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By the time you read this we already will have celebrated 100 years of the **Botanical Society of America** at our centennial meeting in Chico, California. One hundred years ago the founders were concerned with not completely replacing the "old botany" of the external form and affinities within the plant kingdom, that was no longer attracting the new generation of students, with the exciting "new botany" of anatomy and physiology (anon., 1887). Furthermore, some of these botanical leaders were convinced that a change in pedagogy was required. William Ganong suggested: "In the laboratory work everything possible should be done in the independent investigation spirit. The student should be led on by having each new thing placed before him in the form of a problem, so arranged that its solution comes just within his own powers…In general, nothing should be told a student that he can find out for himself."

Times have changed, but some things seem to remain the same. There is still an "old botany" (now including anatomy and traditional physiology) and the exciting field is molecular. Yet we realize that knowledge of the "old fields" remains necessary and those fields are benefiting from application of the new techniques. And we are still struggling with improving pedagogy to make students more active in their own learning.

In this issue we highlight some tools employed by contemporary botanists to engage students in both formal and informal settings. In our feature article Shirley Graham describes some of the forensic botany from an exhibit she helped prepare for the National Botanical Garden. (Have any of you introduced the microscopy lab with a "who done it?" and a variety of microscopic clues?). Later Keith Killingbeck provides an abstract of some of the innovative student writing he uses to enhance his field botany course. Finally, we provide an entry to some of Tim Gerber's work with school teachers getting them excited about using plants to "teach to the standards."

Enjoy the issue! The editor

Anonymous. 1887. The Botanical Gazette 12(4):87-88. William F. Ganong, 1907, *The Teaching Botanist.* New York, Macmillan.

CRIME-SOLVING PLANTS

Recently I was asked to provide text for a projected graphic display on the subject of forensic botany at the National Botanic Garden, Washington, D.C. Subsequently, the program directors asked me to expand on the display with a lecture entitled, "Crime-Solving Plants" for a public audience at the Garden. Bill Dahl, Executive Director of BSA, was directly involved in the original idea and later suggested that I submit the talk to the Plant Science Bulletin. The text follows below together with literature citations added to allow anyone interested in using the information to refer to some of the original studies and to see some of the illustrations that accompanied the presentation.

Early in January, 1935, a man named Arthur Koehler worked his way through crowds of people gathered outside the courthouse in Flemington, New Jersey. He was there to testify in one of the most important trials of the 20th century, the trial of Bruno Richard Hauptmann for the kidnapping of the young son of aviation hero Charles Lindbergh and his wife Anne. Dr. Koehler was an expert on wood anatomy and identification at the Forest Products Laboratory, United States Forest Service in Madison, Wisconsin and what was unique about the particular testimony he was about to give was that it dealt with the structure of wood, namely the wood of the ladder used by the kidnapper. Presenting that kind of evidence was highly unusual, there was little precedence for it, and it was not clear it would even be allowed. The use of scientific expert witnesses was an uncommon and limited practice at that time and botanical evidence had little standing in the criminal courts.

The defense argued strongly against allowing Dr. Koehler to testify, saying "there is no such animal known among men as an expert on wood; that it is not a science that has been recognized by the courts; that it is not in a class with handwriting

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experts, with fingerprint experts, or with ballistic experts... The witness probably may testify as an experienced carpenter or something like that, …. but when it comes to expessing an opinion as an expert or as a scientist, why that is quite different indeed. We say that the opinion of the jurors is just as good..." (Pope 1935). The judge responded, in what we can now consider to be an historical moment for forensic plant science, "I deam [sic] this witness to be qualified as an expert" (Trenchard 1935).

Koehler subsequently went on in the trial to demonstrate how the wood of the ladder, beyond any doubt, linked Hauptmann directly to the crime. The ladder was a unique design, homemade, and in 3 parts that could be disassembled to fit in a car. Koehler presented three kinds of information from his study of the ladder - 1) identification of the wood used, 2) physical marks left by tools on the wood, and 3) comparisons of the wood structure. He was able to determine that the wood used in the ladder was of four kinds: douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco), 2 types of pine (*Pinus ponderosa* Dougl. ex Laws. and *Pinus echinata* Mill., or a close species, commonly called yellow pine) and birch (*Betula* sp., probably *B. alba* L.) used for the connecting dowels. In making the identifications he saw the characteristic presence in pine of very thin epithelial cells lining the resin canals, while in douglas fir he distinguished characteristic thick-walled cells lining the canals and faint spiral markings along the length of the tracheids (Fig. 1). The wood of the top left rail had clearly been used before. It had been sawn away from a bigger piece and there were nail holes present made by old-fashioned square-headed nails. Koehler alerted authorities to look for a missing board in any place connected with a future suspect. Remarkably, Koehler using scarcely visible planer markings was able to trace the some of the pine back to its original mill source in McCormick, South Carolina and then forward to the National Lumber and Millwork Co. in the Bronx, NY just 10 blocks from Hauptmann's home. This was prior to Hauptmann's arrest after passing a bill from the ransom money. A week after the arrest, police realized that one of the floor boards in Hauptmann's attic had been partly cut away. Koehler was able to show in the trial that the attic board and the ladder

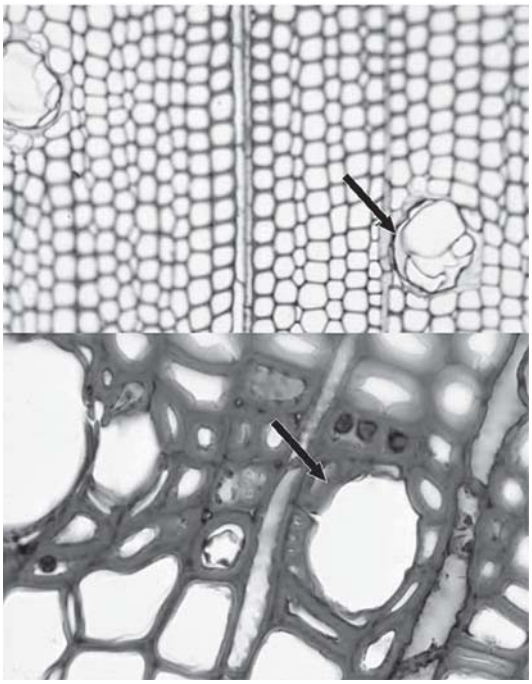

Figure 1. Cross-sections of gymnosperm wood. *Pinus echinata* Mill. (top) and *Pseudotsuga menziesii* (Mirb.) Franco (bottom)

rail had once been a single board by the exact match of annual rings (Fig. 2) and importantly, he demonstrated that patterns of annual rings are unique so that no other random board would have an absolutely identical pattern, just as today we demonstrate that portions of our DNA are unique to each individual. The wood anatomical evidence

ultimately was one of the most incriminating and unshakable pieces of evidence that led to Hauptmann's conviction and eventual electrocution for the kidnapping (Graham, S. 1997).

