Botanical Society Of America

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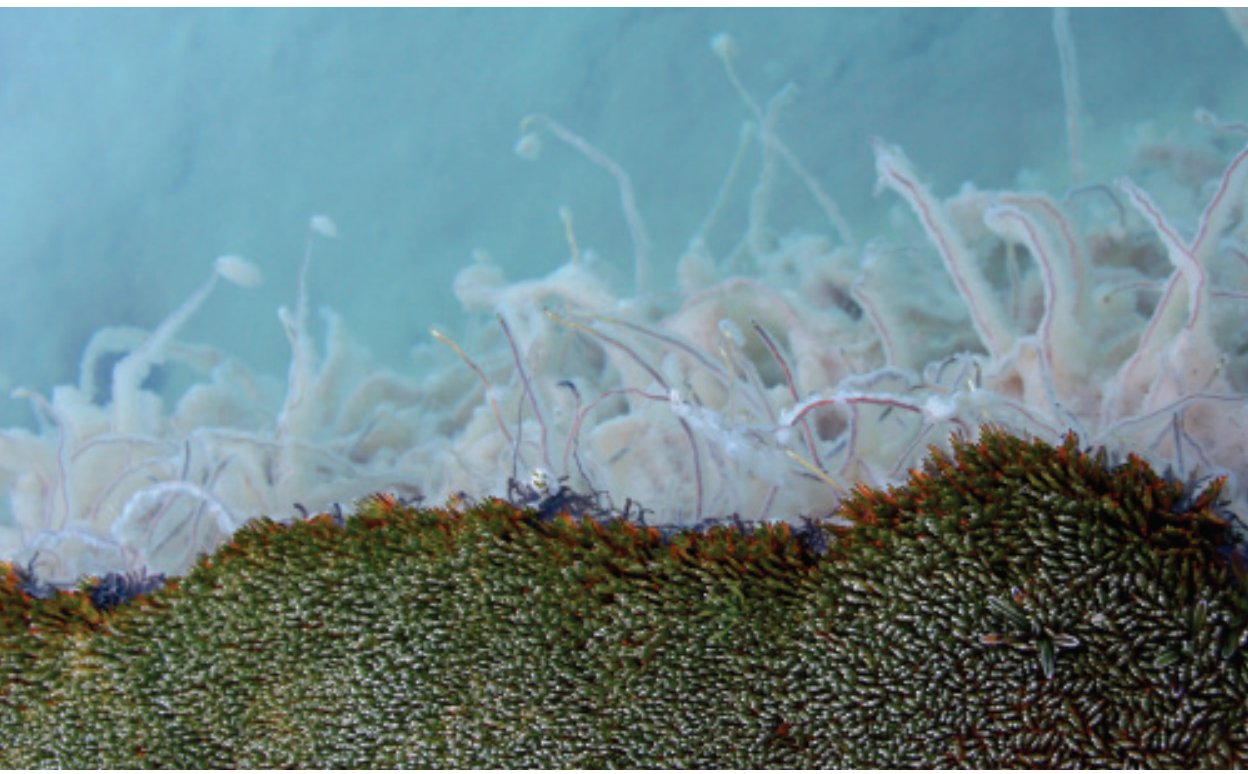


A crystal pond surrounded by cushion plants (Distichia muscoides Nees & Meyen) provides the playground for Nature to play with shapes and colors beyond the imagination. See Inside back cover for the scientific description.

In This Issue.....

Oldenberg &Van Leeuwenhoek at the 1994 BSA annual meeting. Read more on page15

Student's respond to Federal Policymakers go to page 2

Dr. Elsie Quarterman celebrates her 100th birthday see page 11

From the Editor

The *Plant Science Bulletin (PSB)* is starting the year with a new look and high expectations for raising botanical awareness in the public consciousness. For the past few years several of us have been representing the Society on the advisory board of the Botanical Capacity Assessment Project. Through that involvement it became clear that professional botanists in all sectors, including academe, must become more proactive in promoting our discipline to the general public and to policy makers in the government and federal agencies. In last year's issues of *PSB* you may have noticed letters from Past-President Holsinger, sent on behalf of the Society, to key agencies and administrators to provide input on legislation and spending. In this issue I'm pleased to recognize the initiative of our youngest members, whose "An open letter to federal policymakers from science students" is now being promoted by AIBS as a vehicle for all science students to influence policy makers. Forward the link to your students and encourage them to contribute - - then think about ways you, and the Society, can become more effective lobbyists for botany.

Also in this issue is a tribute to the late Professor Larry Crockett, who used history and art to great effect in teaching botany. He opened my eyes to the botanical contributions of Antoni van Leeuwenhoek, which are invariably neglected in textbooks. I hope you will find this brief review of the great microscopist's botanical discoveries to be enlightening and useful in your teaching.

-Marsh

Table of Contents

On "An open letter to federal policymakers from science students"

By Rachel Meyer, student representative of the BSA

I have always been impressed with the energy of the students in the Botanical Society of America. Perhaps what makes this society so special is that the student body is very dedicated to help shape the BSA, and likewise, the BSA is always looking for ways to get students involved and to give them a voice. The result is a community network that transitions very quickly from idea to product.

The power of this network is beautifully exemplified by the open letter from students carrying the message that the US needs not only to continue, but to strengthen, their investment in scientific research and education. It started with one student posting a message to the new student listserv. It was about the need to respond to the YouCut program, which targeted the National Science Foundation's system of funding research grants and choice of research projects that deserve this funding. Several students responded, formed a group, and wrote a detailed letter on this issue as a response.

That letter can be viewed at this link:

http://botany.org/BSA_Students-NSF-12162010.pdf

When the BSA office received news of this student initiative, they immediately were looking for ways to maximize the potential impact of the letter. They also wanted to seize the opportunity for students to learn about how our government works. When large groups of people come together with a message to their representatives, they can be influential. Bill Dahl put me in touch with Robert Gropp from the American Institute of Biological Sciences. We immediately began brainstorming ways the letter could be signed by thousands of students across the country and sent to potentially hundreds of people in politics.

Working with AIBS and the original group of students who wrote the letter, we put together the petition that is now being circulated among student members of dozens of scientific societies. We are acquiring a large number of signatures (in the first week we had already gained 400). As the number of signatures grows, we can use the petition to communicate the change that students want to see: that by prioritizing science education and research opportunity, the US can be a leader in innovation. Statistics on the current state of education in this country are evidence that this leadership position is not guaranteed in the future of this country.

I want to acknowledge the leadership and dedication of the team of students that came together to take action. You have inspired me about what is possible to accomplish. You have also established an example, that future students can follow, about how students can use the BSA community to help bring their ideas to fruition.

Please help the number of signatures on the petition grow by signing and distributing the letter available through this link:

http://www.aibs.org/public-policy/science_students_letter.html

Anecdotes:

When one of the faculty at UGA mass e-mailed the YouCut video, which suggested that citizens re-review NSF projects as a way to "cut government waste," some of our lab members had a brief discussion that basically amounted to our all shaking our heads and saying, "somebody oughtta...." After silence from other quarters, I realized "somebody" might have to start with me. I approached the BSA student section with the idea of writing an open letter and was grateful to find others who had similar concerns. It's been enlightening to work with such a thoughtful group of scientists who are passionate about science policy, and who can transform ideas into wording that is concise, accessible, and politically even-handed.

--from Lindsay Tuominen

In the age of information, it is often difficult for issues to seem immediate or engaging. But when a fellow student sent an e-mail out to the BSA student listserv about the proposed "YouCut" NSF budget cuts, I felt like we had to do something, not just as students interested in our own funding but as members of the larger scientific community. Others felt similarly, and soon this issue had connected students from all across the United States, joining us together in a discussion of what should be done. Though we are students from various fields and

backgrounds, we collaborated together to formulate a nonpartisan response to this attack on the scientific community and the progress of our nation.
--from Natalie Ma

When I saw the YouCut website, my first inclination was to jump on Facebook and post my distaste for the measure. When the opportunity came to be a part of something larger than a Facebook rant, I was extremely excited. Working with a group of young scientists who harbor a dedication to the future of scientific research was an amazing experience that I hope to repeat. Misinformation is a constant phenomenon in the world today and it makes me feel accomplished to have been a part of a movement that seeks to fight misunderstanding. My fellow BSA Student Action Panel members are amazing and show a true understanding of issues affecting students, researchers and our scientific culture. I am very grateful to them and to BSA for being so supportive of students seeking to make a difference.

--from Michael McKain

Although I was unable to participate as much in the earlier part of this process, I was truly impressed by the way this group of students came together to take action on such an important issue. Later on I joined their efforts in editing the letter and getting it out to students across the country. Using a list of scientific societies compiled by the BSA student group, I contacted science policy officers from 21 societies asking them to forward our open letter to their own student membership. Several of them replied immediately saying they were forwarding the message and thanking BSA students for their leadership and efforts. One society's president had already sent the action link to their students before we even contacted them! Another society representative thanked us and shared some of their own activism efforts with us, which we will pass onto BSA students. It is a great feeling to see our message being spread across varying disciplines, encouraging more interactions between us, and to see that science students across America can come together in support of political activism that will benefit our (and future) generations of scientists, and our country as a whole. I'm honored to be a part of this terrific group of BSA students who started it all.

--Marian Chau, student representative of the BSA

Open Science Network

The Open Science Network (OSN) is a National Science Foundation funded project, coordinated by the Botanical Research Institute at Texas. OSN has been leading pioneering work to promote worldwide collaboration between ethnobiologists through the continual exchange and enrichment of educational techniques, materials, and experiences. This Network champions open educational resources and uses the latest web technologies to encourage sharing, generation, and management of educational tools and curriculum for the traditional and non-traditional classroom. Ethnobiological teaching resources have been made openly available by researchers and educators based at the University of Hawai'i at Manoa, Frostburg State University, University of South Carolina, University of Arkansas for Medical Sciences, and University of Kent among others. Everyone is encouraged to visit the homepage[1], to explore the modules and curriculum posted, as well as contribute resources of their own.

We will be hosting an educational colloquia titled *Sharing Our Ethnobotany Curriculum: the Open Science Approach* at the 2011 societal meetings of the Society for Economic Botany and Botanical Society of America in St. Louis, Missouri. Presentations will emphasize the importance of sharing information and resources among colleagues; demonstrate the need for peer and student assessments of curricula in order to maintain fresh and creative ideas in the field; and touch on how the creation of open technology has allowed the spread of ideas to the far corners of the globe. Participants will be introduced to the web-based portal and instructed how to use and contribute to its curriculum resources.

OSN has several travel awards available for any interested educators, students and researchers that would like to attend and participate in OSN's 2011 annual meeting. The deadline for these travel awards is February 22nd. For more information regarding these awards or the Network, please visit us at our WiserEarth page[2].

*Keri Barfield (*kbarfield@brit.org*) &*
*Sofia Vougioukalou (*S.A.Vougioukalou@kent.ac.uk*)*

Links to websites:
Homepage- www.opensciencenetwork.net
WiserEarth- http://www.wiserearth.org/group/opensci_ethnobiology

Science Prize for Inquiry-Based Instruction

Have you ever actively participated in a science lab that left a lasting impact on you? Have you ever taught an interactive science lab and watched as students lit up with understanding? Science would like to recognize efforts such as these with the Science Prize for Inquiry-Based Instruction, which has been established to encourage innovation and excellence in education by recognizing outstanding, inquiry-based science education modules. The prize is open to any module where students become invested in exploring questions through activities that are at least partially of their own design. Rather than a typical laboratory exercise that begins with an explanation and results in one correct answer, an inquiry-based lesson might begin with a scenario or question and then require students to propose possible solutions and design some of their own experiments.

Winners will be selected by the editors of Science with the assistance of a judging panel composed of teachers and researchers in the relevant science fields. Individuals responsible for the development of the winning resources will be invited to write a short essay that describes the resource for publication in Science in 2012. We encourage all members of the scientific community to explore their classrooms, departments, colleges, and universities for nominations in order for the Science Prize for Inquiry-Based Instruction to truly represent the best in science education.

To read the accompanying Editorial please visit http://www.sciencemag.org/content/331/6013/10.full

For more information and to download applications please visit http://scim.ag/inquiryprize

Please contact Dr. Melissa McCartney at mmccartn@aaas.org with any questions.

Melissa McCartney, PhD, Editorial Fellow, Science Editorial, 202-285-0300

SCIENCE: www.sciencemag.org
SPORE: www.sciencemag.org/special/spore/
AAAS- Advancing science, Serving society

Historical Section Announcement for BOTANY 2011

At Botany 2011 in St. Louis, Missouri this summer, the BSA Historical Section and co-sponsoring sections will present a symposium featuring area botanists. Our decision was based on the positive feedback we received from similar symposia organized by the Historical Section in Chicago, at Botany 2007 and in Rhode Island for Botany 2010. We invite you to attend our symposium (see below) and join the exciting field trip on a behind the scenes look at the extensive library and herbarium collections at the Missouri Botanical Garden.

HISTORY OF BOTANY: THE MISSOURI CONNECTION

Joint symposium with the Historical, Developmental and Structural, Ecology, Economic Botany, Paleobotanical Southeastern and Systematics Sections.

Nuala Caomhanach - "Thomas Nuttall and 19th Century Botany: The St. Louis Connection"

Michael Long - "George Engelmann's Fortunate Connections

Deborah Q. Lewis and Lynn G. Clark - "A.S. Hitchcock"

Kim Kleinman - "Edgar Anderson, The Missouri Botanical Garden, & the Rise of Biosystematics"

Betty Smocovitis - "Joseph Ewan and the Cinchona Missions in Latin America, 1942-1945"

Dennis Stevenson - "William J. Robbins: The Missouri Years"

Edward Coe - "Lewis J. Stadler: The Nature of the Gene, and a Clue to DNA"

Lee B. Kass - "Barbara McClintock at the University of Missouri (1936-1942): The Road to Transposition"

Following the symposium there will be a field trip to the Missouri Botanical Garden entitled "Exploring George Engelmann's Legacy: The Missouri Botanical Garden Library and Herbarium"

The Historical Section encourages paper/poster session contributors. Each year the Emanuel D. Rudolph award is given for the best student presentation on an historical subject; this is a cash award with a complementary banquet ticket.

For additional information please contact the Symposium Committee:
Marissa C. J. Grant, mgrant39493@lakeland.cc.il.us
or Lee B. Kass, lbk7@cornell.edu

BSA Science Education News & 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

PlantingScience Spring 2011 Session and Program Happenings.

January is National Mentoring Month http://www.nationalmentoringmonth.org/ . Celebrate by committing to mentor middle school or high school teams as they conduct plant inquiries in the **Spring 2011 Session.** It will run **14 Feb. to 15 Apr. 2011**). Last fall brought together 177 scientists, 289 student teams, and 30 teachers to collaborate online. We anticipate another exciting session this spring. New this spring will be an international collaboration between Florida and Dutch schools.

Inquiry teaching and learning in school settings often presents significant challenges, but PlantingScience teachers are seeking ways to enrich the experience. Do you wonder what your volunteer service as an online mentor offers? Participating teachers share the value of your collaborations with classrooms in these quotes:

"I am a much better teacher because of this program...it let my kids enter the classroom as working lab technicians instead of students ...they came into class ready to go, prepared to do science."

"At every opportunity, all involved kept reminding my students of the process that real science requires. This helped me to convince my students that they are really doing science - not just play acting until some future date."

"While I sometimes get frustrated with the level of effort applied by my students I believe that the end result is worth all the drama. I had several questions this year that came very close to my goal of valid scientific inquiry."

PlantingScience Presentations and Meetings

January 14, 2011. ***NIBI, The Netherlands*** Edith Jonkers, leading the independent Dutch PlantingScience counterpart, will describe PlantingScience to Dutch biology teachers.

