biology, University of Miami

Growing up in the 1960s, I experienced two contrasting visions of the future: one featuring gleaming glass cities, the other a post-apocalyptic return to the caves. Recently, a grim new vision of the future has emerged: one of wild climate changes, rising seas, and mass extinction. To escape this last vision, we must recognize and preserve our interconnections with the Earth and its other residents, especially the plants that nourish us all.

This will be quite a challenge. Many people in the so-called developed world suffer from what Wandersee and Schussler (1999) have so aptly termed "plant blindness." Plants are reduced to decorations (even to plastic imitations), or thought of as boring—symbolized by that iconic diagram of a flower we had to memorize in high school. Kids, when asked where their food comes from, reply "the store." Many people never experience natural areas. Furthermore, in academia, old ways of doing things may get entrenched, and the community of botanists is often not as diverse as the communities we serve. Adding to the challenge is the relentless destruction of plants and their habitats, especially in the tropics. We simply don't have a lot of time. Fueling the destruction, the corporate community tells us we need bigger cars, bigger houses, and more of everything. Meanwhile, our students graduate with a mountain of debt that severely limits their career choices.

After presenting what a friend calls the "doom and gloom" predictions of the climate and extinction models, I ask my students, "Why am I telling you this?" The obvious answer, and one we must stress in our teaching, is that we probably can prevent catastrophe, if we act decisively now—and that doing so is, despite rampant misinformation to the contrary, economically feasible (Zurich 2009, Krugman 2009). Without this "closer," we may unintentionally be advising our students to feel helpless and deny our message.

Teaching is crucial to growing an alternative future vision of a green planet. With our inspiration and guidance, our students will take a botanical journey in which they become aware of and connect to plants, feel included as they explore botany and horticulture, and develop a sense of ownership of the plants in their lives. As they come to love plants, they will be motivated help conserve them and their habitats by sharing the Earth in a sustainable way.

Art students observe and draw plants at the Barnard College Greenhouse in the 1990s.

The first step on the journey is awareness. We will teach our students to see plants as fascinating, cool organisms—able to do anything an animal can do and more, but without being able to move from place to place. For example, plants need to obtain nutrients from the environment, and what better way to see this than a carnivorous huntsman's horn (*Sarracenia leucophylla*) filled with flies that have been lured to their death by the plant's irresistible deception! We'll rescue plants from the prejudice of torpid tropisms, and let our students discover that plants have true behaviors (Trewavas 2003). For example, at a Boys and Girls Club in NYC, my young students grew passionflowers (*Passiflora* sp.) from seed. When the seedlings had developed tendrils, each student stuck a stick in the soil and placed their plant's tendril on the stick to see what would happen. I thought I would have to engage them in something else for at least a half hour, but ten minutes later, their curiosity was so great that we went to look at the seedlings. Already, the tendrils had started to wrap around the sticks! For the first time, my students realized that plants are truly alive, and are able to sense and respond to their environment. The sensitive plant or *morir y vivir* (*Mimosa pudica*) is another, easier-to-grow exemplar of plant behavior that never fails to delight and fascinate students of any age.

We'll incorporate cutting edge research into our teaching. Emerging views of plants as "consortium organisms" (Margulis and Sagan 2002, Margulis 1998) that are linked underground by vast mycorrhizal networks, and may even share resources (Simard and Durall 2004), will continue to amaze us and our students. Together we'll learn about and discuss emergent properties, such as environmental engineering by plants, culminating, on the biosphere level, with the Gaia "hypothesis" (Margulis and Sagan 2003, Margulis 1998). Plant-animal interactions will inspire further interest and teach co-evolution. We will embrace controversy and use it as a teaching tool. We'll view the flower, for example, as what it is—a sex organ—and not just a bunch of terms to memorize. Our students will thrill to stories of sex, lies, and flowers: the *Aristolochia* and *Stapelia* spp. that attract flies with tell-tale visual patterns and rancid smells, or the orchids that entice male wasps to pseudo-copulate with them (Peakall 2007). We won't shy away from religion either—instead, we'll celebrate the rich ethnobotany of sacred plants. For example, when botanists look at passionflowers (*Passiflora* spp.), we see remarkable adaptations for attracting pollinators, excluding other visitors, and presenting male and female structures sequentially, all enhancing pollination (Janzen 1968). But to the 15th century missionaries who were the first Europeans to see them, these same adaptations symbolized the suffering and crucifixion of Jesus (his *passion*, to Catholics; Wikipedia 2009). We'll teach both views.

Young students grow their own gardens and find out where their food comes from at the Madison Square Boys and Girls Club in NYC in 1999.

Instead of focusing on generality, we will highlight the remarkable diversity of plants on many levels. Flowers that look like goblins (*Catasetum viridiflavum*) or parachutes (*Ceropegia* spp.), and plant bodies that resemble pebbles (*Lithops* spp., *Tricocaulon* spp.) or mushrooms (*Balanophora* spp.) illustrate the extremes of what plants can do. Mutant varieties, such as Arabian jasmines that develop corollas-within-corollas (*Jasminum sambac* 'Mali Chat') or branching within the flower (*J. sambac* 'Grand Duke of Tuscany'), maize plants bearing kernels and tassels in unusual places (e.g. tassel seed), and many others form a gallery of botanical oddities for teaching genetics and development. The diversity of plant varieties we have created in agriculture and horticulture reflects our own history and psychology. Popular books like "The Botany of Desire" (Pollan 2001) and "The Orchid Thief" (Orlean 2000) eloquently reveal these stories.

Assistant curator Jason Downing with the Marula nut (*Sclerocarya birrea*) trees he grew from seed at the Gifford Arboretum at University of Miami in 2008

After gaining awareness, the next step in our students' botanical journey will be to connect to the plants around them. This process becomes progressively more active through storytelling, observation, activities, and finally growing plants and doing inquiry-based botanical science. Students may connect with the maple tree (*Acer* spp.), for example, as a symbol of identity (if they are Canadian or Native American); through sports (the recent controversy over maple bats in baseball), East Asian culture (bonsai), or food (maple syrup). Observations of plants can happen anywhere: from the tree-that-grows-in-Brooklyn (*Ailanthus altissima*) sprouting out of a crack in the sidewalk, to your local campus, park, or gardens. So too can activities like botanical scavenger and treasure hunts, and art classes. An activity that helps demystify botanical nomenclature is "Name that Plant," developed by the education department at Wave Hill, a public garden in NYC. After a brief introduction to how plants are named, students are given a glossary of botanical Latin terms and several numbered plants. Students match the plants to their species names, which describe some characteristic of the plant, for example *Euphorbia obesa* (easy: it's the fat one) or *Dioscorea discolor* (difficult: it's the one with leaves of subtly-varying colors). The strongest connection to plants comes through growing them or doing botanical research, and we will be sure to incorporate these into our future curricula. Of course, we will use virtual technologies like the internet, but these will complement—not substitute for—working with real plants.

Undergraduate students Astrid Alfaro and Diane Toledo harvest begonias as part of a research internship for the author's PhD project in the Biology Department at University of Miami in 2006.

In the final step in our students' botanical journey, they will develop a sense of inclusion, ownership, and commitment. This may take place in many venues: community gardens, outreach programs, or greenhouses (e.g. Nuestras Raices in Holyoke, MA); schools and after school programs, or public gardens. Ownership of plants applies to people of all ages and backgrounds: at the Gifford Arboretum at University of Miami where I work as a consultant, the grounds crew is using open spaces to grow their own chili peppers and tomato plants. College students may contribute to (and thereby own a piece of) plant science as research interns (they should be paid if at all possible, to include those who need to work). Ownership will lead to love of plants, and hopefully, a lifelong commitment to them. We will make sure our students know about and explore the many career options in botany, including the emerging fields of horticulture therapy, plant biotechnology, biological pest control, bioremediation of wastes, sustainable biofuels, entrepreneurial horticulture, and local urban agriculture. We'll welcome descriptive science back into graduate training, and cultivate a new generation of taxonomists to study biodiversity. Some of us will spearhead a World Biodiversity Project, which will describe, understand, and conserve plant (and animal) diversity, especially in the biological hotspots.