Figure 2. Attic floor above Hauptmann's apartment. with the top left rail of the ladder (right) in place as a continuation of the floor board (left) from which it was fashioned; one nail corresponding to nail hole in the rail and floor joists visible on the rail. With permission of the United States Forest Service.

Since that trial, what is termed forensic botany, or the use of plant remains to help solve crimes or other legal problems**,** has been widely accepted as valid scientific evidence by the courts. If the wildly popular televison crime shows like CSI, Law and Order, Cold Case, and many others reflect to some degree how real life detective work proceeds, then plants are now beginning to play an increasing role in solving crimes. In February this year in a TV episode of "Bones", one of the forensic anthropologists finds part of an ear bitten off the killer of a young woman. On the ear is ear wax within which pollen is embedded. As the story continues, the pollen is identified as a species of the grass genus *Eragrostis,* a species said to grow only in South Africa, and this leads the scientists to a suspect who has just come from there. I comment further on this story later, but the point here is that although this particular case is fiction, plants or parts of plants can provide significant supporting, sometimes, crucial evidence in solving crimes.

The reasons for this are several: 1) plant remains can be found almost everywhere; 2) they offer multiple sources of evidence, both macroscopic and microscopic, such as pieces of wood, (even as charcoal), seeds, fruits, leaves, twigs, plant hairs, microscopic air-borne pollen and spores, or in aquatic environments, algal cells; 3) their morphological diversity allows us to identify them and from the identification gather other useful information such as the season or geographical location in which a crime took place, whether a body has been moved following a murder; if a body is buried, how long it has been buried, and whether a suspect was present at the crime scene.

Pollen and spores, in particular, have all the useful characters just mentioned**.** Being widespread in nature in the air and on most surfaces, we breathe them into our lungs and they stick to our clothes. Pollen and spore exines are amazingly diverse, sometimes even to the species level, and their production is generally seasonally and often geographically restricted, thus their presence can point to a specific season, sometimes even a specific location, in which a crime was committed (Szibor, R. et al. 1998). There are many published examples of pollen morphology among related families or within families or genera that illustrate this diversity and consequently their usefulness as trace evidence (e.g. Nowicke and Skvarla 1977, Caryophyllales; Graham, A. and Barker 1981, Fabaceae, Caesalpinioideae; Patel et al. 1984, Myrtales; Bruce and Dettmann 1996; Fig. 3). In addition, they have other advantages. They are slow to decay; pollen can be retrieved from rocks millions of years old, a valuable asset for oil companies and archeologists. Because they are microscopic, they remain unseen, silent witnesses and even if they were visible, unlike fingerprints, they would be nearly impossible to eliminate from a crime scene.

A recent example from New Zealand illustrates how pollen as trace evidence was used to solve a crime (Mildenhall 1998). In Christchurch in 1997, a young woman was grabbed, pulled into an alleyway, and raped. Although shaken**,** she was able to describe the assailant and shortly after a man matching her description was arrested. The suspect admitted being in the area and noticing this woman, who seemed a little distressed, he said he stopped to ask her if she was OK. Now, he claimed, she must be putting his face on the face of the rapist, because he had not been in the alleyway. There was no DNA evidence, but the police noted dirt-stains on his clothes. These, he said, came from his yard where he was working on his car.

The alleyway where the crime occurred was lined along one side by a row of low flowering shrubs of wormwood, *Artemisia arborescens* L. a Mediterranean native. The shrubs had been broken and flattened during the struggle that led up to the rape. The suspect's clothes with the dirt stains were sent for analysis together with a comparative sample of soil from the crime scene to the forensic palynology laboratory of the New Zealand Geological Survey. The soil sample was dominated, as might be expected by pollen of *Artemisia* (77%), much of it occurring in clumps, indicating the source was at the scene and had not merely blown in. The pollen of this genus has a distinctive, echinate (spiny), very

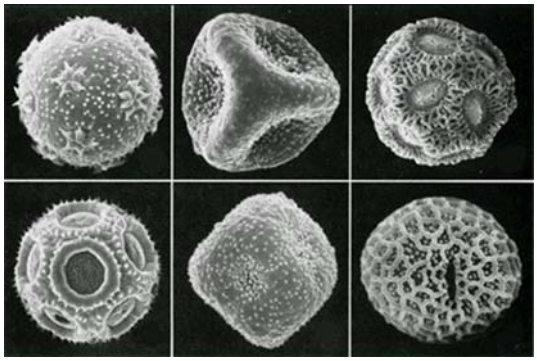

Figure 3. Diversity of pollen morphology in Centrospermae. From Nowicke and Skvarla 1977 with permission.

thick-walled exine. There was a mix of mix of fresh pollen and somewhat older, darker colored grains, as well as an unusual large, thick-walled fungal spore in the soil sample, and other spore and pollen types in very low percentages. The same *Artemisia* pollen dominated the clothing sample (53%), again occurring mainly in clumps, in a mix of fresh and older grains, and the same thick-walled fungal spore type was abundant. The percentage of *Artemisia* was so high that the only explanation was that the clothing was in direct, forceful contact with an *Artemisia* plant. Investigators searched for wormwood near the suspect's home, and other places he visited but found none. The species is not common in New Zealand, being only occasionally planted in gardens. The forensic laboratory had processed over 1000 pollen samples from many localities in New Zealand and never found *Artemisia* in more than a trace amount, so the chances of finding large amounts were statistically 1 in 1000, but in actual fact, chances were certainly much lower. The fungal spores were also rare. This pollen and spore evidence was presented at the trial, the suspect was convicted, and was given an 8 year prison sentence. Similar comparative pollen evidence led to conviction of a murder suspect in northern Australia (Milne 2005), and in a civil case where pollen intake to a gasoline line was cited as the cause of a fatal plane crash, pollen provided important evidence negating the claim (Graham, A. 1997).

Returning to the use of plants in crime TV shows, and specifically the finding of *Eragrostis* grass pollen in ear wax that led to a suspect, the science of this story presents a bit of a problem. Although many plant groups have spectacular pollen morphology, not all pollen is remarkable structurally and sadly the pollen of grasses, one of the most common and widespread plant families in the world, is nearly as feature-less as a ping-pong ball, so it would have been impossible to identify an *Eragrostis* plant to genus or species and pinpoint the geographical source based on pollen (Fig. 4). An interesting exception in the pollen of grasses is cultivated corn which has extremely large pollen, ca. 100um in diameter, compared with a more average pollen diameter of ca. 35um..