January 19-22, 2011. **Minneapolis, MN: Association for Science Teacher Education** PlantingScience Co-PI Carol Stuessy and her graduate students from Texas A&M University present two sessions "Where the Rubber Meets the Road in Authentic Science Learning Contexts: Professional Learning to Classroom Implementation" and "Applying the Online Elements of Inquiry Checklist."

February 3, 2011. **Washington, DC: DC Teachers Night**

Katie Engen, ASPB Education Foundation, will have a hands-on booth to share ASPB activities and information about the PlantingScience Spring Online Session and Summer Institute for Teachers.

March 8-9, 2011. **Berkeley, CA: Cyberlearning Tools for STEM Education (CyTSE) Conference** Claire Hemingway will have hands-on demonstration session at this NSF-sponsored meeting on K-12 STEM cyberlearning tools.

March 10-13, 2011. **San Francisco, CA: NSTA Conference**

Visit us at the booth or attend the March 11 2-3 pm session on "Using Dialogue and Art to Enhance Science Inquiry and Make Student Thinking Visible" with PlantingScience teachers Carol Packard and Allison Landry and botanist/botanical illustrator Jeanne Debons.

Do you have news or activities you'd like to share with the PlantingScience community? Please let us know!

PlantingScience Summer Institute for Teachers
June 23-30, 2011. Held at Texas A&M University, College Station, TX.

High school and middle school teachers, we invite you to join botanists **Marsh Sundberg** and **Larry Griffing** and teachers from across the country to explore plant investigations and inquiry learning in community. This summer we will focus on plant physiology and *Arabidopsis* genetics, and you'll have the opportunity to develop a plan to take any of new or existing inquiry modules to your classroom. The Institute also offers opportunities to immerse in the inquiry experience, engage in the online platform, and share strategies for supporting team inquiries. Stipends, housing and travel allowances provided.

Apply online by April 4, 2011. See www.PlantingScience.org to download a brochure.

http://www.plantingscience.org/institute-application.html

Science Education Bits and Bobs

Mixed PISA Results, Scores Improve but High Achievers Still Scarce in Science — The December 2010 release the most recent data on the Program for International Student Assessment (PISA) reiterate the lower than top performance of U.S. students compared to other nations in reading, math, and science literacy. Compared to the last round of PISA data collected in 2006, US students' science scores for 15-year-olds improved, and the U.S. average score in science literacy in 2009 is now not measurably different from the average for other OECD countries. Countries with higher average science scores than the US include: Finland, Japan, Korea, New Zealand, Canada, Estonia, Australia, the Netherlands, Germany, Switzerland, the United Kingdom, and Slovenia. Proficiency in science literacy is described by PISA according to levels ranging from 1 to the most advanced of 6. 29% of US students scored at a level 4 in science proficiency.

PISA Report
http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2011004

8-10 year-old U.K. Students Publish Bee Visual Perception Research — What can you do with curiosity about the natural world, access to science experts, and a few simple rules to a game? Publish real science for starters. Students in the Blackawton Primary School, their headteacher, and a vision researcher from University College London collaborated on a study of bee vision and behavior. While the researcher trained the bees in the study, the students asked the key questions, hypothesized possible answers, designed experiment features, analyzed the data and contributed to the manuscript by drawing the figures and describing their key findings. This novel publication in "kids speak" speaks volumes about the power of curiosity and creativity to fuel science discovery at any age.

See Biology Letters published online 22 December 2010

http://rsbl.royalsocietypublishing.org/content/early/2010/12/18/rsbl.2010.1056

How much undergraduate learning takes place on college campuses? — During the first two years of college, some 45% of students surveyed showed no significant gains in critical thinking, complex reasoning, and written communication. Over four years of college, 36% of students still had no gains in these critical areas. Academic rigor and administration priorities play significant roles according to the Social Science Research Council, which released the *Improving Undergraduate Learning: Findings and Policy Recommendations from the College Learning Assessment Longitudinal study* and an associated book on the findings, *Academically Adrift: Limited Learning on College Campuses*. Student participation in learning was not left out of the equation, with study habits and greater valuation of degree credentials than knowledge seeking identified as detractors.

Art Instruction in the Botany Lab: A Collaborative Approach

Baldwin Lyn and Ila Crawford. 2010. *Journal of College Science Teaching* 40: 26-31.

"Good observations are often fundamental to good science, and drawing has long been recognized as a tool to develop students' observation skills." If you agree with this, the first sentence of the abstract, you'll want to read the entire article and consider establishing a collaboration at your institution.

College Students' Understanding of the Carbon Cycle: Contrasting Principle-based and Informal Reasoning

Hartley, Laurel M., Brook J. Wilke, Jonathon W. Schramm, Charlene D'Avanzo, and Charles W. Anderson. 2011. *BioScience 61: 65-75.*

Like the next article, this one is about carbon cycle misconceptions, but it provides a sound educational theory basis to attacking the problem. The tables will be particularly useful in helping you to identify misconceptions and how to address that with your students.

Dust Thou Art Not & unto Dust Thou Shan't Return: Common Mistakes in Teaching Biogeochemical Cycles

O'Connell, Dan**.** 2010. *The American Biology Teacher* 72: 552-556.

I've recommended several articles dealing with misconceptions about the Carbon Cycle in the past and here's another one, treated in a slightly different way, that will provide you with some additional information as you strive to help your students to develop a more sophisticated understanding of this concept.

Viewing Plant Systematics through a Lens of Plant Compensatory Growth

Rea, Roy V. and Hugues B. Massicotte. 2010. *The American Biology Teacher* 72:541-544.

Variability and phenotypic plasticity in nature are difficult concepts for all students, but especially for new students beginning their observations in nature. What we seldom think about in our teaching is now the phenomenon of compensatory growth can be used to illustrate these two difficult concepts. The authors condense multiple years worth of data and experience to demonstrate the extreme range of morphology associated with compensatory growth.

Congratulations to
PlantingScience Teacher
Gwen Foote
Nautilus Middle School
Teacher of the Year!

"In the biblical account in Genesis of the Noachian Flood, only the animals were taken two by two onto the Ark. I well remember that I was about twelve years old when the subject came up in Sunday School, and I wondered out loud what became of the all the plants, most of which could not have survived underwater. You know how literal-minded young boys can be. I think it was about this time that the teacher sent a note to my parents, suggesting that I might better spend my Sunday mornings elsewhere than in Sunday School."

-Neil A. Harriman, Biology Department, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin 54901

Frederick W. Case Jr. 1927-2011

Well known teacher and botanist passed away Wednesday, January 12, 2011. Age 83 years. The son of the late Julia Blanche (Coash) and Frederick W. Case Sr. was born February 16, 1927 in Saginaw, Michigan. He married Roberta Elizabeth (Boots) Burckhardt, February 14, 1953. She passed away June 8, 1998. He was a graduate of Arthur Hill High School and received his

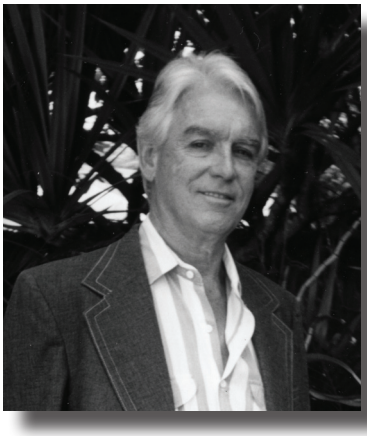
Bachelor of Science and Master's in Education from the University of Michigan. He served with the U.S. Army during WWII. He returned to Arthur Hill High where he taught biology and natural science until his retirement. He was named their Honor Alumnus in 1978. He was named the Outstanding Biology Teacher in Michigan in 1971 and Outstanding Science Teacher in 1987. Fred and Roberta authored three books and authored or co-authored many articles for magazines and scientific publications about native orchids, trilliums, insectivorous plants, wildflowers and gardening. He received numerous awards and recognition for his achievements in botany and lectured extensively. He had been associated with Cranbrook Institute of Science, The University of Michigan Matthaei Botanical Gardens, Longwood Gardens, The Michigan Dept. of Natural Resources Committee on Endangered and Threatened Plants, the Michigan Botanical Club, North American Rock Garden Society, the Saginaw Valley Audubon Society, Saginaw Valley Orchid Society, The Nature Conservancy, Michigan Nature Association, and many other horticultural groups. He enjoyed opera, theatre, reading, traveling, fine dining and Ketchup.

Surviving are a son and daughter-in-law, David B. and Sheri Leaman Case; three granddaughters, Rebecca Case Myers and her husband Chris Myers; Emily Case and her fiancée, David Krueger, Caitlyn Case; a brother, a sister and two sisters-in-law, Win L. and Mary Case; Nancy Cota and Patricia Burckhardt; nine nieces, Julie Swieczkowski, Mary Lou Case, Susan Case, Kathy Case, Caroline Orsini, Amy Case, Jennifer Ashby, Amy Busch, Lisa Bulmer, two nephews, Stephen Cota, Bob Burckhardt; his lifelong friend, George L. Burrows IV; several grand nieces, grand nephews, cousins, other relatives, many dear and loyal friends. He was Pre-deceased by two brothers-in-law, Andrew Cota and Carl Burckhardt and a niece, Debbie Kress. A special thank you to his caregiver, Hazel Irvin, for her assistance during his nearly two years of declining health.

Those planning an expression of sympathy may wish to consider the Nature Conservancy of Alabama, Roberta Case-Pine Hill

Reserve, the Michigan Nature Association, the Children's Zoo at Celebration Square, or the charity of their choice. www.casefuneralhome.com

-Carolyn M. Wetzel, Smith College, Northampton, MA 01063



William Julian Koch (1925 – 2009)

William Julian Koch, age 85, retired Professor of Botany at the University of North Carolina at Chapel Hill, died 17 July 2009 at his home in Glendale, AZ, after a brief illness.

William was the fourth of four sons of Frederick Henry Koch, a pioneer of folk drama in the United States and the founder of Playmakers Theatre at UNC, and Loretta Regina Hanigan, a housewife. A native Chapel Hill, William attended the local public schools. At UNC he earned three degrees in botany: B.A. (1947), M.A. (1950), and Ph.D. (1956). Interrupting his academic studies, he served in the United States Navy (1943-1946).

Koch conducted his graduate research in mycology under the guidance of world renowned mycologist John N. Couch who inspired William's scientific investigations. While a graduate student, he was an assistant and instructor, both in botany. His master's thesis concerned "A study of the motile cells of *Vaucheria*," and his dissertation dealt with "Studies in the Chytridiales, with special reference to the structure, movement and systematic significance of the swimming reproductive cell." After earning his doctorate, he joined the faculty in the Department of Botany at UNC, advancing in the academic ranks to professor. His early research concerned a group of water molds, chytrids, on which he published a series of papers in scientific journals. When he was asked to assume a heavy teaching load, he shifted his focus from fungi to humans, especially undergraduates.

His lively and inspiring classes were always aimed at stimulating students' innate curiosity for knowledge. When teaching a class about edible plants, William would bring samples for tasting, and he was known for waking up students by pouring dried leaves over them. Many of his classes started with music appropriate to the theme of the lecture: Vivaldi's "The Four Seasons" played at the beginning of the class in which changes of trees during the year took place; and the song "John Barleycorn," prefaced the class in which fermentation, including the brewing of beer, took place. His other primary courses were introductory botany, plant diversity, introductory mycology, and advanced mycology. He wrote several textbooks and laboratory manuals to accompany his courses, which he designed to arouse an interest in students and to closely follow his philosophy of teaching (a humanistic approach).

William's innovative teaching, genuine enthusiasm, and engaging personality earned him respect with students who twice honored him as a featured faculty member in the school's yearbook, *Yackety Yack*, and celebrated a "Willie Koch Day" on the UNC campus in 1975. Researchers acknowledged his role as a scientist through such tributes as naming a genus of fungus, *Kochiomyces*, for him in 1980.

William held memberships in a number of professional associations. He held offices in several of them, including the Botanical Society of America (Chairman, Microbiology Section, 1963-1964; Education Committee, 1978-1980), Elisha Mitchell Scientific Society (Vice-president, 1960 and 1974; Recording Secretary, 1961-1967), and Mycological Society of America (Committee on Research Grants and Publications). In honorary societies he was elected to Sigma Xi and held several offices in its UNC chapter: Vice-president, 1966-1967; Executive Committee; Nominating Committee, 1976; and Membership Committee, 1975-1978.

In the summer of 1986, William retired to Pembroke Pines, FL, along with his wife, Dott. He worked there with handicapped children, and as a movie actor and model. Subsequently, they relocated to Glendale, AZ. He then pursued the visual arts and created computer images of the natural world. He also published a book and a separate CD (Plant Close-ups: Designs, 2007) that featured 82 color photographs accompanied by personal comments. Interested in the state of the country, he and his wife volunteered for one year at the Arizona governor's office to become better acquainted with societal problems and possible solutions. In his retirement settings, the local vegetation captivated William's curiosity, just as he had captivated so many students at the University of North Carolina.

His wife Dorothy "Dott" (Clarke) Koch of Roseville, CA, survived William at the time of his death, but she died in 2010. Current survivors include three daughters, Patricia Margolis of Redondo Beach, CA, Jean Austin of Jonesborough, TN, and Deb Plylar of Phoenix, AZ; one son, David "DK" Koch of Lincoln, CA; ten grandchildren; and three great grandchildren.

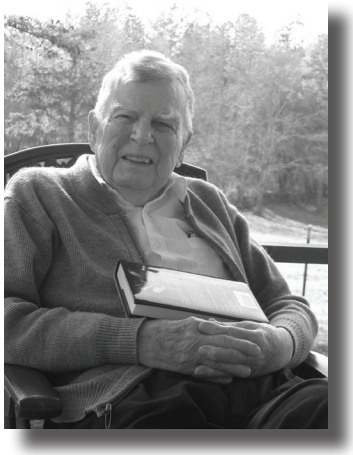
William was cremated, and his ashes have not been spread.

A List of the Graduate Students of William J. Koch and Their Theses.

- Bernstein, Linda Beryl. 1966. A biosystematic study of eight isolates of *Rhizophlyctis rosea* with emphasis on zoospore variability. M.A.
- Bostick, Linda Roane. 1966. Studies of the morphology and cytology of *Chytriomyces hyalinus* Karling. M.A.
- Clausz, John C. 1965. Some factors affecting germination of oospores of *Achlya hypogyna*. M.A.
- McNitt, Rand Edwin. 1973. Light and electron microscopy of *Phlycochytrium irregulare* Koch. Ph.D. (co-advisor Lindsay S. Olive)
- Powell, Martha J. 1974. Developmental studies of the chytrid *Entophlyctis variabile* sp.n. : A light and electron microscopic investigation. Ph.D.
- Register, Thomas Eugene. 1959. Morphological variation in a new species of *Phlyctochytrium*. M.A.
- Senior, Laura B. 1981. Study of the mycorrhizal organs of *Tipularia discolor*, the crippled crane fly orchid. M.S.

- Tingle, Constance L. 1972. Some physiological aspects of oogonia formation in *Saprolegnia diclina*. M.A.

-Prepared by William R. Burk, friend and fellow mycologist.



Charles H. Uhl (1918 – 2010)

Charles H. Uhl, professor emeritus of Plant Biology, died Aug. 29, 2010, in Jefferson, GA. He was 92.