High school students take a tour led by the author of the Gifford Arboretum at University of Miami in 2008.

As we encourage and mentor our students to become aware of, connect with, and own the world of plants, we will be working together with them to grow a new green society. Connections with nature are based on childhood experience, and are being lost with each successive, more urbanized, generation (Miller 2005). We'll prepare our students to reverse this trend, and to explore sustainable new ways to grow food, manage resources, and achieve social justice. The future of botany teaching is now!

This essay is based upon an invited symposium presentation at the Botanical Society of America annual meeting, July 26-30, 2008, Vancouver, BC, Canada.

John Cozza
Department of Biology
University of Miami
1301 Memorial Drive, Coral Gables, FL, USA
jcozza@bio.miami.edu
Web page: www.bio.miami.edu/john
Gifford Arboretum: www.bio.miami.edu/arboretum

REFERENCES

Janzen, D. H. 1968. Reproductive behavior in the Passifloraceae and some of its pollinators in Central America. *Behaviour* 32(1): 33-48.

Krugman P. 2009. It's easy being green. The New York Times: September 24. http://www.nytimes.com/2009/09/25/opinion/25krugman.html.

Margulis, L. 1998. *Symbiotic Planet: A new look at evolution.* Basic Books, New York.

Margulis, L. and D. Sagan 2003. *Acquiring Genomes: A theory of the origins of species*. Basic Books, New York.

Miller, J. R. 2005. Biodiversity conservation and the extinction of experience. *Trends in Ecology and Evolution*, 20(8): 430-434.

Nuestras Raices 2008. http://www.nuestras-raices.org/.

Orlean, S. 2000. *The Orchid Thief*. Ballantine Books, New York.

Peakall, R. 2007. Pollination by sexual deception in Australian terrestrial orchids. http://www.anu.edu.au/BoZo/orchid_pollination/

Pollan, M. 2001. *The Botany of Desire*. Random House, New York.

Simard, S. W. and D. M. Durall 2004. Mycorrhizal networks: A review of their extent, function, and importance. *Canadian Journal of Botany* 82: 1140-1165.

Trewavas, A. 2003. Aspects of plant intelligence. *Annals of Botany* 92: 1-20.

Wandersee, J. H. and E. E. Schussler 1999. Preventing plant blindness. *The American Biology Teacher* 61(2): 82-86.

Wikipedia contributors 2009. Passion flower. Wikipedia. http://en.wikipedia.org/w/index.php?title=Passion_flower&oldid=320602499

Zurich, E. T. H. 2009. Climate Change: Halving Carbon Dioxide Emissions By 2050 Could Stabilize Global Warming. *ScienceDaily*: May 4. http://www.sciencedaily.com- /releases/2009/05/090502092019.htm.

Books Reviewed

Developmental/Structural

Introduction to Bryophytes. Alain Vanderpooten and Bernard Goffinet. - Root Gorelick.......................167

Pollen and Spores, Applications with Special Emphasis on Aerobiology and Allergy by Shripad N. Agashe and Eric Caulton, - Nina L. Baghai-Riding..168

Ecological

Seedling Ecology and Evolution. Leck, Mary Allessio, V. Thomas Parker and Robert L. Simpson (eds) - Suzanne Koptur..169

Economic Botany

Pecans: The Story in a Nutshell. Manaster, Jane. - Amy Boyd..170

Genetics

An Introduction to Plant Breeding. Brown, Jack and Peter Caligari. - Carolyn M. Wetzel.....................171

Systematics

Orchids and Orchidology in Central America: 500 Years of History. Carlos Ossenbach. - Joseph Arditti..173

Catálogo de las Plantas Vasculares del Cono Sur (Argenitna, Sur de Brasil, Chile, Paraguay y Uruguay). Fernando O. Zuloaga, Osvaldo Morrone y Manuel J. Belgrano, eds - Marcel Rejmánek,......................174

The Sibley Guide to Trees. Sibley, David A - Michael A. Vincent..175

Tropical Plants of Costa Rica: A guide to native and exotic flora. Willow Zuchowski. - Joseph E. Armstrong..176

Wildflowers of Wisconsin and the Great Lakes Region. Black, Merel R. and Emmet J. Judziewicz. - Sean Hoban and Daniel Borkowski...177

Introduction to Bryophytes. Alain Vanderpooten and Bernard Goffinet. 2009. ISBN13: 9780521700733. (hardcover US$129.95; paperback US$52.95) pp. 303. Cambridge University Press.

The very appropriately titled “Introduction to Bryophytes” is a delightful book. It is both accessible and broad. The authors dance from topic to topic with aplomb. They start with the basics of ecology and evolution, including a definition bryophytes. They then spend three chapters describing the anatomy, morphology, and life history of each of the three lineages, mosses, liverworts, and hornworts. Although I am an organismal biologist, I especially enjoyed the rich detail in these three chapters. The details on various water conducting tissues alone make this book worthwhile. The latter half of the book is ecological, starting from large scale (biogeography), working down to the details of physiological ecology, and then deftly finishing with human impacts on bryophytes. Anyone with even a passing knowledge of plant biology, even if it is just based on angiosperms, will be able to quickly read and learn a lot from this volume.

The scope of this book means that information occasionally occurs in odd, albeit appropriate, places. For example, discussion of how far sperm move from male to female organs is included in the chapter on biogeography! This makes sense insofar as we are only told how far male and female plants are separated from one another, not how the sperm traveled these distance (up to 3.8 metres in the giant moss *Dawsonia superba*). Did the sperm simply float downhill through rivulets or films of water?

An understated leitmotif of the book is that bryophytes are different from other plants. We cannot predict bryophyte diversity from diversity of other plants, nor vice versa. We cannot predict function from form based on tracheophyte anatomy. While this is not surprising, Vanderpooten and Goffinet are justified in continually gently reminding us of this important lesson.

This book contains many references, including several from 2009. It contains a decent index. It contains a wide array of figures. The only production issue is with the colour photos, which are included as a centerfold, and also included as duplicate monochrome images that are well integrated throughout the text. The problem is that the colour versions lack captions even though there was adequate space to duplicate the captions in the centerfold. Being overly picky, while there was a colour photo of the heterotrophic liverwort *Cryptothallus* (*Aneura*) *mirabilis*, but I was also hoping for a photo of the heterotrophic moss *Hedwigia microcyathea*.

There were some surprises. A few bryophytes can live and grow in extreme environments, such as hyperacidity, e.g. the liverwort *Jungermannia vulcanicola* at pH 1.9. The authors cite a report of a moss (*Hyloconium splendens*) that did well after being watered for two years with pH 2.5 solution. However, their non-chalance that these treated plants had only two-thirds the chlorophyll of controls was a shock. I would have expected much greater loss of chlorophyll. I was also shocked by the authors' non-chalance at neoteny in mosses, especially since heterochrony is so often (erroneously) believed to not occur in plants.

There is also some orthodoxy here. The authors accept, without explanation, that things that look like a pair of non-closeable guard cells form a stomata on the sporophyte of hornworts, but form something that is not a stomata (instead, a mucilage cleft) on the gametophyte of the same plant. Is this only to bolster our prejudice that stomata or homologous structures are complex enough to only be found in diploid tissue?

While bryologists may find this book a bit skimpy on detail, Vanderpooten and Goffinet have indeed given non-specialist a wonderful introduction to these extraordinary plants.

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

Pollen and Spores, Applications with Special Emphasis on Aerobiology and Allergy by Shripad N. Agashe and Eric Caulton, 2009, ISBN 978-1-57808-532-3, 400 pages, (hardcover US $109.00), Science Publishers, Enfield, New Hampshire, USA.