Seeds and fruits, like pollen, very often give away their identity by their specialized features, especially if they are provided with hooks or barbs. These structures have evolved to aid in dispersing progeny away from competition with the parent plant and are very effective in their role, as anyone who has walked through a field in summer or fall has experienced. In 1997 in Ohio, I was called by the sheriff's department of Champaign Co. near Columbus, Ohio to identify some seeds (actually

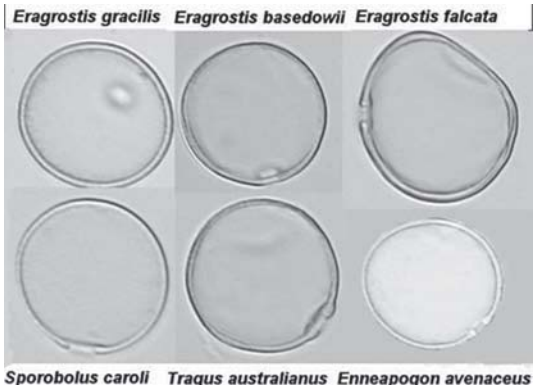

Figure 4. Pollen of the grass genera *Eragrostis, Sporobolus, Tragus, and Enneapogon* illustrating the absence in most grass pollen of useful characters for identification. With permission of The Newcastle Pollen Collection.

single-seeded fruits) associated with the murder of two children. The children were found buried in an area at the shady wooded margin of a local cemetery not long after they were reported missing by the stepfather. He soon became a suspect. I identified the seeds as from *Geum canadense* Jacq. (or possibly *Geum aleppicum* Jacq. with very similar fruits), commonly known as avens, in the Rosaceae and from *Galium aparine* L., bedstraw, in the Rubiaceae, species of shaded to partly sunny places in dry to moist somewhat disturbed woodlands (Fig. 5). The seeds had been removed from a blanket and the stepfather's clothing recovered at his house. He claimed the seeds came from his small farmyard, but neither plant occurred in his open weedy yard, nor would they have been expected there. Both species were found at the gravesite. The seed evidence linked the suspect to a wooded area such as that of the gravesite and was part of the evidence introduced at the trial (State of Ohio vs. Kevin Neal, 2000). He was convicted of the two

murders and is now serving two life sentences. Similar investigations employing seed evidence from crime scenes have been reported by Lipscomb and Diggs (1998) and in a case investigated by David Hall, summarized at www.nwf.org/wildlife/wildlifecrime.cfm.

Botanical trace evidence is also obtained from plant cells found in gastric contents. Many of the common foods we eat contain seeds or other plant parts with specialized cells having thick walls of cellulose and lignin. Because these materials do not digest or digest only slowly they can be present in partially digested stomach contents or excreted in feces, and are often able to be identified in degraded form (Bock, J. H. et al. 1988). It is sometimes possible to determine components of a victim's last meal which, in turn, can provide clues to the setting or timing of death. In a particularly tragic case in London in 2001, partially digested plant material even gave a clue to the victim's homeland and suggested a reason for his death.

The case began in September, 2001, when the torso, minus limbs and head, of a young boy 4-7 years in age was found in the Thames River. There was little to use for identification based on standard techniques and there were no corresponding missing child reports. Scotland Yard suspected from the condition of the body, which had been deliberately drained of blood, that they might be dealing with a ritual killing – a human sacrifice. They turned to forensic scientists, including a palynologist and a plant anatomist to look for whatever evidence might give them a lead in the case. DNA suggested the child was West African in origin and the contents of the digestive tract revealed alder (*Alnus*) pollen, a tree native to northern Europe, and was an indication that the child had been in England in the days prior to his death.

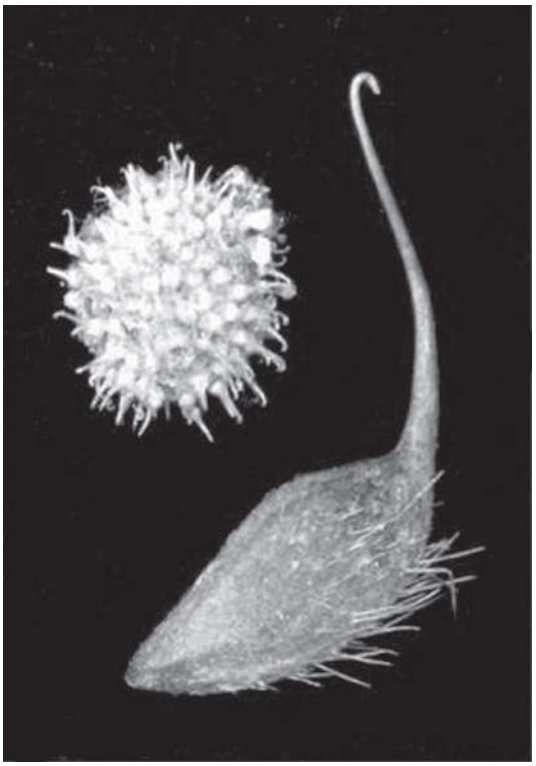

Figure 5. Hooked seeds transported from a burial site on a murderer's clothing. *Galium aparine* L. (left) and *Geum canadense* Jacq. or *Geum aleppicum* Jacq. (right). Photo by S. Graham.

Of greatest interest was the presence in the stomach and intestines of an unusual assortment of small mineral pieces, clay pellets embedded with minute gold particles, and the remains of some type of bean seed. The anatomy of seeds in some plant families, including the legumes (Fabaceae), the mustards (Brassicaceae), and the tomato-potato family (Solanaceae), is quite distinctive and can even be species-specific in some taxa. By comparing seed coat anatomy from the stomach contents of the boy, the seeds were closely matched by a plant anatomist at the Royal Botanical Gardens in Kew to a highly poisonous legume from West Africa, the Calabar bean (*Physostigma venenosum* Balf.). Anatomical recognition of legume seeds is possible because the outermost cells of the seed coat consist of a diagnostic palisade layer in which the cells are typically narrow, elongate, and very thick-walled. It is the heavy walls that make them resistant to quick dissolution. The next deeper layer also can be quite diverse and help in narrowing an identification. The presence of Calabar beans in this case, mixed with the other unusual items in the stomach, suggested the child had been given a toxic paralytic voodoo potion. This finding pointed, like the DNA, to areas of West Africa, like Nigeria, where witchcraft is known to be practised still, and it supported the idea that the child had been a human sacrifice.