Born May 28, 1918, in Schenectady, NY, Charlie moved to Georgia at the age of nine. He earned his B.A. (1939) and M.A. (1941) from Emory University, and his Ph.D. from Cornell in 1947. As for many of his generation, his education was disrupted by World War II. He served in the U.S. Navy from 1942-1946 first as an ensign, then as an executive officer and Lieutenant. He was one of three officers on a standard landing craft, none of whom had any marine experience other than the few months training provided by a wartime navy. Nonetheless, under orders, he and his crew were able to successfully guide their small lumbering boat, without escort and continuously out of sight of land, some 5000 miles across the Pacific to tiny Bora Bora using only a sextant (no GPS in those days!). He and his crew went on to participate in combat operations in the Asiatic-Pacific Theater in New Guinea, the Philippines, and Borneo. Charlie wrote a history of his experiences in the book *USS LCI volume II*. After the war, Dr. Uhl finished his degree and joined the faculty at Cornell in 1947. For many years Charlie was recognized as the expert on cytogenetics of the stonecrop family (Crassulaceae) and published over 80 papers in the field between 1943 and 2004. He created and documented over 1500 specific and generic hybrids in the family. He holds the record for the highest number of chromosomes ever counted in an angiosperm, n = 320 (or a diploid number of 640 chromosomes), for *Sedum suaveolens.* Although best known for his work on hybridization and polyploidy, he had wide-ranging interests and applied his findings to taxonomic questions such as the delimitation of species and genera as well as the phylogenetic relationships among them. He was also fascinated with biogeographic questions and published his observations on the effect of the San Andreas Fault on speciation in stonecrops. His work is still having an impact on young researchers as demonstrated by a recent paper in the American Journal of Botany that was dedicated to Dr. Uhl.

His family fondly remembers many field trips to the western U.S. and Mexico to collect succulents for his research. Over the years, he contributed several thousand plant specimens to the L. H. Bailey Hortorium, both from these field trips and from his laboratory experiments. In 1985 he was elected an honorary fellow of the Cactus and Succulent Society for exceptional achievement in scholarship about succulent plants. In addition to his research, Charlie is remembered by many as an excellent teacher of Cytology, Cytogenetics, and Microtechnique. His labs were well known for having a superb collection of cytological preparations, and for his enthusiastic participation. He chaired the graduate degree committees of a number of students in cytology and served on the committees of many others in the fields of both plant biology and plant breeding. He was also famous for asking probing questions at departmental seminars where his breadth of knowledge was apparent to all.

Among Dr. Uhl's outside interests was stamp collecting and he was a longtime member of the Ithaca Stamp Club and American Philatelic Society. No one in plant biology threw away envelopes from afar without removing the stamp and handing it off to Charlie. Charlie had the opportunity as a child to see the Cyclorama, a 42-foot high cylindrical oil painting depicting the Civil War Battle of Atlanta, which at that time was narrated by some of the last living confederate soldiers. This experience stoked a life long interest in the civil war.

Charlie is survived by his wife of 65 years, Natalie Whitford Uhl, also a Cornell emeritus professor; his four children Natalie Jean of Las Vegas, New Mexico; Mary of York, England; Charles Jr. of Pittsburg, Pennsylvania, and Elizabeth of Athens, Georgia; and three grandchildren, Toby, Hugh, and Amy .

-Melissa A Luckow

Dr. Elsie Quarterman

Dr. Elsie Quarterman celebrated her 100th birthday on November 28, 2010. She grew up in southern Georgia and graduated from what is now Valdosta State University. While teaching high school in Georgia during the 1930's she attended Duke University in the summers, completing her master's degree in plant ecology under Henry J. Oosting. In 1943 she took a temporary position at Vanderbilt University (Nashville, TN), becoming one of the first female faculty members. Her position became permanent and she stayed for 33 years, retiring in 1976. Her Ph. D. dissertation titled "Ecology of the Cedar Glades of Middle Tennessee" was completed under Oosting's direction in 1950.

She met Catherine Keever at Duke in the 1930's and they began a life-long friendship and research collaboration. Dr. Keever, a specialist in old field succession, taught at what is now Millersville State University in Pennsylvania. Their most important joint work—completed after several hot summers of field work—resulted in a 1962 Ecological Monographs paper titled "Southern mixed hardwood forest: climax in the southeastern Coastal Plain, U. S. A." In addition to cedar glade ecology, Dr. Quarterman's 30-plus publications include papers on a wide variety of topics, from bryophytes to forest succession to seed germination.

Always a conservationist, she became more active after retirement and has received numerous awards for her efforts to preserve and protect unique and endangered habitats in Tennessee. Among these are the Oak Leaf Award from the Tennessee Chapter of the Nature Conservancy, a Lifetime Environmental and Conservation Achievement Award from the Tennessee Department of Environmental Conservation and the Sol Feinstein Environmental Award from the College of Environmental Science and Forestry of the State University of New York.

Nearly all of her graduate students did ecological research on cedar glade plants. Among her graduate students are Stewart Ware, Professor Emeritus of the College of William and Mary, Thomas Hemmerly, Professor Emeritus of Middle Tennessee State University, Douglas Waits, Professor Emeritus of Birmingham-Southern College, Gail Baker of Northwest Florida State College, and internationally known seed germination ecologists Carol Baskin and Jerry Baskin of the University of Kentucky.

- Gail S. Baker, Ph. D.

Photo Caption: Left to right: Front row, Carol Baskin, Elsie Quarterman, Gail Baker; back row , Jerry Baskin, Tom Hemmerly.

microMORPH Grants

microMORPH is pleased to announce a funding opportunity for undergraduates ($5,000), graduates students, postdoctorals, and assistant professors ($3,500) in plant development or plant evolution. These grants are available to support cross-disciplinary visits between labs or institutions for a period of a few weeks to an entire semester. We are particularly interested in proposals that will add a developmental perspective to a study of evolution of populations or closely related species. We are also interested in developmental studies that will incorporate the evolution of populations or closely related species. The deadline for proposals is March 1st, 2011. More information about the training grants and the application process may be found on the microMORPH website:

http://www.colorado.edu/eeb/microMORPH/grantsandfunding.html

To be eligible for microMORPH training grants, applicants must fill at least one of the following criteria: 1) be a U.S. citizen, or 2) be affiliated with (enrolled in a degree granting program or employed by) a U.S. college, university, or institution, or 3) propose to train in and be hosted by a lab at a U.S. college, university, or institution.

These internships are supported by a five-year grant from the National Science Foundation entitled microMORPH: Molecular and Organismic Research in Plant History. This grant is funded through the Research Coordination Network Program at NSF. The overarching goal of the microMORPH RCN is to study speciation and the diversification of plants by linking genes through development to morphology, and ultimately to adaptation and fitness, within the dynamic context of natural populations and closely related species.

If you would prefer not to receive any more emails from me about the microMORPH RCN, please email me back with the word "NO" in the subject line and I will remove you from the mailing list. I will use this list for occasional updates on funding opportunities through the microMORPH RCN, and yearly workshops hosted by microMORPH.

Sincerely,

Pamela K. Diggle (Pamela.diggle@colorado.edu)

Ned Friedman (ned@colorado.edu)

2011 Seminars on at the Humboldt Institute on the coast of Maine!

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May 29 - Jun 4	Crustose Lichens: Identification Using Morphology, Anatomy, and Simple Chemistry. Irwin M. Brodo.
Jun 5 - 11	Bryophytes and Bryophyte Ecology Nancy G. Slack.
Jun 12 - 18	The Lichen Genera Rhizocarpon, Fuscidea, Porpidia, and Other Lecideoid Lichens. Alan Fryday.
Jun 26 - July 2	Applied Field Identification of Sedges and Rushes. Andrew L. Hipp.
Jun 26 - July 2	Aquatic Flowering Plants. C. Barre Hellquist.
Jul 3 - 9	The Genus Carex: Advanced Taxonomy and Ecology. Anton A. Reznicek.
Jul 3 - 9	Botanical Latin for Application and Enjoyment. Steven R. Hill.
Jul 24 - 30	Botanical Illustration: Sketching and Painting Wildflowers in Their Natural Environment. Angela Mirro.
Jul 31 - Aug 6	Flora of Maine Coastal Habitats and Islands. Glen H. Mittelhauser.
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In support of field biologists, modern field naturalists, and students of the natural history sciences, Eagle Hill offers specialty seminars and workshops at different ecological scales for those who are interested in understanding, addressing, and solving complex ecological questions. Seminars topics range from watershed level subjects, and subjects in classical ecology, to highly specialized seminars in advanced biology, taxonomy, and ecological restoration. Eagle Hill has long been recognized as offering hard-to-find seminars and workshops which provide important opportunities for training and meeting others who are likewise dedicated to the study of the natural history sciences.

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MSc Degree/Postgraduate Diploma in the Biodiversity and Taxonomy of Plants

Royal Botanic Gardens Edinburgh/ University of Edinburgh

Programme Philosophy

The MSc in Biodiversity and Taxonomy of Plants was established by the University of Edinburgh and the Royal Botanic Garden Edinburgh (RBGE) to address the growing worldwide demand for trained plant taxonomists and whole-plant scientists. A detailed knowledge of plants and habitats is fundamental to their effective conservation. To communicate such knowledge accurately and effectively, training is required in plant taxonomy – the discipline devoted to plant diversity and evolution, relationships, and nomenclature. The MSc is perfect for those wishing to develop a career in many areas of plant science:

- Survey and conservation work in threatened ecosystems
- Assessment of plant resources and genetic diversity
- Taxonomic research
- Management of institutes and curation of collections
- A stepping stone to PhD research and academic careers

Edinburgh is a unique place to study plant taxonomy and diversity. The programme and students benefit widely from a close partnership between RBGE and the University of Edinburgh (UoE). RBGE has one of the world's best living collections (15,000 species across our four specialist gardens – 5% of world species), an herbarium of three million specimens and one of the UK's most comprehensive botanical libraries. The School of Biological Sciences at UoE is a centre of excellence for research in Plant Sciences and Evolutionary Biology. Recognised experts from RBGE, UoE, and from different institutions in the UK deliver lectures across the whole spectrum of plant diversity. Most course work is based at RBGE, close to major collections of plants, but students have full access to the extensive learning facilities of the university.

Aims and Scope

The MSc provides biologists, conservationists, horticulturists and ecologists with a wide knowledge of plant biodiversity, as well as a thorough understanding of traditional and modern approaches to pure and applied taxonomy. Apart from learning about the latest research techniques for classification, students should acquire a broad knowledge of plant structure, ecology, and identification.

Programme Structure

This is an intensive twelve-month programme and involves lectures, practicals, workshops and essay writing, with examinations at the end of the first and second semesters. The course starts in September of each year and the application deadline is normally 31 March.

Topics covered include:

- Functions and philosophy of taxonomy
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- Conservation and sustainability
- Production and use of floras and monographs
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- Phylogenetic analysis
- Population and conservation genetics
- Tropical field course, plant collecting and ecology
- Curation of living collections, herbaria and libraries
- Plant morphology, anatomy and development
- Cytotaxonomy
- Molecular systematics

Fieldwork and visits to other institutes are an integral part of the course. There is a two-week field course to a tropical country in which students are taught field collection and identification of tropical plants ecological survey techniques. The summer is devoted to four months of a major scientific research project of the student's choice or a topic proposed by a supervisor. These research projects link in directly with active research programmes at RBGE.

Entry Requirements

Applicants should ideally hold a university degree, or its equivalent, in a biological, horticultural, or environmental science, and above all have a genuine interest in plants. Relevant work experience is desirable but not required. Evidence of proficiency in English must be provided if this is not an applicant's first language.

Funding

The University of Edinburgh provides a limited number of studentships. Other international funding bodies have supported overseas students in the past. More information can be obtained in the course handbook.

Further Information

For further details on the programme, including a course handbook please visit the RBGE website:

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MSc course Director

Dr Louis Ronse De Craene

Royal Botanic Garden Edinburgh

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Tel +44 (0)131 650 7366

Email: icmbpg@ed.ac.uk

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and click on the link to apply for this degree.

The Botanical investigations of Antoni van Leeuwenhoek

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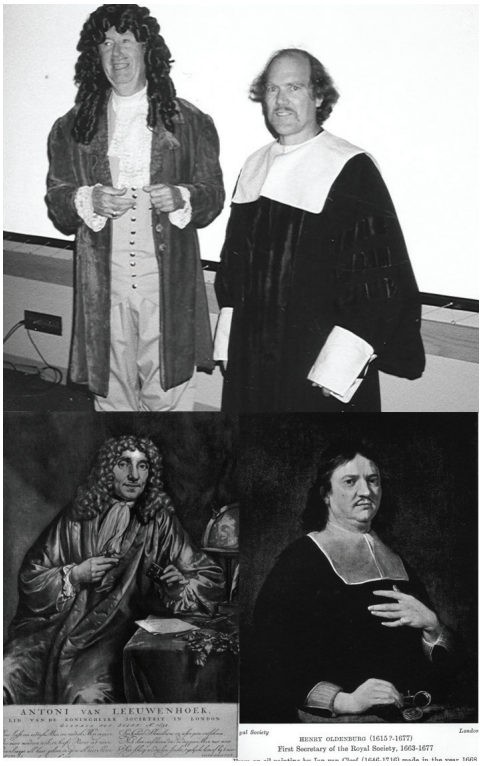
Key words: anatomy, wood, phloem, seeds, sorus, sporangium

ABSTRACT

Antoni van Leeuwenhoek is well known for his single lens microscopes and how he used them to make observations on "little animals," however, the breadth of his botanical observations are less well known. His thorough studies of wood anatomy are well documented but he also reported on the leaf anatomy, phloem, numerous seeds, and ferns. This article is a summary of his major anatomical findings as well as several of his physiological experiments on plants, quantitative measurements and predictions based on his observations, and descriptions of the economic uses of some plants.

Leeuwenhoek and Oldenburg

Most of us are familiar with Leeuwenhoek as a 17th century Dutch maker of single-lens microscopes and discoverer of bacteria and many "little animals," protozoans and aquatic invertebrates. (Dobell, 1932; Ford, 1991) You may have observed that there are multiple spellings of his name: "in the English versions of his epistles, published in the *Philosophical Transactions*, his surname is spelled in no less than 19 different ways." (Dobell, 1932, p.303) In this article I will use the form chosen by the editors of *The Collected Letters of Antoni van Leeuwenhoek*, a 19 volume compilation by Dutch scientists, in Dutch and English, of all of Leeuwenhoek's correspondence (Leeuwenhoek, 1939). (A recent article even describes the construction and use of a "replica" microscope by undergraduate students who then used it to observe onion leaf peels and mosquitoes (Sepel, Loreto, and Rocha, 2009). But it wasn't until I was invited by the late Larry Crockett to perform with him in his unpublished three-act play, "A Market Day in Delft," that I learned of Leeuwenhoek's relationship with Henry Oldenburg and his series of botanical publications in the *Philosophical Transactions*. This brief review of Leeuwenhock's botanical work is dedicated to the memory of my friend, the late Professor Crockett: botanist, thespian, teacher, and mentor.