To non-scientists, pollen is considered to be ubiquitous, fine, dust that is produced by weeds, trees, and grasses They are usually unaware of the varied morphology of pollen and spores, and their usefulness to forensic science, agriculture, plant evolution and many other disciplines. Throughout much of the 20th century, palynology (the study of extant and fossil pollen and spores) was used extensively by oil and coal companies for biostratigraphy, but with cutbacks in the exploration industry in the 1980's this subdiscipline has substantially diminished. Palynology continues to contribute today to such diverse fields as plant systematics and evolution, forensics, agriculture and allergy medicine.

Shripad Agashe and Eric Caulton's book entitled "Pollen and Spores, Applications with Special Emphasis on Aerobiology and Allergy" emphasizes two major aspects of palynology: spore and pollen morphology and procedures for preparation, and practical applications. Major emphasis is given to palynologically important plants from India and Europe, although some attention is given to plant species from Australia and the United States.

The book begins with two introductory chapters addressing the early history of pollen studies, such as the artificial pollination of date palms by ancient Assyrians around 4000 B.C. Wodehouse's book on 'Pollen Grains' that discusses developments in palynology throughout the 13th – 20th centuries, and Gunner Erdmann's contributions regarding pollen morphology in the 20th century. This information helps to provide an overview regarding the development of palynology.

Chapters three through ten provide a basic overview of palynology, such as pollen morphology, development and physiology, and techniques for processing modern and fossil pollen. Particularly informative subsections are devoted to the shape and size classes of pollen grains, exine sculpture, techniques for preparing modern pollen and spores for microscopic analysis, step-by-step guides of recovering fossil palynomorphs from peat, lignite, coal, and methods of determining pollen viability. Detailed drawings labeling distal and proximal views of spores and angiosperm and gymnosperm pollen are especially helpful. Terms for exine sculpture elements also are well defined. The emphasis in these chapters and throughout this book is on spores and pollen of land plants, rather than the broader scope of traditional palynology that includes any microscope organic walled organism.

Chapters 11-21 illustrate the value of pollen studies to agriculture, horticulture, forensic science, honey production, paleoecology, taxonomy, plant evolution and meteorology. Seven chapters are devoted exclusively to aerobiology and allergies caused by mold spores and pollen. These chapters include the contributions from 19th and 20th century aerobiologists, the design, advantage and disadvantages of various gravitational settling sampling devices, pollen/spore calendars from India, Taiwan, Australia, North America and Europe, and source plants (ragweed, grasses, and birch) of common allergens. The authors describe how weather patterns, geographical location, latitude, elevation, and heredity affect the severity of asthma and other respiratory problems, and note that pollen allergies have been recorded in horses, dogs and other mammals. They show how pollen production is controlled by duration of flowering, mechanisms of liberation and dispersal, pollen size, time of release, and other physiological factors. For example, higher rates of *Ailanthus excelsa* occurred from 4 pm to 10 am with a peak at 6 pm that coincides with the activity of honeybees (*Apis cerana indica*). In comparison, *Cyperus rotundus* releases pollen from 4 – 6 am with a peak at 5 am, but its pollen may remain in the atmosphere for many hours.

Chapter 12 is devoted to melissopalynology (the study of pollen in honey) and is especially interesting. Attention is given to how honey is made, what makes honey an energy and nutritious food source, quantity and quality of pollen for maximum honey production, determining geographical origin of honey samples, and pollination management strategies. The shortage of honeybees to pollinate essential agricultural crops (almonds, strawberries, blueberries), throughout the United States and why honey is a regarded as a medicinal food also are discussed. For example, the authors note that honey contains over 25 assorted sugars each one having a different function in human metabolism as well as an abundance of amino acids, and enzymes. They cite authorities who have claimed medicinal properties for honey, such as to promote healing, slow down cell aging, and alleviating menstrual pain.

This book will be useful to upper division undergraduate, graduate and post-doctorate students and research scientists who want to gain an understanding of applied palynology, as well as for educators. For example, I intend to explain and utilize some of the gravitational sampling devices discussed in this book in forthcoming environmental science classes, and will likely utilize some of the described techniques in my research. Excellent drawings, tables and maps are provided throughout these chapters. Color and SEM photographs also are used to show pollen morphology and plant features of *Ambrosia* (ragweed) an invasive plant from North America that is becoming a nuisance in Europe. This book is not without flaws; for example, there are a few misspelled words throughout the book, as well as taxonomic errors. For example, on page 89 *Anthoceros* (a hornwort) is misidentified as a liverwort. Some of the references cited in the book are rather dated (prior to 1960), although references within the last five years are also provided. Overall, this is a book I would recommend.

-Dr. Nina L. Baghai-Riding, Delta State University

Seedling Ecology and Evolution. Leck, Mary Allessio, V. Thomas Parker and Robert L. Simpson (eds) 2008. ISBN 97-0-521-69466-7 (Paper US$70.00) 514 pp. Cambridge University Press, 32 Avenue of the Americas, New York, NY 10013.

For most humans, baby animals elicit warm feelings and happiness, even when their parents are quite ferocious, scary, or ugly. Baby plants don't usually cause the same responses; more often, we are amazed at how different they look from the adult plant , and the difference in size between the seed, seedling, and the adult. Many botanists and gardeners who cultivate plants from their seeds feel some excitement when the seeds germinate, and pleasure when the seedlings grow into juvenile plants, but we are admittedly a select group. Most people, however, rely on plants making it through the seedling stage to grow and provide whatever crop, product, study object, or ecosystem service is expected; all of us, therefore, will find much of interest in this excellent book.

The three editors of this multi-authored volume, all expert in wetlands and a variety of other topics, contribute chapters themselves that introduce and the tie together the many other contributed chapters. Starting with the more autecological aspects of seedling biology, then establishing the morphological, taxonomic, and physiological foundations, the chapters build to many considerations of ecology at the population and community levels. The last part of the book has several chapters dealing with applications, invasions, disturbances, and restorations.

Seedlings are small and vulnerable, and influenced by many factors that affect their establishment and growth. The introductory chapter gives us a short seedling primer, where the parts and their functions of the typical seedling types are outlined. The editors/authors also point out that seedlings are but one part of the plant life cycle, but essential to the continuity of the species. They introduce the concepts of filters and safe sites, topics elaborated by other authors later in the book.

The natural history of seedlings (Leck and Outred) sets the stage for subsequent chapters on seedlings in stressful environments and specialized seedling strategies. The latter chapter (by Whigham et al.) explores some very interesting groups of seedling plants (including orchids, parasites, carnivorous plants). Mostly a review of published works, there is a temperate bias.

The next section begins with a fascinating chapter on embryo morphology and seedling evolution, in which Niklas considers all seed plant groups and their spore-producing forebears (all embryophytes, or land plants). Cotyledons went from absorptive to storage organs. There was a trend from exoscopic to endoscopic embryogeny, with bryophytes, sphenophytes, and some ferns having exoscopic embryogeny, other ferns, all leptosporangiate ferns, and seed plants having endoscopic embryogeny. Farnsworth provides insight into the influences of phytohormones on seedlings; Kitajima and Myers consider the ecophysiology of seedlings, considering patterns associated with opportunistic vs. conservative carbon allocation strategies. They point out that phenotypic plasticity is under genetic control, and that seedlings of 'gap' species show more plasticity than seedlings of late successional species. Horton and van de Heijden examine the role of symbioses in seedling establishment and survival, especially mycorrhizal fungi. This chapter has some very nice figures with photos of both kinds of mycorrhizae, in nicely labeled diagrams.

The next section of the book (Life History Implications) begins with a chapter by Moles and Leishman in which strategies and trade-offs are reviewed. My two favorite chapters of the book are in this section (my ecological bias).

In the first of these, Eriksson and Ehrlen discuss seedling recruitment and population ecology, reminding us that "a stable population is maintained if one reproductive individual is replaced, on average, by one successfully recruited offspring". With this in mind, life span should correlate with the rate of seedling recruitment; short-lived plants should have greater recruitment rates than longer-lived ones. They consider various causes of mortality: herbivores, pathogens, drought, and competition. They weigh the importance of microsite (safe site) limitation versus seed limitation.