Further investigations, using bone chemistry, narrowed the home of the boy to an area near Benin, Nigeria, where Calabar bean is native and where animal, and rarely human, sacrifice is performed. Thus far, no one has been arrested for the murder but as part of the investigation, a ring trafficking in people from Africa into Great Britain and Germany was uncovered and shut-down and 21 people involved were arrested, including the man who brought the child from Africa (The Guardian 2004; see also National Geographic Channel presentation, "The Witchcraft Murder", 13 Feb 2005). Today the fastest growing component of botanical evidence in forensics is molecular evidence. We are in early stages of this type of plant trace evidence. The first instance in which data from plant DNA was accepted as admissible evidence in a criminal

case was in Arizona in 1992. In that case, State of Arizona vs. Bogan, a young woman was murdered and her body dumped in the desert. The suspect was taken into custody after his pager was found near the site. He claimed he had given the woman a ride and that she had stolen his wallet and pager from his truck. A member of the Maricopa Co. investigating team, Charles Norton, happened to notice that one of the palo verde trees (*Parkinsonia microphylla* Torr.) at the scene was freshly scraped, possibly by the murder's vehicle. On an impulse he picked some seed pods hanging from the tree; later, the same kind of pods were found loose in the open truck bed of Bogan's truck and Norton, knowing that DNA could identify human individuals, thought perhaps the pods could be linked by their DNA to the tree at the crime scene. Dr. Tim Helentjaris, a geneticist at the University of Arizona agreed to try. Using RAPDs (Randomly Amplified Polymorphic DNA) to produce profiles of visualized DNA fragments- a kind of 'fingerprint' of individuals being studied**,** he was able to match the DNA from the 2 seed pods found in the truck to the seed pods collected from the tree at the scene and only to that tree. This was because the palo verde trees had an exceptionally high degree of intraspecific genetic variation (Yoon 1993). The truck, if not the suspect, had definitely been at the site. The jurors agreed Helentjaris's findings were very influential in their decision to find Bogan guilty of first degree murder.

In recent plant DNA research, botanists at the Australian National University in Canberra, Australia have produced a prototype identification system for grasses based on DNA, a kind of molecular taxonomic key (Ward et al. 2004). Although grass pollen is not generally helpful in forensics, other parts of grasses like seeds and stem or leaf fragments can be a good source of DNA and because grasses are among the most likely plants to be encountered as trace evidence, a means of identification would be a valuable tool. In their study, using primers designed for the purpose, they sequenced parts of the mitochondrial genome that were representative of subfamily, tribe and genus ranks within a test set of 20 samples. These were then used to identify 25 unknown grass samples in a blind test. With more complete representation, the possibility of identification of many more kinds of grasses by molecular means seems to be within reach.

It is unfortunate that in this country, botanical trace evidence is still poorly integrated into crime scene analyses, in spite of its potential in many situations. In 1990, a survey of 30 of the largest forensic laboratories in the United States found that only 2 knew pollen could be used as a forensic tool (Bryant and Mildenhall 1990). This figure has not risen significantly in the past 16 years even though criminal investigations are becoming more sophisticated in treating other aspects of trace evidence (Bryant and Jones in press).

In great part, the failure to incorporate botanical evidence in investigations is due to lack of knowledge about plants by personnel who study crime scenes and so fail to collect it. The FBI's 2003 Handbook of Forensic Services (www.fbi.gov) mentions the usefulness of wood and cotton fibers and explains how these should be submitted for examination, but refers to no other kind of supporting plant evidence. Unless plant parts are conspicuously evident, samples of plant materials are not standardly taken, nor are specialists brought in to record critical observations of vegetation that could yield credible evidence.

The assessment of plant evidence requires well-trained specialists and frequently also access to extensive reference collections. Today, specialists in plant systematics, plant anatomy and morphology, and palynology are relatively few in number, and aging, and younger replacements are increasingly rare. The balance in plant science research has tipped so heavily toward molecular-based research that students interested in whole plant-based studies find fewer and fewer relevant botany courses available at universities, little research support at the graduate level, and few job opportunities. The value of botanical trace evidence in criminal and civil cases has been clearly demonstrated and is accepted by the courts. Justice can now only be more fully served when law enforcement agencies and other relevant groups recognize and take full advantage of its utility and open employment opportunities for botanically trained investigators. Academic institutions, for their part, must once more appreciate the value of providing well-rounded instruction in botany within their undergraduate biological programs.

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News from the Society

The Botanical Society of America "Centennial Award"

was established to acknowledge and honor outstanding service to the plant sciences and the Society .**We are proud to present the award recipients.**

Dr. Isabella Abbott | Dr. Gregory J. Anderson | Dr. Joseph E. Armstrong | Dr. Charlie Arntzen | Dr. Spencer Barrett | Dr. Carol C. Baskin | Dr. Jerry M. Baskin | Dr. C. Ritchie Bell | Dr. Herb Bormann | Dr. Winslow Briggs | Dr. Sherwin Carlquist | Dr. Dave Cass | Dr. Kenton Chambers | Dr. Mary-Dell Chilton | Dr. Mary Clutter | Dr. Paul Conant | Dr. Peter Crane | Dr. Daniel Crawford | Dr. Chicita Culberson | Dr. Charles Daghlian | Dr. Margaret Davis | Dr. Ted Delevoryas | Dr. Darleen A. DeMason | Dr. Nancy Dengler | Dr. David Dilcher | Dr. Wayne J. Elisens | Dr. Peter Endress | Dr. Hardy Eshbaugh | Dr. Ray Evert | Dr. Jack B. Fisher | Dr. Lafayette Frederick | Dr. Gerald J. Gastony | Dr. Patricia G. Gensel | Dr. Ernie Gifford | Dr. Richard H. Goodwin | Dr. Leslie Gottlieb | Dr. Linda E. Graham | Dr. Verne Grant | Dr. Sydney Greenfield | Dr. Christopher H. Haufler | Dr. Charlie Heiser | Dr. Leslie G. Hickok | Dr. Pat Holmgren | Dr. Kent E. Holsinger | Dr. Harry T. Horner | Dr. Hugh Iltis | Dr. Raymond Carl Jackson | Dr. Dan Janzen | Dr. William Jensen | Dr. Judy Jernstedt | Dr. Don Kaplan | Dr. Ted Kozlowski | Dr. David Kramer | Dr. Art Kruckeberg | Dr. Meredith A. Lane | Dr. Jean Langenheim | Dr. Nels Lersten | Dr. Joe Leverich | Dr. Harlan Lewis | Dr. Gene Likens | Dr. Phil Lintilhac | Dr. Jane Lubchenco | Dr. Rogers McVaugh | Dr. Elliot Meyerowitz | Dr. Hal Mooney | Dr. Jeffrey M. Osborn | Dr. Jeffrey D. Palmer | Dr. Barbara Palser | Dr. Dominick Paolillo | Dr. B.O. Phinney | Dr. Steward Pickett | Dr. Peter Raven | Dr. Jennifer H. Richards | Dr. Scott D. Russell | Dr. José Sarukhán | Dr. Barbara Schaal | Dr. Edward Schneider | Dr. J. William Schopf | Dr. James L. Seago, Jr. | Dr. Henry Shands | Dr. Beryl B. Simpson | Dr. Alan R. Smith | Dr. Allison A. Snow | Dr. Douglas Soltis | Dr. Pamela Soltis | Dr. David Spooner | Dr. Taylor Steeves | Dr. Diana Stein | Dr. Otto Stein | Dr. Kingsley Stern | Dr. William L. Stern | Dr. Dennis Stevenson | Dr. Don Stone | Dr. Tod Stuessy | Dr. Marshall Sundberg | Dr. Ian Sussex | Dr. Thomas N. Taylor | Dr. Robert B. Thorne | Dr. Dave Tilman | Dr. P. Barry Tomlinson | Dr. Shirley Tucker | Dr. Billie Turner | Dr. Natalie Uhl | Dr. Gordon Uno | Dr. Judy Verbeke | Dr. Barbara Webster

The BSA Graduate Student Research Awards

The BSA Graduate Student Research Awards support graduate student research and are made on the basis of research proposals and letters of recommendations. Withing the award group is the Karling Graduate Student Research Award. This award was instituted by the Society in 1997 with funds derived through a generous gift from the estate of the eminent mycologist, John Sidney Karling (1897-1994), and supports and promotes graduate student research in the botanical sciences.