[Figure 1. Top, left to right, Larry Crockett (Leeuwenhoek) and Marshall Sundberg (Oldenburg) in production of "A Market Day in Delft" presented at the 1994 annual meeting in Knoxville, TN. Bottom, left to right, Antoni van Leeuwenhoek and Henry Oldenburg. Top image accessed 10/15/2010. http://www.botany.org/plantimages/ImageData.asp?IDN=35-125&IS=700]

In the *Epistle Dedicatory* to volume 8 (1673), Henry Oldenburg noted that in this volume there would be "…some Microscopical additionals toevince the late improvement of that Instrument in Holland…." Oldenburg was the founding editor of the *Philosophical Transactions* (later the

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Philosophical Transactions of the Royal Society) and in that capacity maintained a professional correspondence with Leeuwenhoek regarding the latter's submissions, and sometimes requesting work on specific topics. For instance, in Letter No. 18 (Leeuwenhoek, 1675b) Leeuwenhoek wrote "You had the kindness in your letter of October 26th 1674 to ask me to examine the sap of plants. I have examined several saps and observed in them various figures, of which I have made rough drafts on paper." Oldenburg also acted as a go-between for Leeuwenhoek to communicate with others. Four months before submitting his first wood anatomy paper, Leeuwenhoek wrote to Oldenburg: "Dear Sir, I received your honoured letter of August 12th in good order, from which I learned that you have received my letter of August 14th[1]). I looked forward to another letter in order to learn the opinion of the Gentlemen Amateurs [Nehemiah Grew and Robert Hooke] (to whom you will have communicated my writings by now) on my theses, for I expect to be contradicted, since the speculations set forth in my letter, will appear strange to some people. I will be greatly obliged if these objections are communicated to me." (Leeuwenhoek, 1675c) Of particular value in the Collected Letters volumes cited above are the extensive footnotes that explain the biology, customs, interpretations, etc., such as the apparent date inversion between Leeuwenhoek's letter and Oldenburg's reply and the use of the term "Gentlemen Amateurs" in the latter quotation. The "microscopical additionals" Oldenberg referred to was Leeuwenhoek's (1673a) first contribution to science, "1. The Mould upon skin…" and "2. The sting of a Bee…."

Petiole Observations

Two years after his initial article, Leeuwenhoek (1675a) published his first observations on plants. He begins by noting that the sap of *Arum* (Wake-robin) tasted "very sharp upon the tongue" and that a cross section of the petiole contained "globuls not exactly round" which themselves contained "particles incomparably smaller." Furthermore, there were special parts "which I shall call Pores" [parenchyma cells] and inside the pores were "heaps" of 10 – 15 "small Figures" that were about "the thickness of that of a Spiders Web," but which appeared to be about "the thickness of a great Bread-knives back" in his microscope. He later calls these small figures "Pipes."[raphid crystals] If he macerated some of the arum petiole and squeezed the juice through bleu [filter] paper, nothing was visible in the strained juice except an "abundance of small Particles." In the thicker material left behind were the same small particles "of which the Leaf were made up" and between these particles some of the pipes "as I said I had seen in the Pores of the Stalk of the Leaf." If he held some of the thicker material to a small flame, the particles burned away but the pipes remained. Later he examined some plain sap expressed form the leaves, and from the stalk of the fruit after the leaves had "faded" and in both of these exudates he found the little pipes. "Now 'tis likely, that these Pipes in this Herb are the cause of the smart that is felt in chawing the *Arum* by the motion of the moist Tongue in tasting." (p. 381)

Later he noted "…that the motion of the sharp Particles that are in some saps, was not less" [than the "very pretty to behold" motion of the "little globuls" he observed in the juice squeezed from lemon peels]. (p 382) Furthermore, although he observed small particles in the sap of many plants, including ones shaped like "a well-polished triangular or quadrangular pointed Diamond", but the "little Pipes" described in *Arum* were found in only a few other plants such as the sap of "green Vine-branches, and *Asparagus*…and very many in the Sap of the Stalk and Leaves of *Cataputia* (Spurge)…" (p. 382).

Unfortunately Leeuwenhoek provided no sketches to support his descriptions in this paper, but it is clear that he has described the parenchyma (pores) in the petiole cross section. His "Pipes" are raphid crystals, either free or clustered within parenchyma cells, and he observed druses and prismatic crystals in the expressed sap of other plants. The "little globuls" with "very pretty motion" were oil droplets from the glands of his lemon peel.

Wood Anatomy

The following year in his Epistle Dedicatory, Oldenburg noted: "The curious Anatome of Plants is here confirm'd, in some main Points, by good Microscopes." (Oldenberg, 1676). In this volume Leeuwenhoek (1676b) included his first botanical illustration, a detailed cross sectional image of an ash twig, with an inset tangential section, to illustrate his description of "the Texture of Trees." (Interestingly, the published image in the Philosophical Transactions (Leeuwenhoek, 1676b) is a mirror image of the figure Leeuwenhoek submitted in his letter of April 21 (1676a). Leeuwenhoek's studies on wood anatomy are the one area of his botanical work that is well documented in the literature (see van Iterson, 1948; Baas, 1982) so I will only briefly

describe some highlights here.

In August,1673, he sent a letter to Oldenburg differentiating between pine wood, with one type of "pipe" (tracheids) and describing two sizes of pipes in the wood of oak. "I have likewise found two sorts of holes or pipes, one larger (vessels) than the other, in beech-, ash-, willow-, and vine-wood, as also in sugarcane and rotan." (Leeuwenhoek, 1673b). In this letter he also described "tiny bands" (wood rays) among the pipes, "white"(spring wood) and "darker" (summer wood) areas with denser cells, and speculated on the movement of fluids through the pipes. The "valves" he describes are bordered pits. This letter was not published.

Subsequently Leeuwenhoek had the opportunity to examine Hugen's copy of Grew's "Comparative anatomy of the trunks of plants" and based on the figures in that text (Leeuwenhoek was unable to read the English text) concluded that Grew was unaware of the two types of vessels he had observed. This was the reason for his illustrated 1676 paper. As a preface, Oldenburg noted: "These observations, as to the Texture of Plants, although they (and very many more) have been already made and published by Dr. Grew, and by Sign. Malpighi; yet because that (for the most part) they may be a further confirmation of the truth of their observations; I thought it not unuseful to have them communicated here also."(Leeuwenhoek, 1675b,p. 656-7) (Grew's earlier publications including "Comparative anatomy of the trunks of plants" were combined in 1682 to become the "Four Books" [sections] of his Anatomy of Plants). Hutton et al.(1809) expanded on Oldenburg's original remarks to justify and ensure Grew's priority in describing the structure of woody stems.

The issue of priority aside, Leeuwenhoek, provided more accurate individual cellular detail in his illustrations, particularly shape variation where large vessels adjoin. His representations of rays, as well as tyloses in some vessels, are clear and accurate.

On at least one point, Leeuwenhoek provided a better interpretation than either Grew or Malpighi, both of whom stated that the large vessels, pores, contained only air. Leeuwenhoek stated that "the greater Vessels [true vessels] sent [sap] upwards," but he thought "that some small Particles did again descend in the smaller Vessels [tracheids]…." (Leeuwenhoek, 1675b, p. 653).

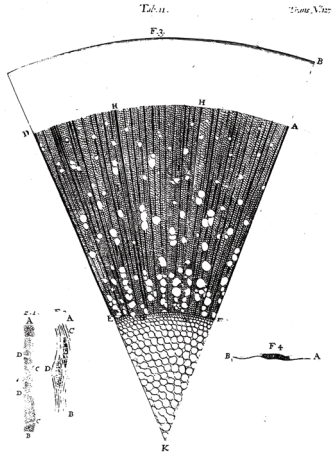

Figure 2. Ash wood, Leeuwenhoek (1676b). The largest figure, 3, is the main sketch of a 1/8 transverse section of a 1-year old ash stem with fine cellular detail in the pith and xylem. Figure 1 is a radial section through an "upright vessel" showing a short series of joined vessels with pitted walls while Figure 2 is a tangential section illustrating two fusiform multiseriate rays. (Figure 4 is of a nematode found in the French wine, the description of which is the last paragraph of the communication.)

Seven years later Leeuwenhoek (1683) acknowledged that he was familiar with the work of Malpighi and Grew, but nevertheless, ventured "to represent the Vessels in Wood after such manner as they offer'd themselves to me." (p. 198). In this wonderful paper he illustrates and describes transverse and tangential sections of six different woods: oak, elm, beech, willow, alder, ebony, as well as palm and "straw" [probably wheat]. Leeuwenhoek's illustrations on a single fold-out plate illustrate rectangular samples of the woods, similar to the student laboratory slides we use today. The transverse sections always include a transition between growth rings except for the ebony and palm, "…because that wood grows in a Climate where it increases always: for the Island *Mauritius* lies in a few degrees North of the Tropic of *Capricorn*." (p. 205). In each of the figures, individual cells are clearly and accurately represented; pit patterns and angle of the end walls of vessels can be analyzed. Leeuwenhoek distinguished between large multiseriate rays and smaller uni-or biseriate ones, calling them two types of "Vessels…lying horizontally." (p 199) Leeuwenhoek provided a clear description of the

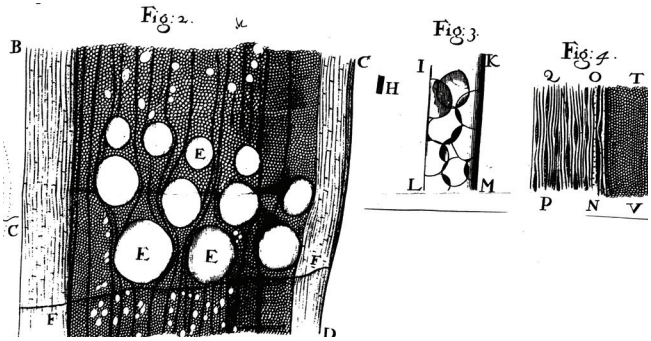

Figure 3. Oak wood sections, Leeuwenhoek (1683), Figs.2, 3, and 4. Fig. 2, cross section at boundary of growth rings. E, large vessels, F, multiseriate wood rays, G, uniseriate wood rays. Fig. 3. Longitudinal section of vessel containing numerous tyloses. Fig 4, Tangential section with large multiseriate ray, T-V, pitted vessels, O-N, and uniseriate rays, P,Q.

formation of annual rings and defines the concept of "spring wood." "EEE denote large ascending Vessels made every year in the Wood in the Spring, when it begins to grow. These are filled within with small Bladders, which have very thin Skins, here expressed in one of the greater Vessels, cut long ways in the third Figure…." (p. 199). The figure he refers to is a portion of an oak vessel, in longitudinal section, with obvious tyloses filling the lumen. Later, in willow, "… the great ones [vessels] beset with little parts, seeming Globuls." (p. 204) He also described one sort of "rising Vessels" as being "…also speck't with parts which by a common Microscope appear like Globuls, as Fig 4. ON where one of the said Vessels is cult long-ways." (p. 199) Again referring to oak, this figure is a tangential section where pitted side walls are evident the length of the vessel running from O to N, top to bottom of the image. This figure also shows an area with numerous biseriate rays adjacent to a large multiseriate ray. In elm he also describes pitted vessels: "HH Shews one of the great rising Vessels in length, cut cross in the midst; yet when we observe the same more exactly we see that they consist of very thin Films, beset with Helical Threds [sic], exhibiting obscure spots upon the hoops or bows as Fig 3." (p. 203)

Extremely interesting are Leeuwenhoek's quantitative musings, 44 years prior to Hales' Vegetable Statics (1727).

All these ascending Vessels in the aforesaid piece of Wood, which is about 1/90 of a Square Inch, are I guess about 20000 Vessels. Hence in an Oak Tree of four foot Diameter are 3200 Millions of ascending Vessels, and in one of 1 foot, there are 200 Millions of Vessels. If we suppose 10 of these great and small Vessels in a day to carry up 1 drop of Water, and that 100 of these drips make one Cubick Inch, there will be 200000 Cubic Inches. These Inches reduced to feet, amount to full 115 Cubick feet of Rhinland measure, of 12 inches to the foot; and one Cubick foot weighing 65 lib. Of our Delph water, the whole will amount to 7475 lib. Or 14 Bordeaux Hogsheads [Bordeaux Hogshead = 220 liters] of water, which a Tree of one foot Diameter in one day can bring up. (p. 200).

(As an exercise in Biology of Plants this semester, I challenged students to test Leeuwenhoek's figures by calculating the number of vessels per mm^2 on our oak slides. Only one student took up the challenge - - her numbers, converted to English units, were 68,000 cells/$in.^2$.)

Fifteen years later Leeuwenhoek (1694) returned to studying wood and made some observations concerning the relationship between growth rate, size, and wood strength. In this short letter he questioned some of the common opinion concerning the strength of wood based on his understanding of wood structure and growth. For instance, it was believed that timber cut in winter was stronger than that cut in summer. However, he noted: "that there is no difference, except in the Bark and outermost Ring of the Wood, which in the Summer are softer, and so more easily pierced by the Worm." (p 224). His most significant observation was that the width of the annual rings is related to growth conditions. "Some of these circles are broader than others, particularly the Ninth, the Tree from some accidental Cause receiving more Nourishment, and growing faster that Year than the former." He said,

"he [a correspondent] examined a piece of Ash growing in Norway, and found it grew 44 years before its semidiameter was one Inch; whereas Ash growing about Delft has been observed to increase an Inch early for several years together." (p. 225).

There is another 27-year span before

Leeuwenhoek's (1721a) next, and last, botanical contribution to wood anatomy - - a short description, unillustrated, of an unknown tropical wood and further observations on the "ascending Vessels" of oak and fir. In oak he describes pits. "…in Oak I found some other Vessels, which enter'd into their sides and appear'd to me like so many small round holes, especially where the Horizontal Vessels lay, which I judge to be united to the ascending Vessels, by means of those small Orifices, and thereby to discharge part of their Sap into them." (p. 136)

I have likewise made some Observations upon Fir Wood, in which the ascending Vessels consist of so very fine and thin a Substance, that they exhibit a very delightful Spectacle in the Microscope. In these ascending Vessels I imagin'd that I saw some Globules, with a small opening in their middle, which seem'd to be of a closer and denser Substance than the rest of the Wood. But I afterwards found myself mistaken, and that these supposed Globules were nothing else but the Orfices [bordered pits], whereby the ascending and horizontal Vessels were united together, and through which the sap was carry'd from the one to the other. (p. 136)

Seeds and Fruits

Already in 1676 Leeuwenhoek (1676c) wrote to Oldenburg about the structure of peppercorns and wheat seeds and vascular bundles in the fruits of several plants, however, this work and several subsequent letters concerning seeds and fruits were not published. Finally, in 1693, Oldenburg published two papers describing the anatomy of seeds (Leeuwenhoek, 1693a,c) and this was from a letter sent by Leeuwenhoek on July 13, 1685! Leeuwenhoek's most extensive observations were on ash, filbert, and willow seeds in the first paper. In his discussion of the two large leaves [cotyledons] of the ash embryo he described how the "liquor or sap" conveyed in the "vessels" [veins] is transported laterally form one "globule" [cell] to the next in the interstitial parenchyma [by diffusion] "…as if you should put several small Pellets of dry'd Clay in a glass Vessel, if the Water touch but one of them, you will find it communicated by that to the Second, Third, and so on till they are all Wet."(p. 701) He also noted that "every Seed containing not only the Rudiments of the future Plant [embryo], but also a certain fine flower [sic][endosperm] to nourish it so long, till striking Root into the Earth, it may thence receive its Nutriment." (p. 701) He modified this statement in the later paper - - "I was surprized [sic] to find a Variety from what I then wrote concerning the Mealy and Oily substance…I found no Mealy Substance at all [in cotton], but four small Leaves enwrapping one another…" (P. 949). Leeuwenhoek's recognition of endosperm was significant. Although Grew (1682) has a small chapter and an early section of the first chapter dedicated to the anatomy of seeds, he concentrated on beans and other legumes, or stone fruits. Thus, he made no mention of the endosperm or its role is food storage to support the dormant embryo in the seed.

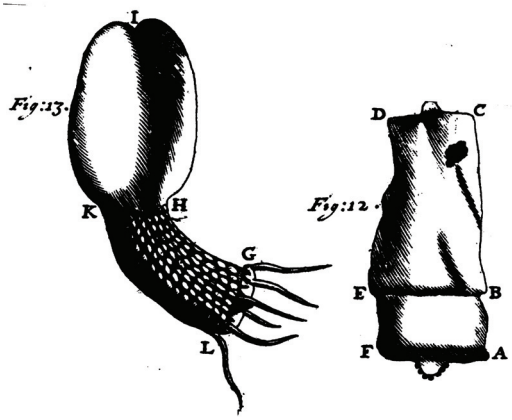

Figure 4. Organ development during willow embryo germination, Leeuwenhoek (1693a) Figs. 12, 13. Fig. 12, 12-hour dried embryo ABEF is ring-shaped wall around radicle sometimes referred to as a collet, ; Fig 13, 36 hr seedling, Cotyledons, I, cotyledonary node, HK, hypocotyls axis, HK-GL and branch roots growing from collet, GL.