The next chapter (by Keeley and van Mantgem) focuses on seedling communities, in the modern light of community assembly rules (restrictions based on the presence/abundance of other species, not simply species-specific responses to the environment). The null model, that taxa assort at random, is not valid if there are significant environmental filters (such as soil type variation, low phosphorous content, fire, distance from coast) that lead to non-random combinations of recruitment patterns. In another chapter, Kollmann considers functional groups in spatial variation in seedling emergence and establishment.

The last contributed section examines applications in invasion biology, anthropogenic habitat degradation, and restoration ecology. Hyatt writes that seedling ecology may not be too important in invasive species, but these invasive species may have negative effects on native seedlings. Baken considers seedlings in restoration of dryland systems, and Dalling and Burslem discuss seedling responses to human disturbance in tropical forests. Galatowitsch considers the pros and cons of using juvenile versus adult stock in ecosystem restoration. Creating safe sites to promote seedling establishment is a key to success, keeping in mind interactions with microbes and herbivores.

The final chapter by the editors puts the seedling into an ecological and evolutionary context, tying it all up nicely. The extensive references (108 pages!) serve to aid readers in following up on topics of interest, and the index is very useful as well, with taxa, concepts, and catchwords for locating items encountered but mislaid.

It is inevitable in an edited, multi-authored work that there is some redundancy of topics. But overall, this is an appealing, interesting, and useful book. My graduate students and I have all found information of use in our various research projects, and I have learned some new things to enhance my teaching in Plant Ecology next spring, both lecture and lab class activities. I recommend this book enthusiastically and predict it will be well received by both general and specialized audiences.

-Suzanne Koptur, PhD, Florida International University

Pecans: The Story in a Nutshell. Manaster, Jane. I2008 SBN 978-0-89672-640-6 (104 pages, Paper, $19.95) Texas Tech University Press.

As Americans prepare for Thanksgiving meals featuring native foods such as turkey, cranberries, and corn, the time is ripe for exploring one of our best native nuts, the pecan. *Pecan: The Story in a Nutshell* is a charming little book presenting an interdisciplinary, albeit agriculture-focused, look at this fruit native to river bottoms along the Mississippi and throughout eastern Texas.

This very readable account includes information on the pecan's range, botanical niche, agricultural history, ecology and nutrition. Manaster begins with the etymology of the word "pecan", including the cultural variations in its pronunciation. She discusses the historical and current range of the species, including both native and planted trees, stretching from the coast of South Carolina and Florida west to Arizona and California, south into Mexico and north along the Mississippi into Illinois and Iowa.

The chapter entitled "Botanical Niche" discusses the evolutionary history of the species and its hickory ancestors, and includes accounts of its botanical nomenclature. Manaster describes the bark, leaves and fruits of the pecan (leaving her description of the flowers, inflorescences and breeding system for the chapter on cultivation), and includes information about habitat and environmental needs and how they impact crop production.

I found the chapter on "History" to be one of the most engaging parts of this book. Manaster has clearly done extensive research on historical accounts of the pecan and shares it with us here, from Native American uses, through European exploration and accounts from botanists such as Michaux and Bartram, to early cultivation efforts. She follows this chapter with an even more detailed account of the history of pecan cultivation and breeding throughout the southern United States, which is then followed by more specific information about the history of pecan cultivation in the state of Texas.

The chapter entitled "Orchards" then takes us up to the present, describing more about the ecological needs of pecan trees and how they are met agriculturally in orchards from Florida to Arizona. This includes information about site selection, choosing protandrous and protogynous varieties, diseases, and methods of harvest. This is followed by a chapter about threats from animal predation and methods of control.

Manaster then returns to the historic account with a chapter on the pecan industry, touching on the economics, trade history, advances in processing (shelling) and refrigeration, as well as labor history. In the final part of the book, she covers nutritional content of the nuts and shares recipes for classic pecan delicacies such as pralines and pecan pie.

In summary, this quick read is enjoyable, full of interesting historical anecdotes and photos alongside details of cultivar development. It is not technical enough to serve as a cultivation reference for orchard growers, but instead presents a breadth of knowledge about this beloved American crop and its history for a wide audience.
—Amy Boyd, Dept. of Biology, Warren Wilson College, Asheville, NC

An Introduction to Plant Breeding. Brown, Jack and Peter Caligari. 2008. ISBN 978-1-4051-3344-9 (Paper US$80.00) 209 pp. Blackwell Publishing, 2121 State Avenue, Ames, Iowa 50014-8300.

Plant (and animal) breeders must address many challenges to ensure a stable human food supply: increasing population size, climate change, limited freshwater supply, ecological degradation, constantly evolving pests and pathogens, and nutritional value (Levine 2009, Evanson and Gollin 2003). To do so, current and future plant scientists need a strong grounding in evolution, botany, genetics, pathology, statistics, molecular biology, management, and nutritional science. The authors of "Plant Breeding" have written an admirable text that touches on all of these topics but focuses on genetics and statistical analysis. In spite of several flaws, this useful and enlightening book will help train plant scientists to engage with practical concerns such as selection, heritability, and experimental design.

The first two chapters provide a crash course in evolution, history of agriculture, and basic plant reproductive biology. A thorough understanding of the text, particularly plant reproductive biology, and beginners should spend substantial time here. The third chapter introduces objectives of a breeding program, such as usable yield, end-use quality, and pest resistance. The core of the book falls within chapters 4 through 7, which cover breeding schemes, genetics, predictions, and selection. This includes fundamentals of plant genetics, (selfing, heterosis, quantitative traits) while also addressing decisions a plant breeder must make, such as predicting the outcome of a cross or choosing the parent plants to retain during each stage of selection. The final two chapters are an assortment of topics and alternative techniques in plant breeding (such as induced mutation, interspecific hybridization, and molecular markers) as well as considerations for putting theory into practice (such as experimental design and data collection). Throughout the book, the reader is treated very well in terms of topic selection, as chapters lead intuitively from one to the next, i.e. genetics before predicting inheritance of traits, and inheritance before methods of selection.

The chapters on genetics (Chapter 5) and selection (Chapter 7) are especially valuable, and could serve as supplementary readings for a more general course in plant science or genetics. The authors provide a challenging yet accessible introduction to segregation, linkage, pleiotropy, epistasis, and tetraploid inheritance. Further, the reader can work through several detailed practice problems for appropriate statistical procedures, beginning with Chi-square and advancing to Griffing's analyses of combining ability. Equal attention and care are given to selection indices, gene *x* environment interactions, quantitative genetics, error, crossing design, and decisions during successive stages of selection. Several techniques are described in detail, such as the Scottish Crop Research Institute scheme for breeding potatoes (pp 54-55) and a challenging program of developing multiple desired characters in wheat (pp 127- 128). Helpfully, the authors frequently give practical advice, provide instructions for interpreting results of statistical tests, and summarize the techniques introduced. Topics are discussed in a manner that is thorough enough for a beginner to absorb (albeit with a bit of page-flipping), and also presents possibilities for the more advanced reader.

Unfortunately, while strong in the aforementioned areas, "Plant Breeding" warrants some criticism. The authors never make use of side boxes or case studies set apart from the main text, which would be of interest to many readers. An excellent model for an interesting side box would be Stokstad (2009), an article on Norman Bourlag and the development of resistance to wheat stem rust. Readers might these fundamentals is crucial for the remainder of also benefit from chapter-length case studies organized by crop, as in *Breeding Field Crops* (Sleper 2006), which provides separate chapters each for potato, sugarcane, sorghum, and others. Further, there is only minimal attention given to the roles of whole genome sequences and DNA fingerprinting in modern plant breeding. This last omission is especially surprising considering the authors advanced treatment of genetic theory.