The 2005 ward recipients are:

J. S. Karling Graduate Student Research Award

Joshua W. Clayton, University of Florida, Department of Botany, (Supervisor: Dr. Doug Soltis) - "Molecular Phylogeny and Biogeography of Simaroubaceae s.s. (Sapindales)"

BSA Graduate Student Research Awards

Monica Carlsen, University of Missouri – St. Louis, Department of Biology and Missouri Botanical Garden, St. Louis. (Supervisor: Dr. Peter Stevens) – "A Revision of the Sectional Classification in Anthurium (Araceae) Integrating Morphology and Molecular Phylogenetics"

Kate Hertweck, University of Missouri Columbia, Department of Biological Sciences (Supervisor: Dr. J. Chris Pires) – "Population dynamics of polyploidy: Phylogenetics, cytogenetics, and hybridization of Tradescantia"

Jamie H. Howard, Arizona State University, School of Life Sciences Graduate Program (Supervisor: Dr. Martin F. Wojciechowski) – "Symbiotic Specificity of Irlc (Fabaceae) and Rhizobia with Unsaturated Fatty Acid-type Nod Factors: An Evolutionary Perspective"

Gretchen M. Ionta, University of Florida, Department of Botany (Supervisor: Dr. Walter Judd) – "A phylogenetic analysis of Periplocoideae (Apocynaceae s.l.) and insights into the evolution of pollinia"

Aaron Jenks, University of California, Riverside, Department of Botany and Plant Sciences, (Supervisor: Dr. Seung-Chul Kim) – "Phylogeny and Biogeography of Salvia L. subgenus Calosphace (Benth.) Benth."

Gabriel P. Johnson, Southern Illinois University, Department of Plant Biology (Supervisor: Dr. Karen S. Renzaglia) – "Developmental changes in the placental transfer cells of Ceratopteris richardii"

Suzanne Joneson, Duke University, Biology Department (Supervisor: Dr. François Lutzoni) – "Differential Gene Expression in Early Algal and Fungal Lichen Symbiosis"

Marcela Martínez Millán, Cornell University, L. H. Bailey Hortorium and Department of Plant Biology (Supervisor: Dr. William L. Crepet) – "A Revision of the Early Fossil Record of Astridae"

Cynthia Skema, Cornell University, L.H. Bailey Hortorium (Supervisor: Dr. Melissa Luckow) – "Systematics of Dombeya (Malvaceae s.1.)"

Vernon I. Cheadle Student Travel Awards (BSA in association with the Developmental and Structural Section) This award was named in honor of the memory and work of *Dr. Vernon I. Cheadle*.

Tania Hernandez-Hernandez, Instituto de Biologia, UNAM, Supervisor - Susana Magallon Puebla

Purbasha Sarkar, Miami University, Oxford, OH, Supervisor - Dr. Daniel Gladish

Richard Tate, Humboldt State University, Supervisor - Dr. Alexandru MF Tomescu

Ramona Walls, Stony Brook University, Supervisor - Dr.R. Geeta

Ecology Section Student Travel Awards

Rebecca Anderson, Illinois State University, Advisor: Dr. Diane L. Byers for her Botany 2006 presentation entitled: "Selection and Adaptation in Heterogeneous Soil Nutrient Environments".

Marissa Jernegan, Eastern Illinois University, Advisor: Dr. Janice Coons for her Botany 2006 presentation entitled: "Seed Longevity of Lesquerella ludoviciana, an Endangered Species of the Illinois Sand Prairie".

Mycological Section Student Travel Awards

Nicholas B. Simpson, Kansas State University, Advisor: Dr. Ari Jumpponen for his Botany 2006 presentation entitled; "Exposure to increased inorganic nitrogen may irreversibly alter arctic ericoid mycorrhizal communities".

Phycological Section Student Travel Award

Nestor Anzola, University of Southern Mississippi, Advisor: Dr. George F. Pessoney for his Botany

2006 presentation entitled; "Algae From the Pascagoula River Basin: Phytoplankton Responses to Water Chemistry Dynamic in Small Streams"

Pteridological Section Student Travel Awards

Michael S. Barker, Indiana University, Advisor: Dr. Loren Rieseberg for his Botany 2006 presentation entitled: "Inferring paleopolyploidy in homosporous ferns using duplicate gene age distributions"

Joshua Der, Utah State University, Advisor: Dr. Paul Wolf for his Botany 2006 presentation entitled: "A global phylogeographic study of the chloroplast genome in bracken (Pteridium: Dennstaedtiaceae)"

Amanda Grusz, University of North Carolina - Wilmington, Advisor: Dr. Kathleen M. Pryer for her Botany 2006 presentation entitled: "Polyploids and reticulate voids: the Cheilanthes fenderli complex revisited"

Chad E. Husby, Florida International University, Advisor: Dr. Steven Oberbauer for his Botany 2006 presentation entitled: "Salinity tolerance ecophysiology of the giant horsetail, Equisetum giganteum, in the Atacoma Desert, Chile"

Annabelle Kleist, Carroll College, Advisor: Dr. Jennifer Geiger for her Botany 2006 presentation entitled: "Alternate pathways of fern dispersal to the Hawaiian Islands, Part 3: Cibotium"

Eric Shuettpelz, Duke University, Advisor: Dr. Kathleen M. Pryer for his Botany 2006 presentation entitled; " Toward a comprehensive phylogeny of extant ferns"

BSA Science Education News and Notes

BSA Science Education News and Notes
BSA Science Education News and Notes is a quarterly update about the BSA's education efforts and the broader education scene.

BSA-led Education Outreach Program Evolves, Expands

Although student researchers and scientist mentors participating in the science inquiry and mentorship program have the summer off, the BSA-led education outreach program was busy evolving and expanding. Summer also provided an opportunity for K-12 teachers and scientists to get together and exchange ideas during the Botany 2006 Education and Outreach Forum. We extend a hearty thanks to the individuals who are helping to bring the science and education communities together.

The BSA was pleased to sponsor educators from around the country to participate in the Forum: **Barb Schulz**, from the National Academies' Teacher Advisory Council; **Valdine McLean**, from Pershing County High School in Lovelock, Nevada; **Carol Packard**, from Sisters Middle School in Sisters, Oregon; **Carla Streng**, from South Albany High School in Albany, Oregon; and **Maria Santiago** and **Elizabeth Copper**, both with the Chicago Public Schools. You'll be hearing much more about Chicago, as we take the science inquiry and mentorship program into Chicago schools this fall and prepare for the joint Botany-Plant Biology meeting to be held in Chicago next summer.