A second major observation of Leeuwenhoek (1693a) is a "ligament, made up of several Vessels also…" (p. 702) [the funiculus] which attaches the developing seed to the fruit wall. For ash he diagramed two spirally coiled xylem vessels that were dissected from the "ligament." In filberts, this structure is substantial enough that he could make and illustrate a hand cross section showing the numerous vessels. "…the Embrio [sic] which is to be the future Plant, perhaps a Tree is so long contained in that Body which we call the Seed, and fed by means of a Ligament from its Matrix, to wit, the Tree, till it be of a competent growth, and has a sufficiency to provide for it self [sic], and grow when exposed on the bare ground, and then it is no longer kept up…This Nourishment is a sort of Flour which encompases the Embrio [sic] Plant,

and in the Seed make the two Lobes." (p. 703-4).

A final innovation in this paper is his documentation of early organography during germination. He laid willow seeds on moist sand in his closet and made subsequent observations after 36 and 72 hours. Emergence of the radicle, elongation of the hypocotyls and development of the cotyledons and branch roots are well illustrated in his figures 12-13.

In 1696 Leeuwenhoek was finally successful in making adequate preparations to describe the embryos in seeds of figs and strawberries (he tried but was unsuccessful in his 1693 paper). His descriptions, however, are most notable for economic botany and ecology and remind us of his interest and facility in math. Concerning figs: "I opened one Fig which I thought to be good and well tasted, and in it I saw some hundreds of Mites creep about, that did crawl in the inside of the Fig; so that when we eat Figs, we send, unknown to us, many Thousands of these little Animals into our Stomachs." (p. 274)

Now if we see that a common Fig has between four and five Hundred Seeds, and that one Tree doth Yearly produce many Figs, and that every ripe Seed of a Fig can produce a whole Tree; and consequently, if a Country was planted all over with Fig-trees, it may produce so many Fig-trees in a Year, that we might not only Plant a whole Kingdom all over with Fig-trees, that all these Seeds might produce, but also the whole earthly World; and that this doth not only succeed in Fig-Trees, but many other; ….We have reason to lay our Hand upon our Mouth, and think that the Almighty has thought this convenient, for the Procreation of all that has moving and growing; and thus all our Reason is but guessing, and that the true Reason is to us incomprehensible. (P. 277)

Similarly, when considering the seeds on a strawberry "We must again lay our Hand upon our Mouth, and be astonished at the increasing and great multiplicity of Seeds of this Plant." (P. 278).

Ten years later Leeuwenhoek (1706a,) returned to the study of seeds but this time most of the paper is an ethnobotanical description of the uses of these seeds, or the plants that produce them. The first, from a tree he called *Euwane*, 'Tis used inwardly by no body, excepting some Women, that, disagreeing with their Husbands, make use of it in order to kill themselves; it being consequently a certain Poyson [sic]." (p. 2205) The poison is made by boiling the leaves, mixing with oil, and drinking. In half an hour convulsions and other symptoms (detailed by Leeuwenhoek) commence. Ever the experimentalist, Leeuwenhoek cracked some of the seeds and soaked them in clean rain water for a few hours. "I took a little of the Water and mixed it with my Blood, as it dropt from my Finger by the pricking of a Needle, and I immediately observed that the Blood was extreamly [sic] coagulated, yea, more than I had ever seen it in my Life… the Particles of Globules [of the blood which is normally bright red in water] did assume a Blackish or Dirty Colour." (p. 2206).

While Leeuwenhoek's anatomical description of the coffee seed (Leeuwenhoek, 1687) was not published, in the 1706 paper he described coffee use by the Moors. "If a person that is not us'd to it should take but10 or 20 grains, 'twould have the same effect as if they had drank 10 Bottles of Wine." (p. 2207-8) If used too often it has the effect of "depriving them of their Memory together with the Appetite, and at last making them so lean, that they would have hardly any Flesh upon their Bones…" A drink called "Bosta" is a mixture of the Canfie [coffee]drink with seeds of poppies. "This Seed is little used by them in Physick, tho I doubt not that it might be excellently well apply'd, because it does not only imitate the effects of Opium, but also, if there be not too much of it us'd at a time, it has the same operation as the best Wine" (p. 2208). In the last page of the paper he describes the dissected embryos of these seeds, and hemp seed for comparison.

In his last botanical paper (1721b) he acknowledged that in his studies of seeds he often observed the "so called Membranes, in which the Substance of Meal, or Flower [sic], is inclosed, like little Packets in Cells or Boxes[storage parenchyma filled with starch grains]…. I at length, with astonishment, discover'd very plainly, that what I call the membranes, were endured with an unspeakable number of little Holes, thro' which, in many places, one might perceive the Light;" (p. 200). Leeuwenhoek apparently was describing simple pits in the parenchyma cell walls. Unfortunately, he provided no illustrations for this final contribution to plant anatomy. He continued with some speculation on the function of these pores.

…the Orfices of Seeds are so form'd, that many of their little Vessels do admit Moisture to pass

inwards, and accordingly Water is driven into them by the pressure of the Air, and causes the Seed to swell; upon which, a Warmth and Fermentation succeeding in the Seed, it requires a greater space, and by the particular Formation of the Particles, which lie in the Cells, and which have derived their Encrease [sic] from the Cells, the mealy Substance, of which they consist, is partly driven out of them into the body of the young Plant, which by this means increases so much in bulk, that the Root is now able to supply it with Nourishment from the early, at which time the Seed is found to be diminished in its bigness. (p. 202)

Leeuwenhoek's physiology may be incorrect, but his anatomical observations were excellent. His last paragraph may be viewed as a summary of his career in science and as an inspiration to scientists today. The key to success is persistence and careful observation.

As often as I have view'd Seeds, for several Years past, with the Microscope, yet I never imagin'd that the little Cells were endued with so many Vessels, tho' I have often been considering, how the Intrusion of the Particles of the Meal, or Flower, into the Membranes was effected; nor should I ever have attained thereto, but by continual Labour in the investigation of things, which are concealed from our naked Eyes, and towards which I have a much greater inclination, than what I observe in most other men.

Ferns

Leeuwenhoek's (1705) descriptions and experiments with fern "Seed-Vessels and Seeds" [sporangia and spores] are worthy of incorporation into a modern laboratory manual. He began by describing a walk where he came upon a patch of *Polypodium* ferns having a great number of "Seed Vessels" [sporangia] on its leaves "…soon one and soon another of them burst before our Eyes, which spectacle seem'd exceeding strange to us." (p. 1868). That winter he was given some leaves of Oak Fern and he noticed that it too had seed vessels but that these were much larger than those of the polypod and this time "I observed several little Bundles of Parcels of these Seed Vessels, sometimes thirteen of them lying in a row by one another." [sori]. (p. 1868) So he went out, in February, to collect some polypods to grow and observe in his study.

His first illustration, the "greater part" of one of these leaves (he has now employed a painter to do his drawings), "..to shew you the many Seed Vessels that are upon the same, together with the unspeakable number of small Seeds that are shut up in each Vessel." (p. 1869) He noted that in a single row "on one branch only of such a leaf" [pinna] there may be "13 of those little Particles, which to the naked Eye appear like Roses [sori]…and when I separated one of these Seed Vessels from the rest, I observed that all of them had very short kind of Stalks, whereby they were fastened to the Leaf, and by which they received their Increase…and the Leaf

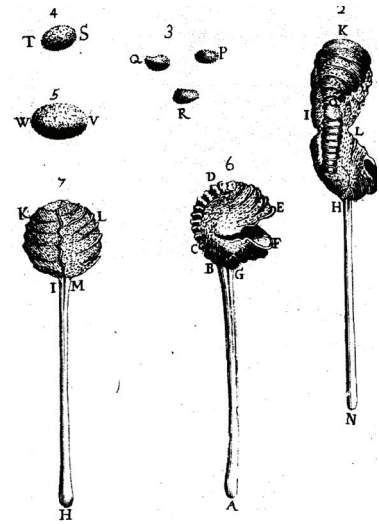

Figure 5. Polypodium sporangia, Leeuwenhoek (1705). Fig. 2. Dorsal view of opened sporangium, showing annulus.KO, stomium, M, and sporangium stalk, HN. Fig 6, side view of sporangium beginning to open. annulus, GBCD; stomium, Figure 7, unopened sporangium.

seem'd clearer or more transparent there, in which place I judge there was a Canal or Vein of the leaf."(p. 1870) He carefully dissected several of these sori and counted from 120 to 140 sporangia in each. Unlike the summer, however, all of them were open and contained no "seed"[spores]. "This openness seem'd at first very strange to me, because I could not perceive in any of them that it was occasion'd by any bursting or breaking in pieces; but when I'consider'd the matter better, I fancied to my self that Nature had ordered it so in those Seed Vessels, that as soon as the Seed was ripe, and received no further Nourishment, the Seed Vessels should open of course." (p 1870).

Detained examination of the opened sporangia revealed "8 Screw-like parts" [an annulus] one each one.

Let us suppose now that when the Seed is ripe, and receives no further Nourishment, it, and particularly its Shell or Vessel, which for the most part is composed of a thin Membrane, shrinks in, by reason that its moisture in dry weather is all exhal'd; now this shrinking in is greater in the 8 Screw-like parts, that are described between H and O, than in any other part of the Seed Vessel, because that the Screw-like parts are there of more than an ordinary thickness, in comparison of the other parts of the Seed Vessels; by which extraordinary shrinking the Seed Vessels are forc'd open, and the inclosed Seed [spores] thrown out. (p. 1871)

He went on to describe the individual spores, which are slightly oval, yellowish, and have a sculptured surface, and that 50 or more are contained in each sporangium. He suggested that the sporangia are produced and fed by the veins of the leaf and that they, in turn, "are fed from the same." In analogy to his previous studies of seeds, he postulated that each spore must also be "indued with particular Canals of Vessels" (p. 1872) to supply them. In breaking open a spore "I was mightily surpriz'd to find a great deal of Oyl coming out of one of them; and as each of these Seeds was of a Yellowish Colour, so was the Oyl also, where 'twas a little thick; but where it was thinner, it was a clear as any Water; the other Particles that lay in and about the Oyl, were of an exceeding smallness." (p. 1873) Because of this small size "it is easie [sic] to conceive how the same, after that they are full ripe, may be scatter'd abroad with a brisk Wind…" (p. 1873-4).

The most interesting part of the article, however, is the last paragraph where he described some experiments to investigate how the sporangia released their spores.

For my further satisfaction in this matter, I took a Fern Leaf, in which the Seed Vessels being quite ripe, were for the most part open, and had discharged their Seed, and put it into boyling [sic] hot Water; in this expectation, that the hot Water insinuating itself immediately into the Screw-like parts, as they are represented in Fig. 2. Between H and O, would so extend or swell out those parts, that the Seed Vessels would resume the same figure or appearance as when they were full of Seed; and this Experiment I repeated several times, and always observed that almost all the Seed Vessels shut up themselves, just after the same manner as they were before they discharged their Seed; and when I spread those Seed Vessels abroad, and let them dry again, they were all of them as open as that which is represented by Fig. 2. (p. 1874)

Bark

While Leeuwenhoek purposely omitted the bark from his descriptions of the stem of ash in 1676, he turned to this subject in his second paper of 1693(b). Unlike Grew (1682), who provides a detailed description of a number of different barks in his chapters on roots and stems, Leeuwenhoek made some generalized comparative descriptions of about a dozen species. Most of the species he examined had "vessels" [sieve tube elements] running "upwards" in the bark and those barks "…grows thicker as the Tree increases, the outside cracking grows Dead, and sticks to the young Bark underneath, which is the only living Part of the Bark." In a few trees the "vessels" in the bark "run round the Tree; for as the Tree increases in Vessels not being able to Stretch nor Separate from each other, must necessarily break asunder; so that the Old Bark is easily Separated and falls off from the New." (p. 841) Furthermore, he states that because

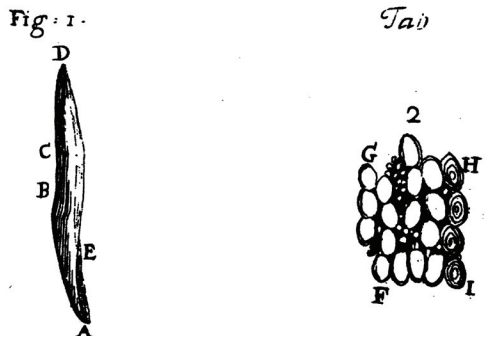

Figure 6. Phloem, Leeuwenhoek (1706b). Figure 1, sieve tube element in longitudinal view. Fig 2, phloem cross section with sieve cells, FG, tiny companion cells with dark walls, and four phloem fibers HI.

of the horizontal "vessels" [xylem rays] he described earlier in the wood, "the Bark…is produced and nourished from the Trunk of the Tree…" (p. 841).

His second paper on bark (1706b) was a closer examination of the bark of a tree he calls "China

China" – probably *Cinchona* "which is made use of with success in the most Obstinate Fevers" (p. 2446). The first part recalled his conversation with Angelus van Wikhuysen, a physician from Middleburgh, who supplied the material and who shared his methods of preparation. For his part, Leeuwenhoek recounted his understanding of the growth of bark.

Our Discourse amongst other things rolled upon this Topic, That between one Bark and another there is a great deal of difference; for in all Woods that are known to me, the Bark proceeds out of the Wood, and every Year there is produced a new Bark between the Wood and the old one of the former Year, by which means the Barks of Trees grow every Year thicker and thicker; so that at length the extreamest Bark that lies farthest from the Tree does not only receive no nourishment, but also dies, so that that which before had a taste in it becomes altogether tasteless, as I have shewn pon [sic] other Occasions; and consequently those Barks, which we call China China, are best when separated from the youngest Trees. (p. 2446)

Leeuwenhoek proceeded with some remarkable descriptions of secondary phloem and phloem rays. He began by describing some of the "long Particles," [fusiform-shaped series of sieve cells] pointed at both ends running lengthwise through the bark, "Some of which, at first view, one would judge to be twice or thrice as long as the rest; but examining them more nicely, I found that they were several

Particles sheathed, as it were, within one another, in such a manner, that without looking very close upon them, would take them to be one continued Particle. (p. 2447) His illustration and description of a single cell emphasizes the "small dent" where adjoining cells connect. "…but I never observed any thing like this in other Barks of Trees that I have examined, save only in that which is called Cinnamon." (p. 2448)

He then described a cross section through some of these same long particles and had his artist sketch a small block of these cells. "I have seen six of them lie so near one another, that you could but just distinguish the Number of them [companion cells], and that which divides these long Particles from each other is only the Vessels [phloem rays] that compose part of the Bark, and proceed from the Wood, as I often said before, and from whence also I conclude, that the above mentioned Particles receive their increase [sic]….the above mentioned Particles, so as they are cut across, whereby they appear in an Oval Figure [crescent-shaped secondary phloem separated by dilated phloem rays]; and if we view them very nicely we may discover, that [a small part of the particles] they are composed of Screw-like Parts [phloem fibers]…"(p. 2448). The sieve cells, companion cells, and phloem fibers are illustrated in his Fig. 2 (Fig. 6).