A more pressing issue for at least some readers is that there are fewer than ten citations in over 200 pages of text, and there are no lists of relevant literature for future readings. For most uses of this book, from a practical handbook to classroom training, some list of references will help the reader to explore a topic in greater detail. It is also confusing that the authors include a conclusion section for the first few chapters but not for later chapters. Most readers would appreciate a summary of the techniques learned, their applicability, and future prospects. Lastly, lack of a glossary, while not a fatal flaw, sets this text a step below more complete books.

The weaknesses of "Plant Breeding" may frustrate some readers. However, the content, especially the central chapters, is an excellent source for students of plant genetics and biometry, as well as advanced practitioners. The opportunity to work through statistical procedures is especially informative. Perhaps in later editions the authors will expand their text with more captivating case studies, a list of references, and an exploration of other topics in plant breeding, such as ecology, pathogens, or agribusiness. A very intriguing and relevant additional topic would be how recently developed methods of targeted gene modification (Porteus 2009) will alter plant breeding. With some improvement, "Plant Breeding" could be both an essential introduction and a handy toolkit for all agricultural scientists.

References:

Evenson, R. E. & D. Gollin, 2003 Assessing the Impact of the Green Revolution, 1960 to 2000. *Science* **300**, p758-762.

Levine, A. S. 2009 "Agriculture" Is Not a Dirty Word. *Science* **324**, p1140.

Porteus, M. H. 2009 Plant biotechnology: Zinc fingers on target. *Nature* **459**, p337-338.

Sleper, D. A. 2006 *Breeding Field Crops*. Wiley-Blackwell

Stokstad, E. 2009 The Famine Fighter's Last Battle. *Science* **324**, p710-712.

-Sean Hoban, Department of Biological Sciences, University of Notre Dame.

Orchids and Orchidology in Central America: 500 Years of History. Carlos Ossenbach. 2009. ISSN-1409-3871. Soft-cover, 268 pp. Lankesteria, International Journal on Orchidology,Vol. 9, No. 1-2, August 2009, University of Costa Rica, San Jose.

It is not uncommon for orchid growers to develop a hobby within a profession or an avocation. Photography, painting, line drawing, book collecting and travel are common choices. A scholarly undertaking like delving into the history of orchids, especially in a manner which leads to publication in a peer reviewed journals, is less common. Carlos Ossenbach, an architect, has been doing just that. His first major contributions in journals (Ossenbach, 2005, 2007) dealt with the subject from pre hispanic times until approximately 1870. That was no easy feat because in its zeal to convert the local population the Catholic Church destroyed many documents. A sad and cruel example is an Auto da Fe in which Diego de Landa (1524-1579), a now infamous Franciscan, destroyed 27 rolls of Mayan codices which according to him were "work of the devil": "Fray Diego de Landa throws into the fire, one after the other, the books of the Mayans. The inquisitor curses Satan, and the fire crackles and devours. Around the incinerator, heretics howl with their heads down. Hung by their feet, flayed with whips, Indians are dowsed with boiling wax as the fire flares and the books snap, as if complaining. Tonight, eight centuries of Mayan literature turn into ashes" because Landa could not read them and described as "work of the devil" (one is reminded of the destruction of ancient statues by the Taliban in Afghanistan some years ago). Still, Ossebach managed to piece together an interesting historical account.
Some of the same history, but in more detail (including the quotes above) is at the start of this volume. The historical narrative proceeds from there chronologically. Ossenbach places orchid history in the broad historical context not only of Central America, but of the entire continent and tells a rich and fascinating story. Without his scholarship, ability to locate and use rare and interesting illustrations, and storytelling gifts, it is hard to even imagine, let alone realize, that the Alamo, the Panama Canal, the California gold rush, the Mexican-American war and an Englishman from Sheffield who settled in Saint Louis (Shaw) all affected orchid history.

Central American orchids are beautiful and fascinating. The individuals who collected and studied them may not be beautiful or even attractive, but they are fascinating and intriguing. They include a individuals such as: George Ure Skinner (1804-1867), a respected merchant in his day who also collected orchids and corresponded with William Jackson Hooker, the Director of the Royal Botanic Gardens, Kew; Josef Ritter von Rawiez Wascewicz (1812-1866), a Pole who spoke "a mixture of Spanish and Polish" and was "all hair, from his nose downwards;" Benedict Roezl (1824-1884) a Bohemian who was a "passionate mixture of ambition and madness;" Oakes Ames (1874-1950) who came from "a cultivated and wealthy family in New England," graduated from Harvard and became director of its Botanical Museum; Alphonse Henry Heller (1894-1973), a wealthy American who lived in Nicaragua, and many others.

Ossenbach tells all of their stories, describes their activities, places them in the general historical and economic perspective of the continent and in most cases includes a likeness. He does that in a manner which makes for engrossing and pleasurable reading. His history reads like a novel or a series of vignettes about eccentric and wonderful characters. He leaves out several juicy details which circulate in the orchid community despite questions or at least uncertainties about their veracity, but this only adds dignity to his book and increases his stature as an orchid historian and a scholar (who is a prominent architect in Costa Rica in everyday life).

Ossenbach's history is a double issue of a journal, but in reality it is a book which should be of interest not only to orchid growers, enthusiasts and scientists, but to all those who are interested in the historical perspectives of plant exploration, collecting and shameless exploitation. At about $26 (the subscription price for a volume of *Lankesteriana*) it is also a bargain

Literature Cited

Ossenbach, C. 2005. History of orchids in Central America Part I: From prehispanic times to the independence of the new republics. *Harvard Papers in Botany* 10: 183-226.
Ossenbach, C. 2007. History of Orchids in Central America Part II: The NewRepublics,1821-1870. Selbyana 28: 169-209.

-Joseph Arditti, Professor of Biology Emeritus, University of California, Irvine.

Catálogo de las Plantas Vasculares del Cono Sur (Argenitna, Sur de Brasil, Chile, Paraguay y Uruguay). Fernando O. Zuloaga, Osvaldo Morrone y Manuel J. Belgrano, eds. 2008. ISBN 978-1-930723-70-2(hardcover, 3. volumes, US$375.00). 3348 + xcvi pp., Missouri Botanical Garden Press, St. Louis.

Catalogues and checklists of biota living in particular terrestrial or marine regions represent a backbone for our assessments of the Earth's biodiversity. For South America, we have several catalogues of vascular plants growing in individual states or other, relatively speaking, small areas(e.g., Argentina, Chile, Ecuador, Guiana Shield, Mato Grosso, Peru, Venezuela). Unfortunately, so far we do not have any catalogues for the three extremely species rich staes: Bolivia, Brazil, and Colombia. The catalogue for Bolivia will be available soon (P. M. Jørgensen & al.,in press) but for the other two we will have to wait some time. Now, however, we have a catalogue for the southern part of South America – the Southern Cone. The catalogue under review covers 4,708,617 km^2, representing about 26% of the surface of the continent. It includes Argentina, Chile, Paraguay, Uruguay, and the three southern states of Brazil south of parallel 22^{0}S (Paraná, Santa Catarina, Rio Grande do Sul).

Since 2001, this project has been coordinated at the Instituto de Botánica Darwinion, Buenos Aires, in collaboration with the Missouri Botanical Gardens, St. Louis, botanical institutions in all Cono Sur countries, and more than 200 contributors from different centers of botanical research. Execution of this project utilized the database IRIS , that was created and developed in the Instituto de Botánica Darwinion, Buenos Aires. Continuously updated electronic version of the *Catálogo* is now available at: http://www.darwin.edu.ar/Proyectos/FloraArgentina/FA.asp. It allows for fast search of information about individual species with links to detailed bibliographical references. The Introduction (in both Spanish and English) presents a description of the biogeographical regions in the area and, in nine tables, extensive numerical analyses of the flora.

In three volumes of this catalogue, 17,697 accepted species are listed alphabetically by families (308) and genera (2586), documented with bibliographical citations, references to herbarium specimens, information on their distribution, habit, native status, elevation ranges, and synonymy. More than 42,300 synonyms are treated in this catalogue. There are 7691 endemic species in the Southern Cone (46.3% of native flora). Comparison with two other large areas of the Southern Hemisphere – Australia and Southern Africa (Namibia, Botswana, South Africa, Swaziland, Lesotho) - puts the species richness of the Cono Sur flora into a broader perspective (Germishuizen & Meyer 2003, Hnatiuk 1990).