During the Botany 2006 Education Forum, two key changes to the BSA-led education and outreach program were unveiled: the addition of a team of scientist mentors with training in online mentoring and a name change.

A new opportunity for scientist mentors is to become a member of the Master Plant Science Mentor Team. This opportunity has the potential to positively affect the rest of your professional life, and inspire life-long appreciation for plant science in young learners. We aim to have a team of 10 trained, compensated scientists mentors in place this fall, and double the size by the following year. We particularly encourage graduate students, post-doctoral fellows, and professors emeriti to join.

Becoming a Master Plant Science Mentor includes committing to an initial training session and mentoring 6-7 student research teams via the web during the fall and spring sessions. Each session lasts 2-4 weeks (~2 hours per week time commitment). Team members receive free BSA membership for the year, 50% off meeting registration, and a Master Plant Science Mentor T-shirt. If you are interested or would like to know more, please contact Claire Hemingway (chemingway@botany.org or 562-433-4057).

Scientific Inquiry through Plants now goes by the name **PlantingScience**. Bringing the excitement of hands-on plant investigations to students remains our focus and disciplinary contribution to improving science literacy. The shorter, snappier name is part marketing strategy and part planning for the future. A variety of professional societies have expressed an interest in the BSA-led program and its software platform. We hope scientists in other disciplines will join forces in fostering a society where science is accessible, understood, and appreciated.

A common interest in promoting plant science and taking plants into classrooms around the country is forging stronger collaboration within the botanical community. The BSA has formally invited the American Society of Plant Biologists (ASPB) and our sister societies, the American Fern Society, the

American Bryological and Lichenological Society, the American Society of Plant Taxonomists) to become partners in PlantingScience. Our united efforts allow us to connect a large cadre of diverse scientist mentors to more students and teachers.

Expanding the reach of our outreach program is not the only benefit of joining forces. Stronger partnerships among societies can provide better support to the members on issues of national concern. One such issue is NSF's Criterion 2—the broader impact statement required for all proposals. The ASPB invited the BSA to participate in the Education Workshop "Broader Impact and Beyond" during the Plant Biology 2007 meeting to share successes and strategies in helping researchers connect with broader audiences. We are looking forward to long and profitable partnerships.

Botanic Gardens Break New Ground in Informal Science Education

The first-ever plant-based Conservation Education Symposium, co-sponsored by Botanic Gardens Conservation International (BGCI) and the U.S. Botanic Garden, was held May 18, 2006 at the U.S. Botanic Garden. BGCI is leading an international collaboration to halt the loss of plant diversity worldwide. Improved education and public understanding of the importance of plant diversity is target 14 of 16 specific outcomes they seek. Symposium focus questions were: (1) to what degree is the importance of plant diversity and the need for its conservation incorporated into communication, education and public awareness programs in the United States and (2) what actions can be taken both locally and nationally to strengthen plant-based conservation education programs in the United States? Results of the symposium will be presented at the 6th International Congress on Education in Botanic Gardens to be held September 10-14 in Oxford, England.
http://www.bgci.org/usa/T14_Symposium
http://www.bgci.org/educationcongress/themes.htm

Evolution Supported by State Standards and Professional Societies

In the June 28 edition, *New York Times* writer Michael Winerip told the story of Pat New's personal battle to teach evolution in her middle school classroom, and pivotal role the state standards played in settling the argument. New York Times Select Subscribers can read the entire article at http://select.nytimes.com/gst/abstract.html?res=FA0E12F93C540C7B8EDDAF0894DE404482

The American Institute of Biology (AIBS) continues to support symposia promoting evolution at the National Association of Biology Teachers (NABT) meetings. Don't miss the contributions of BSA members. In an interview conducted during the 2005 symposium and now available on the AIBS actionbioscience website, **incoming BSA President Pam Soltis** describes how flowering plants make life as we know it possible. At the upcoming 2006 symposium on Macroevolution: Evolution above the Species Level, **Scott Hodges** will speak about patterns and processes of plant biodiversity. The AIBS Education Report, with further details on the 2006 symposium and other issues, is available online.

http://www.actionbioscience.org/genomic/soltis.html
http://www.aibs.org/education-reports/education-report-2006_06_02.html

Be sure to read the forthcoming October issue of *BioScience*. The Eye-on-Education column will feature the BSA-led education outreach program.

Progress Along the Pipeline

Recent studies and surveys of precollege and college students provide insights on changes in interest, participation, and achievement. Robert Tai and colleagues identified interest in 8th grader's career preferences as a more reliable indicator than mathematical aptitude for predicting which students become scientists. Michael Summers and Freeman Hrabowski found that an innovative program creating a strong community of scientists and scientists-to-be can greatly increase participation and achievement of minorities underrepresented in science. In a re-analysis of demographic data from the 2003-04 college population, The American Council on Education found that women outnumber men on college campuses in general, but among traditional-aged undergraduates of all racial groups belonging to the highest income groups, men are slightly more likely than women to be in college.

Tai, R.H., Liu, C.Q., Maltese, A.V., and Fan. X. 2006. Planning early for careers in science. *Science* 312: 1143-1144.

Summers, M.F. and Hrabowski, F.A., III. 2006. Preparing Minority Scientists and Engineers. *Science* 311: 1870-1871.

King, J. 2006. *Gender Equity in Higher Education*. American Council on Education. Washington, D.C.

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.

Enhancing Botanical Education with Project 2061 Publications

Daniel (Tim) Gerber recently had an article involving botanical education published in AAAS' Project 2061 electronic newsletter: 2061 Connections. The article is titled "**Enhancing Botanical Education with Project 2061 Publications"** and can be accessed at **http://www.project2061.org/publications/2061Connections/2006/2006-01b.htm**. This work is part of the **Teachers Using Living Plants (TULIP) Project** and gives several examples, with Benchmarks citations.

Dr. Gerber is an associate professor in the Biology Department at the University of Wisconsin-La Crosse and director of the TULIP Project.

Field Botany 323: An Alfred Hitchcock Movie, Almost

The trailer of the Hitchcock movie you have never seen goes like this; the first scene opens with 25 larval botanists struggling to learn the field identification, common names, scientific names, and family names of 300-plus plant species that grace the landscapes of southern New England. The time frame is the first nine weeks of any Fall Semester and the botanists are undergraduates enrolled at the University of Rhode Island in the semester-long Field Botany and Taxonomy course, BIO 323.

Now, the horror; heaped onto the already gargantuan workload of the students is nothing less than, horror of horrors, a writing assignment. Yikes! Anthony Perkins never looked so tame. Or so sane.