Conclusion

Leeuwenhoek's observations are clearly remarkable, and it has sometimes been suggested that they were in part due to a vivid imagination. We all know that a small number of his original microscopes exist (at least 26 additional microscopes, known to have been given to the Royal Society, along with separate dried specimens, have been lost; Ford, 1991, foreward and p. 130, 164), and they have been demonstrated to produce magnifications of up to 266 X and a numerical aperture of up to 0.37 (on an 110X lens; Ford, p. 166). Furthermore, a few of his samples exist, including hand sections of cork and elder pith. Ford provides a wonderful chapter comparing Leeuwenhoek's lenses with modern Leitz lenses of comparable magnification and Leeuwenhoek's hold up very well indeed in the areas of focus (they are obviously not "flat field"). Similarly, his hand-sectioned specimens, observed with SEM, are comparable to modern microtome-produced material! In his papers on wood and seeds, he frequently describes his preparations techniques; soaking or boiling in water, soaking in brandy or wine, etc. which were required for him to make sections of these hard materials with his straight-edge razor. He is an inspiration for my botany students struggling to produce adequate sections of herbaceous material with their half-double edge blades!

Acknowledgement

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Ecological

Botanic Gardens: Modern-Day Arks

Sara Oldfield.
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MIT Press. Cambridge, Massachusetts USA.

The title for this book, "Botanic Gardens: Modern-Day Arks" is absolutely brilliant. It brings to mind all the right mental images for the role of botanic gardens in today's ever-changing world. Botanic gardens have been around of a long time. Often their image is that of a delightful but somewhat antiquated institution, perhaps because of the beautiful Victorian-era conservatories in some of the more well-known gardens. But this image is very far from the modern-day truth as botanic gardens currently have an increasingly vital role to play in the future of plant biodiversity (and by association animal, and even ecosystem) survival in our changing world.

Almost all botanic gardens have a "pretty face", showcasing the glorious wonders of the botanical world far and wide no matter where they are located. The general public can see and appreciate not only the ornamental and native plants, but also plants that grow wild in faraway places that the viewer could not even have imagined existed otherwise. This book, with a wealth of gorgeous images from all over the world, certainly is large enough to be a coffee table book of just pretty pictures. However its goal is to highlight the conservation, research and education roles of botanic gardens. Its very real value is in the fascinating text about sixteen different botanic gardens, about half in temperate areas and half in the tropical realm.

Several of the botanic gardens described here were established in European countries (Royal Botanic Gardens, Kew and Edinburgh, Berlin and France, for example) that for years have sent their botanists

all over the world to help less "developed" countries by collecting and sending home living and pressed specimens of their flora. Such dedicated and hard-working botanists were often unaware of the elaborate taxonomies and plant knowledge held by the indigenous people. But today that is changing and the emphasis is on collaboration and on encouraging the local staff to run their own botanic gardens and projects. The Nezahat Gokyigit Botanic Garden in Istanbul Turkey, is an example: the original flora of Turkey was produced by the Royal Botanic Garden Edinburgh, but later volumes were written by local botanists based in Turkey. Currently the two gardens exchange staff for a truly collaborative approach to horticultural, education and conservation work.

While each botanic garden has its own personality and focus, I think it is fair to say that it is an institutional form recognized and respected throughout the world. They are generally located on relatively small areas of land (250 acres or more would be a large botanic garden) often in cities or suburbs of cities (for example, the 160 botanic gardens in China, some of which are described in the chapter on South China Botanic Garden). Therefore, the challenges of population pressure on biodiversity commonly encountered by the management of large preserves and parks are less of a problem in a botanic garden. This book demonstrates that while a botanic garden may not be able to protect a large number of species ndigenous to their small site, the living collections, research programs and outreach can be of national, regional or even global importance.

My only (very minor) criticism of this book is the use of acronyms, especially in the introductory chapters. Although the author works for the Botanic Gardens Conservation International (BGCI), I doubt that many of the intended readers of the book have any idea what the acronym stands for and yet it is repeated several times before being interpreted on page 19. Even after identifying the meaning of an acronym (for example, GSPC = Global Strategy for Plant Conservation), I suspect the reader will immediately forget and then have to look back. There is a good index and also short lists of further reading and other organizations acting as conservation advocates at the back of the book, but this section should be perhaps referenced in the introductory material.

Each chapter of the book, though nominally describing a single botanic garden, actually describes a different system of interactions among people and institutions throughout the world. The introduction and summary chapters also give more examples from other botanic gardens. Each garden's focus on research and conservation is unique, thus the book provides a user-friendly introduction to many subjects worthy of further study in an undergraduate or botanic garden classroom such as plant genetics, micropropagation, extinction, invasives, *ex situ* horticultural methods, ethnobotany, and community relations, to name but a few.

-Joanne M. Sharpe, Coastal Maine Botanical Gardens

Globalization and Agricultural Landscapes: Change Patterns and Policy Trends in Developed Countries

2010. ISBN 978-0-521-73666-4.
(Paper US$59.00) 275 pp.
Cambridge University Press
32 Avenue of the Americas
New York, NY 10013.

Landscape Ecology as a discipline makes direct use of botany to a limited extent, but it must necessarily deal in broader generalizations, in order consider geology, meteorology, sociology and a dozen other "ologies" too. However, even such a broad subject as landscape ecology is only one facet of globalization. Globalization as a phenomenon may be largely about the "space of flow" more than the "space of place" as referred to by Castells. This book attempts to deal with both kinds of space.

Primdahl, from Denmark, and Swaffield, from New Zealand, have edited a volume attempting to give a broad survey of some issues of globalization in relation to agricultural landscapes in developed countries. This means, of course, that much of the world's land, and a very large fraction of its population, is not explicitly considered. Another volume addressing the less developed and rapidly developing countries would likely identify many of the same themes, but translated into myriad forms. Even within the developed OECD countries only a few are considered in any detail. While every country, and region, will show significant differences from the case studies considered here, some general principles may be discerned.

Urbanization of the population and industrialization of agriculture seem to be major drivers of changing patterns of agricultural landscapes. Both are consequences of the substitution of outside energy for human energy in agricultural, and other, production. Reenburg et al.consider the land use patterns of an impoverished soil area in Denmark, and tropical forest in Malaysia. For Denmark, marginal agricultural land has been extensively converted to forest land, presumably to yield pulp or timber. In Malaysia, native forests have been logged over for cash and replaced by oil palm plantations, to supply a continuing cash crop. In both instances, the landscape is dramatically altered, to supply the needs of a **distant** population. This is globalization in action.

In an introductory chapter, Primdahl and Swaffield consider how globalization and landscape sustainability are affected by contrasting regulatory and marketing systems, with Denmark having a system of complex controls imposed by the EU and New Zealand depending mainly on the free market as an economic driver. The rates of change, and types of change, occurring in these two settings may be quite different. Yet dairy farmers in these two systems may be both competitors, and collaborators, sharing a common interest in maximizing production and profitability, through use of some similar strategies, while maintaining the identity of their place of production. They participate in the space of flows, with common ideas and interconnected economies, but each lives in a unique space of place, their particular agroecosystem.

This is not an easy book; it might serve well as a textual basis for an entire course. Generally it is well-written, though a few chapters have what feels rather impenetrable prose to one not schooled in the intricacies of planning and policy. Still, policy matters tremendously, driving ecosystem change directly and indirectly through market forces, so understanding it is worth the effort. The book is well produced with ~ 500 index terms, and a literature cited section of ~50 references in each chapter. Most chapters have some illustrations, tables or graphs. We could benefit from having more. Only three plant (tree) species appear in the index, all cited in a single paragraph. You will have to look elsewhere for details of landscape properties or change.

The chapter I found most fascinating was a case study of urban agriculture in Tokyo, Japan. Yokohari et al. look toward the inevitable de-densification of Japan which is driven by simple demographic and economic facts. With a low birth rate, population aging and decrease is inevitable. In its geographic location, Japan cannot effectively produce many commodities at a lower cost than they can be imported from elsewhere. So, the authors recognize that planning, which formerly assumed inevitable growth of cities, must accept that they will slow their growth. More importantly, place should be made for integrating agriculture and horticulture into the cities, through use of empty spaces for vegetable and fruit production.

Other chapters provide a comparison of Argentine pampas and Brittany, examine the transition of farmland to forest in Portugal, and consider the several transitions happening in Estonia during the collapse of collective farms, and the suburbanization of cities. A very detailed consideration of urban/rural planning in the Dutch context gives insight into changes of landscape at the scale of a few to tens of km. More sweeping discussions of policy changes are found in a chapter on the impact of U.S. federal policy on rural landscape, nationwide.

At an intermediate scale, Switzerland, surrounded by, but not part, of the EU, provides a case study in how market competition and comparative advantage force change on the landscape, unless significant counter-forces are provided through explicit policies. The authors discuss alternative paths but can only suggest some potential outcomes. Major change seems inevitable though its direction and magnitude may vary.

Primdahl considers change patterns through a half-dozen case studies, two areas each in Denmark, Portugal and New Zealand. Common factors and outcomes appear to be, that on the better land production is being intensified for increased profits, while in the more marginal land there is a de-intensification, perhaps heading toward abandonment, or return to "nature." A closing chapter by Swaffield and Primdahl sums up broad trends and points toward areas for further research. The particular challenge noted by those authors is to reconcile open markets and sustainability. Further compounding this challenge is the observation that urban planning and agricultural planning are usually done independently, often by groups of stakeholders with little overlap of interests or even mutually usable vocabulary.

One main message provides a continuing thread weaving the various studies together. Change will happen, and we might or might not be able to

control its direction. But we must at least try to understand and modulate what happens, for the health of both ecosystems and humanity.

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Mapping Species Distributions. Spatial Inference and Prediction

Janet Franklin with contributions by Jennifer A. Miller
2009. ISBN 978-0-521-87635-3 (hardback, US$125.00), ISBN 978-0-521-87635-3 (paperback, US$48.00), xviii + 320 pp. Cambridge University Press Cambridge.

Mapping of the actual or potential species distributions is currently an important discipline for at least three reasons: (1) we need accurate inventories of biodiversity for conservation and basic ecological purposes,(2) survival of some species is uncertain because of global climate change (e.g., Aitken et al. 2008, Ledig et al. 2010), (3) it is desirable to know what is the actual and potential distribution of invasive species (Gallien et al. 2010). The key questions are habitat suitability, dispersal opportunities of studied taxa, and use of proper statistical methods. Therefore, a detail review of available methods in this area is highly desirable. The book under review is logically divided into four parts: I. History and ecological basis of species distribution modeling, II. The data needed for modeling species distributions, III. An overview of the modeling methods, IV. Model evaluation and implementation.

Much of the book reviews modeling approaches that link species location information with environmental data. The reader is guided step by step from the Hutchinson's niche concept to spatial sampling designs, digital terrain maps, generalized linear and additive models, Bayesian approaches, spatial autocorrelation, decision trees and random forests, artificial neural networks, envelope models, ecological niche factor analysis, habitat suitability indices, and measures of prediction errors. Examples of recent studies are summarized in many tables. The book is simply packed with information that will be helpful for beginners as well as for advanced researchers.

While usefulness of remote sensing is discussed in general (p.94-9), the use of remote sensing for mapping of invasive plant species (e.g., Asner & Huang 2011) is not mentioned. This is the only missing information I can think of. With over 1200 references, this book more than sufficiently presents contemporary situations in species distribution description and modeling. In spite of the exponentially growing number of publications in this area, the book will be extremely useful for several years to come. Franklin herself tried to summarize some new developments in her more recent article (Franklin 2010).

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Economic Botany

Ethnoveterinary Botanical Medicine.

Katerere, David R., and Dibungi Luseba, Eds.
2010. ISBN 978-1-4200-4560-4 (Hardcover US$139.95) xv + 434 pages, CRC Press/Taylor and Francis Group, Boca Raton, Florida

Ethnoveterinary Botanical Medicine is a compendium of research articles about herbal medicines for domestic and companion animals. Its 17 chapters cover all aspects of the practice, including case studies from around the world and

details of research approaches. The authorship is truly international making this the first global-scale compilation of traditional and modern knowledge of the use of plants for animal health. It is a "must-have" for all individuals serious about ethnopharmacology, veterinarians working with the studied populations, and anthropologists interested in getting a better idea about traditional approaches to animal care. As stated by one author (p. 257), "The era of treating [ethnoveterinary medicines] and any other ethnic knowledge system with suspicion and labeling it as myth, superstition, and witchcraft is long gone."

The book arrived at an opportune time for me – one hen in our flock of organic chickens was suffering from "sour crop", a potentially fatal malady. We did not want to inject her with drugs and were trying a variety of organic remedies. I carefully leafed through my new copy of *Ethnoveterinary Botanical Medicine* searching for poultry digestive aids but to no avail. Quickly I realized that this is not a guidebook to animal care organized by ailment or symptom, but is a detailed scientific study of the entire practice.

The chapters cover all of the inhabited continents of the planet. They include both developed regions like the European Union and less developed regions like areas of Africa. The focus is on farm animals, but there is one chapter devoted to study of treatments for pet and companion animals. As is the case for most books that are compilations of chapters by many authors, this book suffers somewhat from inconsistency in organization and the clarity of writing among the chapters, and hence, access to specific information. Some chapters are mostly comprised of tabular lists of plants by scientific name, a category for which they are used (e.g., "endoparasite"), and a reference to a primary document. Others have more useful summaries of the primary literature and synthesis of information. I do not mean that the tables are not useful; in fact, some provide a quick way to find specific treatment information (e.g., *Leonitis leonurus* (Lamiaceae) is "added to drinking water to prevent sickness in poultry and [is] used for gall sickness in cattle" in South Africa, Table 11.1). All figures and images are black and white and clear. Chapter organization varies between plant taxon-based and disease/condition-based. Some chapters include more information about culture and geography, and some have more history than others, but all have a wealth of information about the current state of practice in their given region. And all agree that ethnoveterinary medicine is seriously understudied and in need of documentation before traditional knowledge is lost.

Ethnoveterinary Botanical Medicine has much to offer on the topic of plant discovery and commercialization. Technical, ethical, and legal considerations of bioprospecting are covered in the first four chapters. Stated reasons for scientific study of traditional practices were multi-fold but generally fell into two categories: evaluation of plants for effective treatments that could be used globally, and assessment of safety to minimize inadvertent harm caused by farmers using dubious practices. Very intriguing to me was the information that traditional knowledge of animal health care is generally passed down within families, not held by a centralized person as is found for most traditional human healers. This results in more ready sharing of information among farmers because none of them is making a livelihood directly from the knowledge. This also means that there isn't a local specialist in a position to assess and synthesize the various methods used by different farmers, which may lead to propagation of less than optimal practices. The dispersed nature of indigenous knowledge may prove a challenge to investigators who go looking for it. The authors cover topics of intellectual property and access and benefit sharing in a meaningful way. Having a broader context in which to place the specific plant and treatment information in the later chapters helped me (a non-specialist) gain a better appreciation for the field.

One might think that knowledge we have gained about herbal medicine for humans could be directly applied to other animals. But as a veterinary friend of mine described, about 95% of what she learned in vet school could be applied to all animals that she treats, but it's the last 5% that makes the difference between success and failure. Katerere (South African Medical Research Council, Cape Town) and Luseba (Tshwane University of Technology, South Africa) make a strong case that herbal medicine for animals deserves its own serious study.

Post script: For those of you wondering how our hen fared, she was able to live on for a few months after treatment of her sour crop with some folk remedies picked up from local farmers, and then succumbed to a different disease!

-Carolyn Wetzel, Smith College

Historical

The odyssey of a woman field scientist. A story of passion, persistence, and patience.

Jean H. Langenheim.
2010 ISNB 978-1-4415-7442-8 (hardback US$35) 539 pp. Xlibris Corporation. www.Xlibris.com

I think the word "amazing" should be in the title of this book, i.e., this is "An amazing story of passion, persistence and patience." The story of Professor Jean Langenheim's (J. L.) life, scientific accomplishments, sense of adventure, eagerness to learn about and experience other cultures, and ability to see herself in the context of her place in history is fascinating and highly informative.