	Area (km^2)	Native Species	Naturalized Species
Australia	7,617,930	15,638	1,952
Cono Sur	4,708,617	16,599	1,098
Southern Africa	2,693,422	20,073	882

Even if flora of Australia may be in fact by 15% richer, it is clear that, considering differences in areas, species richness of the Southern Cone is intermediate between Australia and Southern Africa.

The *Catálogo de las Plantas Vasculares del Cono Sur* is a monumental achievement. It will be an irreplaceable source of information for all botanists working in South America.

– Marcel Rejmánek, Department of Evolution and Ecology, University of California, Davis, CA 95616.

Literature Cited

Germishuizen, G. & N.L. Meyer, eds. 2003. Plants of Southern Africa: An Annotated Checklist. National Botanical Institute, Pretoria.

Hnatiuk, R.J. 1990. Census of Australian Vascular Plants. Australian Government Publishing Service, Canberra.

Jørgensen, P.M. et al., eds., *in press*. Catálogo de las Plantas Vasculares de Bolivia. Missouri Botanical Garden Press, St. Louis.

"Botany I rank with the most valuable sciences"
-Thomas Jefferson

The Sibley Guide to Trees. Sibley, David A. 2009. ISBN 978-0-375-41519-7 (Flexibound, US$39.95) 426 pp. Alfred A. Knopf, New York, NY.

I am only a casual bird-watcher, but among those bird guides I do possess, most are written by David Sibley. I have used them happily (and I might even say, successfully) to identify birds when I am out-and-about doing my botanical pursuits. So it was with great anticipation that I awaited the publication of Sibley's tree guide. I cannot say I am disappointed.

The Sibley Guide to Trees is a relatively small volume, measuring 25 X 16 cm, a good size to carry in a backpack in the field. It contains illustrations and/or descriptions of most native and naturalized species of trees in North America, and many commonly (and some less-commonly) cultivated tree species; over 600 species are discussed to varying degrees in the text, and there are over 4100 illustrations in the volume. The book begins with about 30 pages of introductory material, covering such topics as making observations, recognizing patterns, understanding cultivated trees and their potential impact on ecosystems, and valuing taxonomy as a science. Following this, Sibley discusses taxonomic hierarchies of plants, how his maps are constructed, and conservation issues. His introduction concludes with a thorough overview of a wide range of morphological characteristics that are used in the identification of trees, many of which are illustrated. The remainder of the volume is coverage of tree species, arranged by families. Families in the guide are arranged phylogenetically, beginning with gymnosperms, followed by the monocots (palms, *Yucca*), and then the "dicots". The dicots follow in a more-or-less APG arrangement, beginning with Lauraceae and ending up with Adoxaceae. Nomenclature used throughout is mostly up-to-date, and common names are given for all species. There is a checklist *a la* a birder's life list toward the end of the volume, followed by a complete species index.

Species coverage in this book is quite thorough. For example, all 8 species of *Magnolia* included in the FNA treatment for the genus are covered in Sibley's book, as are two commonly cultivated species. Among the oaks (*Quercus* spp.), of the 90 species covered in the FNA treatment (some of which are shrubs), 68 native and 8 cultivated species are treated by Sibley. Some less common species which I might consider trees are excluded, such as *Jacquinia* (Theophrastaceae), but these tend to be species of very restricted range. Discussion of species that escape is good, as exemplified by the coverage of *Acer ginnala*, *Eucommia ulmoides, Pyrus calleryana,* and *Tetradium daniellii*, all of which are species I see escaping in the eastern United States. Some genera are not as completely covered, such as *Crataegus* and cultivated crabapples.

Descriptions are given for most species, and are generally very good. The usual descriptive characters are given, including whether the species is deciduous or evergreen, something about its size, and some traits that can be used to distinguish among similar species. Characters of flowers, fruits, bark, and twigs are often included, and subspecific taxa are sometimes distinguished. Most species are given a page or half-page, with less common or more restricted species given less. Illustrations and maps are included for most species. In some groups, distinctive characters (such as circular stipule scars in Magnoliaceae) are not mentioned. The treatment of *Fraxinus* omits some good traits to distinguish some of the species, such as petiole scar shape or branching patterns. But, overall, the descriptions are quite useful.

Since many are already aware of Sibley's bird illustrations, the quality of the illustrations in this volume should be discussed. Generally, color illustrations are given for leaves, flowers, fruits, twigs, and sometimes bark or habit. The illustrations are fairly small, and some characters can be difficult to see, but, by and large, the illustrations are of good quality and show essential characteristics necessary for identification. They are often augmented by descriptive phrases that accentuate a given, sometimes definitive or helpful, trait. Considering the difficulties that might present themselves when painting bark, for example, the pictures are very good, and for the most part very useful. In my opinion, they do not live up to the quality of his bird paintings (those birds are just so gaudy!), but are none the less quite effective. Great pains appear to have been taken to show colors and surface features on what could have been presented as plain green leaves.

Distribution maps are provided for many of the species in the book. These appear to have been carefully researched, and give a very good approximation of the distributions of many of the species. Those for some species, however, do not adequately represent the range of the species, such as the map given for *Pinus sylvestris*, which would lead the reader to believe that the species is not known from the western US or Canada.

I can find very little to criticize in this nice volume. There is the occasional nomenclatural point with which to disagree, or map with which to argue, or a branch put in upside-down, but beyond that, I can find little of substance that should be corrected. The one major, glaring omission, in my opinion, is the lack of a key to the species, or at least the genera, included in the book. While this may limit its usefulness in a college botany class (or not), it is not a fatal flaw.

This book is so thorough and so well written that I think it will prove very valuable in many venues, and for many people. I can see it in use in a high school botany class, as a guide for any natural area or park, as a guide for birders, or for anyone else interested in trees, from the rank amateur to the “hardened professional.” It is wonderful to have a single-volume guide to trees that covers the whole continent, and that covers both native and introduced species. Now, if only David Sibley can be convinced to write a companion “Sibley Guide to Shrubs and Woody Vines”!

— Michael A. Vincent, Department of Botany, Miami University, Oxford, OH, USA

Tropical Plants of Costa Rica: A guide to native and exotic flora. Willow Zuchowski. 2007. Zona Tropical Publication, Comstock Publishing Associates of Cornell University Press, Ithaca and London. 529 pp. Cornell ISBN 0-978-8014-7374-6.

As a frequent botanical traveler to Costa Rica, either to conduct field research or as an instructor for our annual rainforest ecology field trip, I am always interested in new field guides for Costa Rican biota. Distracted as I was by sabbatical leave travel and the time demands of domestic field research, I had not yet seen the 1st edition, then the Cornell edition I sent for review was lost in the mail, but fate intervened and I received a copy from a lucky colleague who had won it as a door prize.

Like any other tropical country, the plants readily observed in Costa Rica are a mixture of native and exotic species, and the author of this guide tried, and largely succeeded, in selecting prominent, important, and conspicuous plants for inclusion, resulting in well over 400 species in 124 families of vascular plants. Each entry is illustrated with quite good to excellent color photos, and here and there, useful B&W diagrams showing details of flowers, fruit, or vegetative structures. Each description includes the scientific name, common names in both Spanish and English, the family name, an accurate physical description, flowering and fruiting seasons, the geographic distribution, habitats, and altitude, related species, and comments. The author dispenses a considerable amount of informative botanical knowledge in the “comments” section. The many interesting eclectic tidbits presented include information about the pollinators and pollination biology, indigenous uses of the plant, mutualistic interactions, the origins of either the scientific or common names, conservation or problems (if an exotic), toxins and their medicinal values, if any, and organisms that consume the fruits and seeds. This is great material, real biology delivered in a field guide.