So why have we never seen this botanical thriller on the silver screen? Tentatively titled *Phyto*, or was it *Vertigrow*, it should have become a cult classic. However, it likely never made it past the "heap scene" in the script because the horror vanished faster than the ginseng at a Home Remedies Convention. In fact, there never really was any horror. The totally uncooperative undergraduates in the script deep-sixed the movie possibilities when they actually embraced the idea of a writing assignment. The result was an unimagined array of plant-based novellas, haikus, pneumonic devices, student confessions, epic poems, and song lyrics that ultimately emerged as the ongoing class assignment fondly called *Plant Notes*.

No terror? No student revolt? Does this sound more like an episode of Twilight Zone than anything that smacks of academic reality? Well, I thought so too until I actually tried the heaping myself on an unsuspecting Field Botany class. The result has forever opened my eyes to the limitless possibilities of dovetailing science with creative writing.

The inception and evolution of *Plant Notes*, along with enough *Plant Notes* to fill a small vasculum, are portrayed in Field Botany and Creative Writing: Where the Science of Writing Meets the Writing of Science (2006. Journal of College Science Teaching 35: 26-28). Reading the article, you will become privy to, for example, *Confessions of a Field Botany Student*. "Forgive me, Professor, for I have sinned: I touched *Datura stramonium* on more than one occasion. I had evil thoughts about pressing frogs. I, under the guise of lagging behind, relieved myself informally twice, and formally once (I was nicely dressed)."

Dr. Keith Killinbeck, is a professor in the Department of Biological Sciences, University of Rhode Island.

Announcements

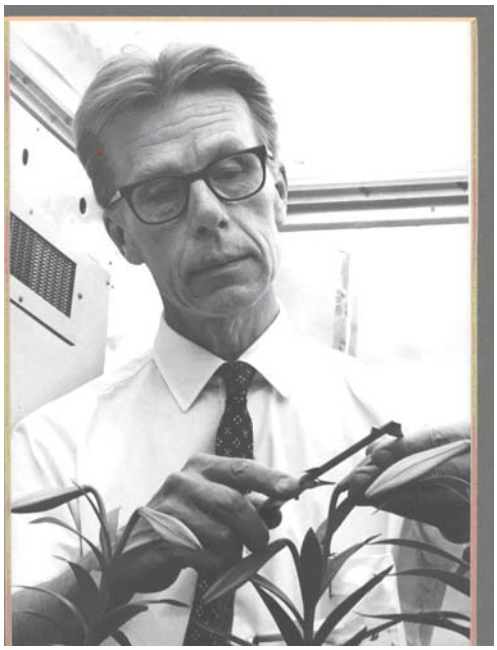
In Memoriam:

Ralph Erickson 1914 – 2006

Dr. Ralph O. Erickson, professor emeritus of botany, died March 24, 2006 at age 91.

Plant physiology textbooks now feature a discussion of the spatial pattern of growth within roots as determined by Erickson in the 1950s. Erickson brushed a root with carbon particles and placed it before a modified camera. The camera lens was open continuously, and the film was moved at a constant rate past a vertical slit. When the exposed film was unrolled and developed, the black spots on the root appeared as streaks in the resulting photograph. To process this information Erickson used a protractor to obtain the slopes of the streaks at equally spaced increments. He plotted the resulting values of growth displacement velocity versus distance from the root tip. He then developed and used a numerical differentiation technique to find the "relative elemental growth rate" (mathematically, the velocity gradient) to reveal growth as a function of position on the root. This study had many of the hallmarks of Erickson's work. The growth analysis was conceived in mathematical terms; the experimental technology was handmade by the author; the mathematical methods were also derived by the author; the results had fundamental implications for plant physiology; and the paper remained relatively unrecognized for decades after its publication. At the time of Erickson's retirement from the University of Pennsylvania, the 1985 edition of the text *Plant Physiology* by Salisbury and Ross ad a new section on analysis of plant growth. The description of the l860's marking experiment of Juliusvon Sachs, with its erroneous interpretation, was replaced by a discussion of the relativeelemental growth rate. Thus Erickson's work was recognized, three decades later, as the classic fundamental analysis of growth in plants.

It is typical, we feel, that Erickson was nderstood and appreciated by the scientific comunity only many years after he published. Hiswork was visionary. The great originality of his scienific studies came partly from a unique geniusfor geometry and partly from a tremendous persnal integrity. Ralph never followed the fashion of an ra. Asking the questions he saw as fundamental,he found answers he could not always express interms his botanical colleagues could understand. He was perhaps unique among biologists inrecognizing the power inherent in the ENIAC computer being assembled at the University of Pennsylvania's Moore School of Electrical Engineering at the end of World War II. During his career Erickson designed, conducted and interpreted analyses of root and leaf growth, found a developmental index for studies of meiosis and mitosis in lily anthers, devised a plastochron index for shoot and leaf development, and conducted studies of phyllotaxis and the more general problem of the packing of spheres on various surfaces. These studies and Ralph's suggestions inspired a number of younger



colleagues to work on plant development, including **Yasuo Hotta and Herbert Stern on meiosis**, Paul Green on biophysics of morphogenesis, Roman Maksymowych on leaf development, Zygmunt Hejnowicz on mathematical and physical aspects of development, and our own work on growth kinematics and phyllotaxis. Erickson's growth studies are still inspiring research efforts by younger scientists throughout the world. For instance, his algorithms are cited as the basis for computationally complex image analysis programs published recently by Tobias Baskin in Massachusetts and Achim Walter in Germany.

Ralph's original approach to science was perhaps forged during his childhood on the midwestern frontier. He was the eldest of six children. While Ralph was in grade school, his father was pastor of the church and principal of the three room school in Leonard, a town of 75 people near the Red Lake Chippewa Reservation in northern Minnestota. High school was in Iron River, a mining town on the upper peninsula of Michigan. Ralph had many stories of assisting his father in clearing brush, building roads, constructing homes, doing carpentry, wiring, and plumbing. His father also taught him photography. As a teenager Ralph was an omnivorous reader, favoring Darwin's *Origin of Species* and *Voyage of the Beagle*, as well as the *Encyclopedia Americana*. He studied the local plants and longed to know them by name.

Erickson earned a B.A. from Gustavus Adolphus College in 1935, and a Ph.D. from Washington University (St. Louis) in 1944. During his graduate studies he researched the limestone glades of the Ozarks, where a native variety of *Clematis* was named for him: *Clematis fremontii* var. riehlii Erickson, Taxonomic Serial No.: 533675. Until the late 1990s, he continued to visit and study the glades. It was in Missouri that he met his wife, Elinor Borgstedt Erickson, a musician.

Erickson served as an instructor for Gustavus Adolphus College in Minnesota (1935-1939), assistant chemist for Western Cartridge Co. in Illinois (1942-44), and as an instructor and assistant professor for the University of Rochester (1944-47). Dr. Erickson began his career at the University of Pennsylvania in 1947 as a research associate. In 1949 he became associate professor of botany and in 1954 was promoted to professor. He achieved emeritus status in 1985.