J. L.'s placement of her life story in the context of developments of ecological and evolutionary thinking, creation of the field of chemical ecology, and changes in opportunities for women in society and science provides unique insight into a period (post World War II) of rapid and exciting changes in science and the role of women in science. The book is of great value in terms of the historical record it provides.

The style of writing is very engaging. One minute you are reading about travels in Alaska, but a few pages later you are on a small ship traversing the fjords of Norway. However, although J. L. describes extensive travels in Africa, Australia, China, Europe, Mexico, North America, South America, and the boreal and tundra regions of the Northern Hemisphere, the book is not a travel log. Travel to various places is an important part of the story, but travel through time is an even more important. The book traces the developement and changes in the field of ecology. Also, the book follows J. L.'s ever expanding interest in ecology and in particular amber, resins, and eventually the new field of chemical ecology.

Throughout the book, J. L. explains ecological concepts in some detail (like a good professor should), but she stops before the reader starts to wonder if perhaps he/she has stumbled on some old lecture notes from a course on the history of ecology. Her descriptions of concepts and ideas are clear and very useful in helping the reader understand how/when ecology and especially the various aspects of chemical ecology grew and changed during J. L.'s lifetime of research. That is, as J. L. tells the story of her life and career, you can see how she fits into the whole picture of changes in ecological thinking and ways of doing research.

I especially enjoyed J.L.'s accounts of being a graduate student at the University of Minnesota and in particular her descriptions of Professor William S. Cooper. How else would I have ever known about his drive for absolute perfection in writing a manuscript and his love of music. He accepted J. L. as a Ph.D. student only because she was married at that time to Ralph Langenheim, who was one of Professor Cooper's Ph.D. students.

Many of J.L.'s trips were to various places, e.g., Africa and South America, to collect research material of the legumes Hymenaea and Copaifera. Also, she attended scientific meetings all over the world. Her description of a trip to one of these meetings includes the location, title of her oral presentation, interactions with colleagues, field trips, social events, and the difficulties and interesting challenges of her travels – often alone.

There are some important lesions to be learned from J. L.'s story. One, do not be afraid of hard work. Two, upset plans often mean the beginning of a rich new experience. Three, never lose your love of learning and experiencing new things. Four, collaborations with colleagues around the world not only enhance the pleasure of living but can promote the development of new ideas and new avenues of research. Five, service to others (students, colleagues, university, and societies) is demanding but has rich rewards.

One gets the impression that J. L. has kept detailed records of her research activities, participation in scientific societies, mentoring of students, leadership roles in various societies, and her many travel adventures. She has successfully meshed this wealth of information into a very readable story that keeps everything in proper historical perspective. Thus, much can be learned from reading this book. I conclude that Professor Langenheim's book is an amazing story about an amazing person.

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A Color Atlas of Photosynthetic Euglenoids

Ionel Ciugulea; Richard E. Triemer (2010
Hardcover: 232 pages; List price: $89.95
Publisher: Michigan State Univ Press ISBN-10: 0870138790 ISBN-13: 978-0870138799

The euglenoids represent one of the most fascinating group of algae. They have a distinctive chloroplast structure in that three membranes compose the chloroplast envelope, a feature that is reflective of the secondary endosymbiotic events and origin of the this group. The euglenoid algae also have a characteristic undulating motion termed metaboly, and many species can also use their flagella to swim. In addition, euglenoids utilize paramylon, a beta-1-3-linked glucan, as a storage carbohydrate in the form of membrane-bound crystals in the cytoplasm.

Euglenoid algae are of interest from an ecological perspective since they usually occur in high numbers in stagnant waters with elevated levels of nutrients. As such, these algae are indicative of the ecological status and health of bodies of water and can be used as biomonitors. Studies have shown *Euglena* to exhibit both gravitaxis and phototaxis depending on the light conditions.

This book begins with a brief introdcution to the euglenoid flagellates including a key to the photosynthetic genera. The authors are both well-known authorities of the systematics, morphology, structure, and ecology of the euglenoid algae. The bulk of this large format book consists of high-quality color light microscopy of these algae. The morphological variation and cellular structures in the euglenoids are fascinating, and the quality of reproduction is very high. This is a beautiful book.

The figure legends focus on the key diagnostic features that are necessary to identify the taxon. Thus, this book will be useful to botanists, phycologists, and limnologists. The illustrations also are valuable to professionals who monitor water quality in rivers and lakes and would provide a useful basis for the identification of the photosynthetic euglenoids.

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Aquatic Plants of Wisconsin

Skawinski, Paul M.
No date [2010]. ISBN: none (Softcover; spiral binding US$34.00). xx + 150 pp. Published by the author.

Admittedly, I was somewhat skeptical of this book when I first learned about it because I had never read anything else on aquatic plants by the author or had even heard of him for that matter. Also, the book was published privately, which raised my suspicions of why a traditional publisher would not have been interested. I was relieved to find my fears to be mostly ungrounded; however, I did find both pluses and minuses in this text.

First I'll mention a few technical issues. As soon as I picked up the book to summarize the bibliographic information, I found that no publication date was provided. The omission of publication date is not trivial because it creates in every case a major nuisance for anyone trying to cite the work. Bibliographic citation is made even more difficult by the lack of a city (or any locale) corresponding to the place of publication. As a consequence, the task of providing an appropriate citation for this book is sure to give many editors a headache. The book first appeared in September, 2010, so pencil in the date if you own a copy. Also, I noticed that for some reason, the very first page was repeated unnecessarily as the third page, except for the author's e-mail address. Such technical aberrations are to be expected in unedited works, so I was not surprised. However, the overall quality of the book is decent. The plastic coil binding is substantial and the pages turn readily without sticking like they do in many spiral-bound booklets. The paper is glossy (perhaps to help repel water when used in the field) and the print is crisp and dark. There is a metric ruler reproduced on the back of the first text page and it was accurate to 0.5 mm across its 20 cm span.

The book is subtitled "A photographic field guide to submerged and floating-leaf [sic!] aquatic plants" for good reason as one immediately finds that it contains color photos on nearly every other page. Generally, the photos are of pretty good quality and are produced quite well on most pages. There are a few line drawings (e.g., page x), which are fairly crude and could be improved. There is a two-page reference section.

This guide uses a picture association approach to facilitate the identification of common aquatic plants for those with limited botanical training such as average lakeshore residents and the like. Although its coverage is limited to the state of Wisconsin, this book also would be useful in most of the upper Midwestern region of North America due to the similar aquatic floras. There are 120 species included in total. A few technical dichotomous keys (*Myriophyllum*, *Sparganium*, *Utricularia*) are provided by R.W. Freckmann (University of Wisconsin); however, the majority of the book follows a color-coded scheme that groups various species primarily using a combination of leaf shape and leaf arrangement, which is not unlike the strategy incorporated in past treatments of aquatic plants such as the popular Fassett (1957) manual. A problem with methods that avoid a step-by-step keying process is that they can be subjective, reflecting primarily one individual's concept of whether a particular set of features is 'similar enough' to be placed within one category rather than another. One example is *Callitriche*, a genus with leaves that vary in shape from linear (submersed) to spatulate (floating). Yet, *Callitriche* is keyed only in the section for "round or oblong leaves", which would describe many of the species but would not accommodate some such as *C. hermaphroditica*, a resident of Wisconsin with entirely linear, submersed foliage. Furthermore, grouped with *Callitriche* are genera like *Brasenia* and *Wolffia*, which exhibit little commonality in leaf shape, especially the latter where the entire shoot is modified as a frond or thallus. Here it might have been better to adopt a format in which the plants were grouped by their habit, e.g., those species that float or have at least some leaves that float on the water surface. There also is a category for 'irregularly shaped leaves.' I'm not sure what that category means, but for some reason it separates *Najas marina* from the other *Najas* species, which are grouped with the opposite, lance/linear-leaved category. Again, the 'irregular' category contains an eclectic assemblage of taxa such as *Azolla*, *Ranunculus sceleratus* and *Berula*, which I cannot envision as a cohesive group of any sort. Also, what does one do with *Utricularia*? Are those leaves feathery or irregular? I predict that many users could find it difficult to place many of these plants in the desired category, but I suspect that they then will simply flip through the pages until they find a plant that looks like the one they are trying to identify. There is a precaution (on page viii) to identify any heterophyllous species using only the submersed foliage. However, if this advice is followed, then none of the *Callitriche* species could be identified properly.

Non-technical terminology is used for the most part (except in the formal keys) and there is a glossary at the back. Most of the definitions are adequate, but some are incorrect or at least need to be improved. An axil, for instance is the angle formed between the leaf and shoot and is not "a location where the leaf meets the stem" as defined in the book; that definition would apply to "node" instead. Similarly, "peduncle" is defined as "a stalk supporting a flower", which technically is the pedicel. A peduncle supports an inflorescence; thus, the definition given is correct only in the case of solitary flowers. 'Annual' is described as a plant that "completes its life cycle" in a year; however, many perennials flower, fruit, set seed and germinate (i.e., complete a life cycle) within a year. Properly the term 'annual' should refer to plants (or structures) that survive only for one year (i.e., growing season). The definition of 'perennial' also is incorrect ("a plant that lives for more than two years") because a plant needs only to live for more than one year to be perennial. Biennials are short-term perennials, with some requiring more than the two years specified in the definition to complete their life-cycle. A 'clasping leaf' is defined as one with no stalk, which "wraps around the stem." Although the author surely was referring to the base of the leaf, a non-botanist could perceive such leaves as coiling around the stem like tendrils. 'Lacunar cells' are described as "large hollow cells"; however, lacunae actually are voids between cells, not the cells themselves (which cannot be hollow). I'm always picky about definitions, but clarity is important to reduce confusion and glossaries should provide an opportunity to train uninitiated readers in the proper use of botanical terminology.

The nomenclature mostly is up-to-date with a few exceptions. A number of fairly recent name changes (e.g., *Schoenoplectus*, *Stuckenia*) have been incorporated. However, *Utricularia macrorhiza* is still referred to as *U. vulgaris*, a genetically distinct Old World taxon (see Jobson et al., 2003). *Persicaria amphibia* is assigned to the genus *Polygonum*, which has been shown to be distant phylogenetically (e.g. Kim & Donoghue, 2008). The name *Ruppia cirrhosa* is used for *R. maritima*; however, the former is not distinct from the latter (Ito et al., 2010).

Now that I have picked at a number of fairly trivial

things, I can get to the good stuff. I found this book to be extremely accurate at describing and depicting the included taxa, despite a number of them being quite difficult technically. The author's skill in the identification of aquatic plants is evident and has resulted in a very useful reference indeed. In most cases, the photographs nicely depict the correct species described in the text. I found only one picture (attributed to *Potamogeton alpinus* on p. 51), which seemed a bit 'iffy' to me and looked more like *P. illinoensis* or a hybrid of the same. By providing key identification characteristics in the text descriptions (accented in bold type) the author effectively conveys the more important identification features to the reader. The inclusion of magnified inset photos also serves nicely to accent features that are useful in field recognition. In most cases, anybody with reasonable observatory skills should be able to identify an unknown species at least close to the actual species using the procedure outlined in the introductory pages or just by comparing their specimen to the photos. So, despite a few glitches, I would regard this book as a useful reference that effectively meets its intended objective of providing assistance with the identification of aquatic plants in the region specified.

However, because this book is not written to be a technical botanical text, I would not recommend it as an alternative to more standard taxonomic guides (e.g. Crow and Hellquist, 2000). It is not suitable as a textbook for use in a taxonomic course (due mainly to the lack of dichotomous keys for most species), but certainly would serve as a nice supplement to such works.

I applaud the emphasis of the author on promoting the use of his book to document new occurrences of invasive and potentially invasive species. The former are indicated clearly in the text and the latter are summarized in a separate section (appendix A). Making such helpful works available to the non-technically trained individual is indeed an excellent way of increasing the network of persons on the lookout for invasive plants. There also is good advice given regarding whom to contact if an invasive or imperiled species putatively is located.

The last section of the book (appendix E) is a list of species provided with 'coefficient of conservatism' values. Unfortunately, I could not find anywhere in the book where this appendix was explained. It appears to assign a number (from 0-10), which is relative to the conservation value of each species; however, no information is provided regarding how the index was derived or exactly to what it refers.

In summary, this photographically enriched guide to the aquatic plants of Wisconsin is a useful supplement that will be valued by those conducting routine identification of hydrophytes in this region. Anybody conducting pertinent field work in the upper Midwest region would be well-advised to procure a copy while they are available. Apparently, only 750 copies of this book were printed, so supplies are limited. Interested parties can order a copy at: http://www.uwsp.edu/cnr/uwexlakes/publications/aquaticPlantsWi/aquaticPlantsWi.asp

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The Book of Leaves: a leaf-by-leaf guide to six hundred of the world's great trees.

Allen J. Coombes.
2010. ISBN 9780226139739. (Cloth US$55.00) 656 pp. University of Chicago Press, Chicago, Illinois, USA.

Leafing through Allen Coombes', The Book of Leaves, leaves you impressed by its handsome, although somewhat spartan, encyclopedic

approach and extensive coverage, but it leaves you wondering about the intent of the book, which is not exactly a pretty picture book, not a field guide, and not an atlas of tree leaf form, but something of all these things. This book seems designed to simply illustrate a lot of tree leaves, and it certainly does that. Exactly 598 trees were selected from all the world's temperate regions are profiled, one species to a page. Two monocots are included and seem strangely out of place. Each profile is dominated by a life-sized image of a typical leaf, and if the leaf is too big, a life-sized portion thereof is accompanied by a reduced-size image of the whole leaf, which really does give you a sense of size for the bigger leaves. The color images, toned down to an appropriate level of green, are uniformly high quality. The six hundred species are organized alphabetically by botanical family name, which appears in the upper corner of each page, i.e., Fagaceae rather than Beech family, and then alphabetically by genus and species, which makes it hard to access a specific tree without knowing its generic and family names. Although there is an index by common name and an index by scientific name, even the table of contents fails to list the families and inclusive page numbers. To complicate access further, up to date taxonomic placements mean that for example maples and buckeyes are no longer in their long- familiar respective families, but submerged into Sapindaceae, and this book is not really written for the people who would know this. One is tempted here and there to quibble about certain species omitted or included, but the coverage is broad and even includes the southern hemisphere, e.g., Nothofagus.

Each profile consists of a set of standard elements: tabular data on leaf type, leaf shape, leaf size, leaf arrangement, bark, flowers, fruit, distribution with a world map, and habitat, a small silhouette of a mature tree showing the general shape and size relative to a small human figure (the author perhaps?), and the species name with authority and common name. One or two short paragraphs provide a general description of the tree including information on horticultural varieties or selections and landscape value, flowering, growth habits, and similar species. A caption accompanies each leaf image with a detailed description of the leaf similar to what would be found in a taxonomic manual.

The introduction provides a brief general botany level background on leaves, their form and function, and plant taxonomy. An attempt is made to provide a dichotomous key and tabular type of organization for leaf forms showing thumbnail images of all the leaves in the book in a way that could be used to identify an unknown leaf, but it strikes me as wholly inadequate for that use because even within such general categories you would end up trying to match your leaf to dozens of images. At 656 pages in a hard cover this is a hefty tome, not a field guide. This is not a book most botanists will need or want, but the Book of Leaves will find a place on many a book shelf as a reference book for arborists, horticulturalists, nurserymen, and tree-loving gardeners. With my interest in tropical trees the temperate zone orientation was disappointing, but perhaps leaves of tropical trees will be the author's next project. Coombes has written a number of handbooks and guides to trees and shrubs among which are the Illustrated Encyclopedia of Trees and Shrubs and the Dictionary of Plant Names. Priced at $55 in hard cover the Book of Leaves seems a very good value.