Of particular note are the many “essays” sprinkled here and there throughout the book where the author provides some brief exposition (1 or 2 pages) of detailed knowledge about botany, for example, the pollination of figs by fig wasps, members of the coffee family Rubiaceae, tropical cacti, mahogany and rosewood, gap specialists, and, my favorite, drift seeds (seeds and pits often found on beaches). In addition to knowledgeable comments, these interludes demonstrate the author’s extensive knowledge, as does the extensive bibliography, however, without citations in the text, there are no connections to these references and publications, and as an educator, I find that very unfortunate.
In my experience Costa Rican naturalists are quite good, but often quite vertebrate oriented, and this may well be because better field guides and more information has been available for mammals, reptiles, and birds. No doubt many naturalists will incorporate more botany now that they have a ready source of material.

I could quibble a bit here or there about the plants chosen for inclusion, but generally the author demonstrated well-informed decisions in selecting plants for inclusion. One seemingly obvious omission I noted was a failure to mention the stilt palms of the wet Atlantic lowlands, but this was rectified by including these oddly conspicuous plants in a special section on palms. And this brings me to my only serious criticism, the system of organization.

Not being a stickler for taxonomic organization, I take no offense from books that organize wild flowers by season or flower color, for example. Unfortunately in the words of the author herself “A guide to the tropical plants of Costa Rica incorporates several different organizing principles”. This was a mistake because not only do you not know where to look for some plants, you must constantly check in several different groupings. Like many field guides, this one works best if you already know what the plant is.

The book is organized into eight chapters, some with several subsections: 1. Painted Treetops (common trees with showy floral displays), 2. Other Common Trees (those lacking colorful floral displays), 3. Roadside and Garden Ornamentals, 4. Fruits and Crops, 5. Living Fences and Reforestation (woody species used to construct fences, which often sprout and grow, and those grown in plantations), 6. Special Habitats (wet Atlantic lowlands, Tortuguero canals, seasonal dry forest, montane cloud forests, beach and mangroves), 7. Typical Tropical Groups (aroids, bromeliads, palms, heliconias and birds of paradise, orchids, ferns and lycophytes (which means clubmosses, but horsetails were included too), 8 Conspicuous Grasses (mostly roadside species). Obviously the systematic groups in chapter 7 intersect habitat and uses groupings at right angles. For example, all of the typical tropical families are quite common in the wet Atlantic lowlands and the montane cloud forests, so you have to look in at least two places, if you recognize the plant as say a bromeliad. This places several quite common and conspicuous plants of the wet Atlantic lowlands in Chapter 7 under aroids, palms (the stilt palm), heliconias, orchids, and ferns. A novice who is not familiar with these taxonomic groups is quite likely to miss plants so placed. Sorry, but you cannot have it both ways. Even then some plants fall into more than one chapter, for example, *Spondias* are used for living fences and are grown for their scantly fleshy tart fruits. Similarly the pejibaye or peach palm could be placed under fruits and crops or the wet Atlantic lowlands, but it was placed in palms. On the plus side the brief introductions to these families are quite good.

Seldom has color photography been used so effectively to illustrate a field guide. The photographer, Turid Forsyth, demonstrates a great eye for detail and effective presentation. Many are among the best photographs I have seen of some of these plants, and if you have not tried to take good photos under the many exacting conditions of the tropics, you will not understand this achievement. The more sophisticated will be disappointed by the number of pages "wasted" on UTF – *ubiquitous tropical flora*, those ornamental species that have been spread around the world to provide a certain colorful monotony to tropical landscaping. Having vented my UTF frustrations, inclusion of these species will doubtless satisfy the curiosity of the less botanically experienced travelers. My students always get a huge charge out of *Spathodea campanulata*, the African tulip tree, not because it is pollinated by perching birds seeking a reward of water, but because the large fluid-filled flower buds can be used to squirt someone.

On the whole this is a very good, very useful field guide for a country where a reasonably accessible and non-technical introduction to botany and plants is most welcome. However, at just over 900 g (2 lbs), this is a mighty hefty addition to your backpack. —Joseph E. Armstrong, Professor of Botany and Head Curator of the Vasey Herbarium, School of Biological Sciences, Illinois State University, Normal, Illinois 61790-4120.

Wildflowers of Wisconsin and the Great Lakes Region. Black, Merel R. and Emmet J. Judziewicz. 2009. ISBN 978-0-299-23054-8 (Paper US$29.95) 320 pp. University of Wisconsin Press, 1930 Monroe Street, 3rd floor, Madison, WI 53711-2059.

As the introduction of "Wildflowers of Wisconsin and the Great Lakes Region" states, field identification guides are for "those who want more than to just enjoy the beauty." They are for those who "want to name them accurately, understand how they relate to one another, and gain awareness of the ecological context (p xi)." Such books are for (whether in name or in heart) botanists, ecologists, taxonomists, and naturalists. The best guides are accessible to a novice, but also sufficiently detailed for veteran outdoorsmen. Although "Wildflowers" is remarkably thorough, and still small enough to take to the field, it has some flaws in content and accessibility that keep our enthusiasm bridled and ultimately make the book not quite first rate.

We'll start at the beginning. In keeping with their ecologically minded goals, the authors thoughtfully include one page descriptions of 20 native habitats/ ecosystems found in Wisconsin. This useful overview presents the relative contribution of each of these habitats to the whole of Wisconsin, and a list of flowers and other plants likely to be found in these environs. The section gives context to the flowers, illustrating that they exist as just one piece within a large mosaic of other plants, animals, and abiotic factors. However, this section does not capture the fine scale with which communities often are defined, and ecologists may feel miffed. While they list 20 community types, the Natural Heritage Inventory Natural Community Descriptions (Epstein 2008) lists approximately twice that. A thorough survey of community types occurs in Elizabeth Thompson and Eric Sorenson's (2000) Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont, and serves as an example of a guide that has the right amount of detail to approach the topic of communities.

The utility of a field guide depends heavily upon the structure of the identification keys. Unfortunately, this is the weakest aspect of "Wildflowers of Wisconsin". The authors differentiate plants based on the number of "parts", with the definition being "the obvious or showy parts of the flower including the sepals and/or petals, but sometimes parts also include the bracts or upper leaves" (p 1). This is very easy for some flowers, i.e. *Trillium* (p 37, 38), but many flowers will not be so easy, i.e. the prairie-clover (*Dalea*, p 129). Granted, it is always tricky when designing an identification key. Sometimes a break with tradition is welcome and fresh, and some readers may like the guide in "Wildflowers". However, this arrangement made identification more difficult for us than the standard character-keys found in guides such as Newcomb's (1989) Wildflower Guide.

Once the reader finds a species of interest, an informative and concise summary of the flower awaits them. Each entry takes about one-quarter of a page, and leaves the reader satisfied they have keyed out the correct flower. The descriptions are excellent, beginning with the general plant form-hairiness, tendency to branch or form rhizomes, height, annual or perennial. This is followed by descriptions of flower, leaf, fruit, habitat, and more. For example, the entry for the Devils paintbrush (*Hieracium aurantiacum*) gives descriptive characteristics, ecological status (introduced), and life history characteristics (like blooming time), and even informs the reader that people often mistake it for "Indian paintbrush" (p 193).

Each species also has an approximately one inch square full color photo of the whole plant, the flower or both, an attractive feature to any reader but especially to first-time field botany students. Adjacent to the photo sit easily interpreted symbols, indicating whether the plant is invasive, poisonous, or both. Both photos and descriptions are extremely well chosen to point out distinguishing characteristics, and to our limited expertise they typify normal field specimens. Granted, though, the photos are not as large or vibrant as the National Audubon Society (2007) Field Guide. Next to each photo is a thumbnail size county map of Wisconsin, indicating reported occurrences of the flower. However, no other states are included, even though the book is subtitled "and the Great Lakes region," so those of us in Indiana are unable to make use of this tool.