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Diversity, Phylogeny, and Evolution in the Monocotyledons

Seberg, Ole, Gitte Petersen, Anders S. Barfod, and Jerrold I. Davis (eds).
2010. ISBN 978-87-7934-398-6. (US$68.50 [398,00 DKK]) 664 pp. Aarhus University Press Langelandsgade 177 DK – 8200 Århus N.

This book provide an accurate and timely compendium of current research on Monocotyledons (monocots), a traditionally recognized, monophyletic group of angiosperms. There are about 100 families and 67,000 species of monocots, so that monocots comprise about one-fourth of the approximately 250,000 species of flowering plants. Monocots provide most of world's staple foods including grain crops as rice, wheat, corn, barley and rye. They also include other economically important groups like orchids (the largest family of monocots in terms of species), gingers, lilies and aroids. Several orchids are important epiphytes in tropical forests, providing food and habitat for insects, fungi, and other kinds of organisms in the forest canopy. Another group of great economic importance is the palm family (Arecaceae), which includes coconuts, dates, and the oil palm. Several chapters of this

book focus specifically on specific families like Orchidaceae and Arecaceae but half of book is devoted to Poales. Diversity, Phylogeny, and Evolution in the Monocotyledons includes reviews and reports of the current research held by some of the world's leading specialists in this field. Edited by Ole Seberg (University of Copenhagen), Gitte Petersen (University of Copenhagen), Anders Barfod (University of Aarhus) and Jerrold Davis (Cornell University), this book is based on the scientific presentations made at the Fourth International Conference on the Comparative Biology of the Monocotyledons and the Fifth International Symposium on Grass Systematics and Evolution held in Copenhagen in 2008. The 1993 Kew monocot conference (published as Rudall et al, 1995) became the first in an ongoing meeting series held periodically to discuss major advances in monocots. These conferences usually gather a huge amount of, and sometimes overlapping information, so that it is always very good to find a comprehensive book that centralizes major ideas. The newly updated compendium of monocot research builds upon the strengths of former books although it is more specific than the previous ones - published as volumes 22 and 23 of Aliso (2006 and 2007) – where a huge amount of information (and colour pictures) were gathered concerning several taxa of monocots (eg. arecales, asparagales, agavaceae and xanthorrhoeaceae, alliaceae/amaryllidaceae, iridaceae, orchidaceae, commelinales, discoreales, liliales, zingiberales). Within this new, recently published monocot book, the reader can find information concerning diverse aspects of monocots like species boundaries, relationships among closely related-species, differences in morphological characteristics, and the origin and diversification of some lineages, specially Arecaceae, Araceae and Orchidaceae. With 664 pages of text in 32 "chapters," there is more than enough to appeal to, and challenge, a wide-ranging audience although some knowledge of monocots is required. Most of the data presented are derived from phylogenetic studies so that some background information concerning molecular tools and interpretation of phylogenetic trees is required to understand this book. Personally, I missed some chapters concerning floral evolution, pollination systems and other ecological basic knowledge that might help readers to understand the importance and diversification of monocot species. Apart from their obvious economic importance as sources of foods and other materials to mankind, several monocots play an important ecological role in a variety of habitats, such as prairies, marshes, bogs, ponds and streams. Nevertheless, scientists looking for current information about monocot research, as well as specialist in this field will find it a handy tool for quick cross-referencing and current phylogenetic advances in monocots.

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- Isabel Marques, Universidade de Lisboa. Museu Nacional de História Natural. Jardim Botânico. Rua da Escola Politécnica 58. 1269-102 Lisboa. Portugal

Gymnosperms of the United States and Canada

Elray S. Nixon
Illustrated by Bruce L. Cunningham.
2010. ISBN-13 978-0-934115-05-6 200 pages (hardcover, US$74.95; paperback, US$59.95). Forester-Artist.com, 180 County Road 8201 Nacogdoches, Texas 75964.

This is a striking and unusual book whose greatest strength is the detail and accuracy of the illustrations. The coverage includes the native and naturalized gymnosperms of North America. Each species is very thoroughly illustrated: bark, cones, seeds, leaves, aspect (both summer and winter, as appropriate), all in intense color. The vivid hues on every page are reminiscent of the artistic wall charts of the past. The drawings are absolutely faithful to the real plants, the parts are all properly labeled, and the bright colors, while exaggerated, are not at all misleading. In fact they are an aid to instruction. There's no denying, they draw the eye and focus on the key characters of each species.

There are thorough keys from the level of Division

(Phylum) down to species. There are no species descriptions but the full-page color illustrations more than make up for that. The pictures mostly lack scale bars, but the captions give the real size of each element in the composition.

The nomenclature is taken verbatim from Eckenwalder and Thieret and contributing authors, *Flora of North America, volume 2*, 1993. It follows, therefore, that research findings since then are not reflected here. A notable example is the work of D. P. Little, *Systematic Botany* 31: 461-480. 2006, on the genus *Cupressus*, wherein the generic name is restricted to the Old World species, and those of the New World become *Callitropsis*. It's an area of active research, and it is easy to see why the author chose to stick with FNA. Taxonomists working in the area would find a treatment of some of the synonymy to be useful, but for most of us that is beyond the basic morphology of gymnosperms we would want for teaching and research and in this the book excels.

The book concludes with an illustrated glossary, a page of references, and a nicely done index, including references to all the illustrations. Finally, there are 19 numbered pages of advertisements, all in full color, for other products from this publisher, including note cards, plaques, and posters. After-the-index publishers' advertisements were common in the 19th century; perhaps the custom is being revived.

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Seeds of Amazonian Plants

Cornejo, Fernando and John Janovec. 2010. ISBN 978-0-691-14647-8 (Paper US$24.95) 186 pp. Princeton University Press 41 William Street Princeton, New Jersey, 08540-5237.

The study of seed dispersal is crucial to many investigations in community and population ecology, including questions involving succession, recovery from anthropogenic disturbances, and mechanisms maintaining diversity. For example, the role of dispersal limitation in structuring plant communities typically involves comparing the composition of dispersed seeds to that of established seedlings (e.g. Harms et al. 2000). Yet it is extraordinarily difficult to identify seeds that arrive in seed traps. The same problem is encountered in studies of the diets and dispersal effectiveness of fruit-eating animals – how to identify seeds in feces, where one has no traces of other parts of the plant. This challenge increases with the diversity of the flora. In one of the most diverse regions, Amazonia, this challenge has been eased considerably by the publication of 'Seeds of Amazonian Plants' in the Princeton Field Guides series (Cornejo and Janovec 2010). This 155-page volume includes high quality color photographs of seeds of 543 genera, primarily from the Peruvian Amazon. Most genera are represented by an image of just one species, but some of the more diverse genera (e.g. *Ficus*, *Piper*, *Chamaedorea*, *Inga*, *Miconia*) are represented by two or more images, for a total of 750 photographs.

The images are organized alphabetically by family and genus (with 131 families represented). Each family has a one-paragraph description, which describes growth forms and major vegetative and fruit characteristics. Each genus has a similar paragraph, which additionally lists the genus' range in the Western Hemisphere. The vegetative characters are those that are useful for field identification, including leaf shape and arrangement and characters relating to bark, sap/latex, and spines, thorns, and other distinctive structures. A Glossary and plates of line drawings at the end of the text make these descriptions useful to those not familiar with the botanical terminology.

If the user does not already have an idea what genus a seed might belong to, he/she can use key the authors provide in the first part of the text, 'Aid to Identification of Amazonian Seeds.' This key is very pragmatic, and quite distinct from a key to floral or vegetative characters of the same set of genera. The first choice in the key separates seeds [and diaspores(fruits)] with obvious adaptations for wind dispersal (wings or hairs) from those lacking such structures (and thus likely dispersed by animals). The wind-dispersed taxa are next separated into diasporas with wings or hairs, seeds with wings, and seeds with hairs. The key separates non-wind-dispersed seeds first by size, and then within each size class by shape and color. Most of these categories are further separated by characteristics of the surface (e.g. pubescent, smooth, or striate). Each terminal node of the key lists the genera that are potential matches (typically 2-10 genera), each with a page number,

enabling the user to narrow the possibilities further by using the images and genus descriptions. The images themselves include seed size information, and are of very high quality, and beautiful to those of us who appreciate seeds. The tiniest seeds are represented by scanning electron micrographs, but the majority are illustrated with color photographs taken under natural light.

I found it slightly frustrating that the images were identified only to genus, and not to species. I imagine the authors did this so that users would not erroneously assign their seeds to the illustrated species. Species within a single genus typically have similar-looking seeds, and with most genera represented by only a single species, the 'best match' would frequently be the right genus, but the wrong species. Nevertheless, the species identification would occasionally be useful to a researcher. For those genera where seed appearance is variable, and the text includes photos of two or more species, identification beyond the genus would be particularly helpful.

The only real problem with this text is that erroneous page numbers are given in the key for some of the genera. In fact, a few of the genera listed in terminal nodes in the key are not even described or illustrated in the text. The other genera can be found by looking through the pages for the appropriate family (the book does not have an index). If one does not know the family, one would need to consult another source in order to locate the genus, and the images of its seeds, in the text. This editorial problem is unfortunate, but does not detract significantly from the book's value.

To produce this unique volume required authors knowledgeable not only with the diverse flora of Amazonia, but also with seeds of this flora, and the characteristics of dry seeds that are useful in identification. Fernando Cornejo began developing his own reference collection of seeds in 1984 in Manu National Park in Peru. His expertise in seed identification increased further as he rose to the challenge of identifying seeds in both seed traps and fecal samples of birds and bats during our collaboration in northeastern Peru in 1988-1992. At that time he began pursuing the idea of a photographic guide to seeds of the Peruvian Amazon. Further field work in multiple sites in Amazonia, and the collaboration with John Janovec, led to completion of a very useful reference. Janovic is research botanist and director of the Andes to Amazon Biodiversity Program at the Botanical Research Institute of Texas (also Cornejo's home institution), and has published extensively on the flora of the neotropics, particularly Myristicaceae and the flora of southeastern Peru.

This book will be extremely useful to anyone studying dispersed seeds, whether in seed traps, exposed substrate, or diet samples from animals. It is not really a 'field guide,' but a reference book for one's lab or field station. Because most of the photographs are from seeds from Peru, and the authors' expertise is greatest for the Peruvian Amazon, this volume will be most useful to those working in western Amazonia. However, many genera are widespread across Amazonia, making this book useful throughout the region.

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Systema Naturae 250: The Linnaean Ark.

Polaszek, Andrew (editor).
ISBN 978-1-4200-9501-2 (hardcover US$99.95) xvi + 276 pp. CRC Press, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, Florida 33487.

This volume is an outgrowth of a symposium held in Paris in August of 2008. The title and subtitle of the book indicate that the book is concerned with Systema Naturae, ed. 10, volume 1 only, of 1 January 1758, the starting point for binomial nomenclature in animals; there is but passing mention of volume 2 of Systema Naturae, 1759, devoted to plants.

There are 8 unnumbered pages of color photographs without captions, except for a reference to another page, where the same photograph is properly captioned, and there reproduced in black and white – but without reference to the colored version of the photograph between pages 16 and 17. This is a very

unusual, and one wonders what technical detail of book publishing wrought it; it cannot have been the editor's wish.

The 18 chapters cover just about every subject that could be subsumed under this title, from speculations about Linnaeus' childhood to problems with computerizing the names of all the world's plants and animals. The lengthiest chapter, 54 pages, was authored by B. Dayrat; it is a history of zoological nomenclature, written in a most engaging style. It may be old stuff to zoologists, but every botanist with an interest in nomenclature will want to read it.

There is a BIG problem (chapter 14). BIG is an acronym for "Biodiversity Indexing Group." I infer that these people are leaders in what is sometimes called "bioinformatics." The chapter's title is "The All Genera Index: Strategies for Managing the BIG Index of All Scientific Names." The underlying notion is to make every name for every organism available at a single website, with all manner of ingenious cross-links. The chapter is sometimes difficult to follow, because the author uses "invalid" in the sense of the ICZN (i.e., the name is not correct in an author's taxonomic judgment), versus the sense of the ICBN (i.e., the name fails to meet the manifold requirements of Articles 32-45, which are minutely specified but do not include an author's taxonomic judgment). Evidently, the aim is to indicate which generic names are valid, in the zoological sense. This is clearly a hopeless task; with the daily appearance of new monographs, "correctness" shifts constantly – and yesterday's invalid name may become today's valid name. "As a result [of new studies], 5-10% of scientific names become taxonomically invalidated each decade."

The compilers of the original two volumes of Index Kewensis (1885; seed plants only) made many decisions about synonymy and "correctness," a vain effort not abandoned until Supplement 4 of 1913. This is not mentioned, but it may be relevant to today's computer-driven efforts at completeness.

The discussion of homonyms is instructive: the computer sees *Oenanthe* Vieillot, 1816, Aves, as being a homonym of *Oenanthe* Linnaeus, Apiaceae (or Umbelliferae), 1753. They are homonyms in a grammatical sense, irrelevant except to a computer, but not nomenclaturally, given the explicitly stated independence of the two Codes. In the example cited in this chapter, there is also said to be an *Oenanthe*, Orchidaceae. Other than at the Global Biodiversity Information Facility (GBIF) website, this so-called orchid is not to be found in any other index. Best I can tell, this is a ghost reference. The chapter author also refers to an avian *Oenanthe* Pallas, 1771. This is a nomen nudum, and therefore to be ignored; moreover, it is not recognizable at the GBIF site, because authors of names are suppressed. Further, at the GBIF site, it is said that *Oenanthe* of Kingdom Plantae, is an ambiguous synonym of *Oenanthe* (of Phylum Animalia, presumably). It is, of course, nothing of the sort, except in the "mind" of a computer. It may be mentioned in passing that the website fails to list the names that have been given to the parsley-related *Oenanthe*, but it does list some of the avian names and assigns a few to Kingdom Plantae. It is easy to see how immensely difficult assessing biodiversity on a worldwide scale is going to be.

The final chapter of the book is "250 Years of Swedish Taxonomy." This is not only great history, but also an excellent treatment of current efforts in Sweden to assess the biodiversity of an entire country. The book concludes with a thorough index, sadly missing from many symposium volumes. The cover illustration for the book is a reproduction of "La fontaine d'os," "The fountain of bones," by surrealist Wolfgang Paalen. It is colorful; its relevance to the contents of the book escapes me.

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The lament of Captain Arthur Phillip, leader of the squadron carrying the first colonists and convicts to settle in Sydney, January 26, 1788, - -

"I am without one botanist, or even an intelligent gardener."

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Books Received

Aloes: The Definitive Guide. Carter, S., J.J. Lavranos, L.E. Newton, and C.C. Walker. 2011. ISBN 978-1-84246-439-7 (Cloth US$160.0) 760pp. Royal Botanic Gardens, Kew. Distributed by University of Chicago Press1427 E. 60th Street, Chicago, Illinois, 60637.

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

Plant Science Bulletin Featured Image

Nature Games

Mauricio Diazgranados

Saint Louis University

A crystal pond surrounded by cushion plants (Distichia muscoides Nees & Meyen) provides the playground for Nature to play with shapes and colors beyond the imagination.

This pond was found at 14,500 ft of elevation, in a deep valley surrounded by snowy peaks of more than 16,500 ft. The acid sulfate-chloride thermal water gives rise to the accumulation of white and yellow mineral crystals on the bottom of the pond and covering the roots of a colony of Distichia muscoides. The extremely imbricated leaves of these plants are adapted to the constant freezing temperatures. The ice of the dawn is still covering the tips of the leaves.

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