The guide is especially appealing to students for several small but useful additions. We were especially pleased with the inclusion of many invasive species, such as multiflora rose (*Rosa multiflora*) and Eurasian water-milfoil (*Myriophyllum spicatum*), right next to their native, related counterparts (p 168). The authors have taken special care to describe how to distinguish related plants, such as the common tansy (*Tanacetum vulgare*) from the Lake Huron tansy (*Tanacetum huronense*), with distinguishing features in bold print (p 226). (It would be nice if the authors had included where the invasive species originated.) The word glossary introduces the reader to beginner terms such as entire, bulb, colony, drupe, and more advanced ones like pappus and corymb. The pictorial glossary shows various leaf shapes such as arrow, halbard and heart, as well as features like bract, stipule, and tendril. Another fun feature (for beginners and experts alike) is the origin of the scientific names. For example, the hooker's orchid (*Platanthera hookeri*), is named for Sir James Hooker (p 23), and American red raspberry (*Rubus idaeus*), "of Mt Ida in Crete where Jupiter was hidden as an infant (p 168)."

The work does "increase knowledge and awareness of the diversity and beauty of the wildflowers that surround us every day (p xi)." Its main drawback is that many readers may find Wildflowers of Wisconsin difficult to work with due to the confusing identification key. However, the book's aesthetics and more than extensive inventory make this a strong compliment to other guides such as Newcomb (1989). We certainly both enjoyed leafing through it and look forward to our next encounter with flowers in the fields and woods.

-Sean Hoban and Daniel Borkowski, Department of Biological Sciences, University of Notre Dame.

References

Epstein, Eric, Emmet Judziewicz and Elizabeth Spencer. 2008. Wisconsin Natural Heritage Inventory: Recognized Natural Communities. Updated 10/13/2008, accessed 8/31/2009. http://dnr.wi.gov/org/land/er/communities/pdfs/communities.pdf

National Audubon Society. 2007. National Audubon Society Field Guide to North American Wildflowers: Eastern Region. Knopf-Doubleday Publishers.

Newcomb, Lawrence. 1989. Newcomb's Wildflower Guide. Little, Brown, and Company, Canada.

Thompson, Elizabeth H. and Eric Sorenson. 2000. Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont. The Nature Conservancy of Vermont and the Vermont Department of Fish and Wildlife, Vermont, USA.

Books Received

If you would like to review a book or books for PSB, contact the Editor, stating the book of interest and the date by which it would be reviewed (15 January, 15 April, 15 July or 15 October). E-mail psb@botany.org, call, or write as soon as you notice the book of interest in this list because they go quickly! Note that books in green are already in review and no longer available. Books received are now posted on the web site as they become available and may be requested as soon as they are posted. - Editor

The Alga Dunaliella: Biodiversity, Physiology, Genomics and Biotechnology. Ben-Amotz, Ami, Jurgen E. W. Polle, and D. V. Subba Rao (Eds.) 2009. ISBN 978-1-57808-545-3 (Cloth US$149.00) SCIENCE PUBLISHERS, P.O. Box 699 Enfield, NH 03748, USA.

Biodiversity and Ecology of Lichens. Aptroot, André, Mark R.D. Seaward and Laurens B. Sparrius. 2009. ISBN 978-3-443-58078-0 (Paper €89.00) 439 pp, J. Cramer in Gebr. Borntraeger Verlagsbuchhandlung, Johannesstrasse 3A, 70176 Stuttgart, Germany.

Botanicals: Environmental Expressions in Art. The Alisa and Isaac M. Sutton Collection. White, James J. and Lugene B. Bruno. 2009. ISBN 978-0-913196-83-0 (Paper US$35.00) 133 pp. Hunt Institute for Botanical Documentation, 5th Floor, Hunt Library, Carnegie Mellon University, 4909 Frew Street, Pittsburgh, PA 15213-3890.

Common Freshwater Algae of the United States, 2nd revised edition: An Illustrated Key to the Genera (Excluding the Diatoms). Dillard, Gary E. 2008. (Spiralbound €34.90) 188 pp. J. Cramer in Gebr. Borntraeger Verlagsbuchhandlung, Johannesstrasse 3A, 70176 Stuttgart, Germany.

Diversity of Lichenology – Anniversary Volume. Thell, Arne, Mark R.D. Seaward, and Tassilo Feuerer (eds). 2009. ISBN 978-3-443-58079-7 (Paper €124.00) J. Cramer in Gebr. Borntraeger Verlagsbuchhandlung, Johannesstrasse 3A, 70176 Stuttgart, Germany.

A Fifth Checklist of Tennessee Vascular Plants. Chester, Edward W., B. Eugene Wofford, Dwayne Estes, and Claude Baileu. 2009. ISBN 13-978-1889878-26-3 (Paper US$20.00) 102 pp. Botanical Research Institute of Texas, Inc., 500 East 4th St., Fort Worth, Texas 76102-4025.

Fossil Dicot Wood Names: An Annotated List with Full Bibliography. Gregory, M., I. Poole, and E.A. Wheeler. 2009. ISBN 978-90-71236-68-6 (Paper US$49.00) IAWA, c/o Nationaal Herbarium Nederland/Leiden University Branch, PO Box 9514, 2300 RA Leiden, The Netherlands.

Genera Orchidacearum Volume 5 Epidendroideae (Part II). Pridgeon, Alec M., Phillip Cribb, Mark W. Chase, and Finn N. Rasmussen. 2009. ISBN 9780198507130ISBN10 (Cloth US$195.00) 664 pp. Oxford University Press,198 Madison Avenue, New York, NY 10016 U.S.A.

Hybrid: The History and Science of Plant Breeding. Kingsbury, Noel. 2009. ISBN 798-0-226-43704-0 (Cloth US$35.00) 493 pp The University of Chicago Press, 1427 East 60th Street, Chicago, Illinois, 60637-2954.

Invasive Species Management: A Handbook of Principles and Techniques. Clout, Mick N. and Peter A. Williams. 2009. ISBN 978-0-19-921632-1 (Cloth £65.00) 308 pp. Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, U.K.

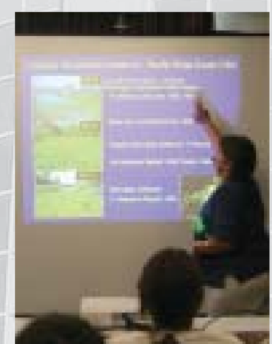
Methods in Molecular Biology, Volume 553 Plant Systems Biology. Dmitry A. Belostotsky. 2009 ISBN 978-1-60327-562-0 (Cloth US$110.00) 412 pp. Humana Press Ï% C/O Springer Science + Business Media 333 Meadowlands Pkwy Secaucus, NJ 07094 USA

Picturing Plant: An Analytical History of Botanical Illustration, 2nd ed. Saunders, Gill. 2009. ISBN 978-0-9817736-4-3 (Cloth US$50.00) 160 pp. KWS Publishers c/o The University of Chicago Press, 1427 E. 60th Street, Chicago, Illinois 60637.

A Rare Botanical Legacy: The Contributions of Ruby and Arthur Van Deventer. Bennett, R. and Susan Calla (editors). 2009. ISBN 978-1-59714-116-1 (Cloth US$35.00) 160 pp. Heyday Books, P.O. Box 9145, Berkeley, CA 94709.

Seed Dispersal by Bats in the Neotropics. Lobova, Tatyana A., Cullen K. Geiselman, and Scott A. Mori. 2009 ISBN 978-0-89327-501-3 (Cloth US$70.00) 492 pp. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, NY 10458-5126.

Weedy and Invasive Plant Genomics. Stewartm C, Neal. 2009. ISBN 978-0-8138-288-4 (Cloth US$199.99) 253pp. Wiley-Blackwell Publishing, 2121 State Avenue, Ames, Iowa 50014-8300.



Save the Date

Start Planning Now

Get Connected, Make Connections, Stay Connected
with the Botanical Community

Speakers, Posters,
Field Trips, Exhibits, Special
Events & More

Special Discounts for Students

Abstract Submission Site
opens January 2010

www.2010.botanyconference.org