Dr. Erickson was involved in many scientific activities. He was president of the Society for Study of Development and Growth (1954-55), acting chairman of the University of Pennsylvania Department of Biology (1961-63), and chairman of the University of Pennsylvania graduate group in botany (1957-66). Dr. Erickson was also a fellow of the Guggenheim Foundation at the California Institute of Technology (1954-55).

At the 1982 Annual Meeting of the BSA, Ralph received a Merit Award "for contributions to our understanding of integrative mechanisms of plant development using mathematical analyses; for introducing the plastochron index for measuring the shoot apical activity, and for leadership in developing models allowing computer analysis of

plant growth."

During his retirement Ralph continued to pursue his interests in botany and computing. He set up computers for his colleagues in the retirement community at the Quadrangle, Haverford PA; and he founded a Sigma Xi chapter there.

Elinor and their daughters Elizabeth Erickson and Diane Field provided loving support in his last years. Ralph Erickson died peacefully on March 24. He is survived by his wife and daughters, a brother, three grandchildren, and one great-granddaughter.

Wendy Silk adds the following reminiscence, based on a letter sent on the occasion of Ralph's retirement from Penn:

My personal association with Ralph began in 1970 when I began graduate work in biology at the University of Pennsylvania. Paul Green, then at Penn, was my major professor and assigned me a desk in Ralph Erickson's laboratory. I was alarmed. With graduate students, Erickson had the reputation of being a bear—critical, taciturn, and severe. I asked Dr. Green to find me a desk elsewhere. Luckily for my development as a botanist, Green didn't pay attention to my request. As the year went on, Ralph and I began to chat. We talked about *Psilotum*, linear regressions, computers, microscopes, mitochondria, root growth, leaf arrangements, optical illusions, Beethoven, sound waves, internal combustion machines—in fact, the problem became how to STOP TALKING. What had seemed to be severity could be viewed as a search to satisfy high standards; taciturnity was apparently the manifestation of an endearing diffidence. At the end of the year I left Penn with great reluctance. And when I finished my doctoral studies at Berkeley, I knew my first choice for postdoctoral work was to return to Philadelphia and Ralph Erickson's laboratory. It was with Ralph that I began to put together the applied mathematics of my undergraduate training, and the physiology I had learned at Berkeley. His vision of plant growth has been my greatest inspiration; and our collaboration, begun at Pennsylvania and continued during Ralph's sabbatical at Davis, has been one of the most satisfying of my career.

My appreciation of Ralph Erickson the scientist is enhanced by my appreciation of Ralph Erickson the person. He was a scholar, inquisitive and delighted by new insight. His fund of knowledge was awesome. He knew the anatomy of a pine tree, the Newton-Raphson solution to partial differential equations, the flora of the Precretaceous era, the statistics of directional data, how to fix a Saab car engine, and how to build a computer. He had the courage to take apart a microscope, and the wisdom to put it back together. He and his wife Elinor were devoted naturalists and music lovers. Canoeing skillfully in the New Jersey Pine Barrens, building high fidelity audio systems, and playing chamber music, they provided an inspiring model for domestic collaboration that coexisted comfortably with Ralph's scientific genius.

Roger Meicenheimer adds the following appreciation, written to Erickson in celebration of his ninetieth birthday: 30 October 2004

Happy 90th Birthday, Ralph! I find it of interest that this October's American Journal of Botany is the 90th Anniversary issue of that journal. I remember many years ago you told me that biologists, particularly those of us working with plants, live much longer than average. I've forgotten if you offered an explanation for this observation, but certainly you are living proof of that conjecture!

I will always consider you as my foremost academic mentor. Much of what I learned under your guidance - like statistical validation of experimental results; taking developmental time seriously; innovative ways of collecting and analyzing the cellular processes that give rise to the tissues and organs comprising plant bodies; and, of course, the intriguing mathematics and complexities of phyllotaxis - formed the core of my approach to plant development research. I am forever grateful for the guidance and inspiration you provided me.

Many of your contributions will undoubtedly remain valid and useful far into the future that lies beyond your and my lifetimes. I am deeply honored to have had the pleasure and privilege of working with you.

Some of Ralph's influential papers:

Erickson, R. O. 1945. The *Clematis fremontii* var. Riehlii population in the Ozarks," Annals of the Missouri Botanical Garden. 32: 413-460.

Erickson, R. O. 1948. Cytological and growth correlations in the flower bud and anther of *Lilium longiflorum*. American Journal of Botany. 35: 729-739.

Erickson, R. O. and K. B. Sax. 1956. Elemental growth rate of the primary root *of Zea mays*. and Rates of cell division and cell elongation in the growth of the primary root of *Zea mays*. Proceedings of the American Philosophical Society. 100: 487-498. and 499-514.

Erickson, R. O. and F. J. Michelini. 1957. The plastochron index. American Journal of Botany. 44: 297-305.

Erickson, R. O. 1966. Relative elemental rates and anisotropy of growth in area: a computer programme. Journal of Experimental Botany. 17: 390-403.

Erickson, R. O. 1973. Tubular packing of spheres in biological fine structure. Science. 181: 705-16.

Erickson, R. O. 1976. Modeling of plant growth. Annual Review of Plant Physiology. 27: 407-34

Erickson, R. O. 1983. The geometry of phyllotaxis. pp. 53-88. In The Growth and Functioning of Leaves. Dale, J. E. and F. L. Milthorpe (eds). Cambridge University Press.

Erickson, R. O. 1995. **Growth and Development of a Botanist.** In Excitement and Fascination of Science: Reflections by Eminent Scientists. Volume 4.

- Roger Meicenheimer and Wendy Kuhn Silk

Lloyd, David 1938 -2006

The University of Canterbury is mourning the death of one of its most pre-eminent academics, Emeritus Professor David Lloyd who was a corresponding member of the Botanical Society of America.

Professor Lloyd, who had suffered ill health and multiple disabilities for a number of years, died this morning at the age of 68.

UC Vice-Chancellor, Professor Roy Sharp, says Professor Lloyd was one of the finest researchers the University has seen.

"That was reflected in 1992 when David became just the seventh resident New Zealander to be elected a Fellow of the Royal Society of London, one of the world's oldest and most prestigious scientific societies.

"You just need to look at the citation that accompanied the announcement of his fellowship. It said his exceptional knowledge of the flora of New Zealand had led him to conclusions that transformed the thinking of plant scientists around the world." The citation's sentiment is reflected in an upcoming book by Professor Spencer Barrett (University of Toronto) and Dr Lawrence Harder (University of Calgary) who describe Professor Lloyd as a pre-eminent plant evolutionary biologist of the modern era.

"The extensive body of concepts that Lloyd developed through keen observation, incisive intellect and realistic theory established him as the founder of the theory of plant reproduction and comprise his enduring legacy," they write.

"Lloyd pioneered the concept of plant gender and was the foremost authority of the evolution of plant sexual systems.

"Lloyd's scholarly work laid the foundation for much of today's research on the ecology and evolution of flowers, as well as several other fields of evolutionary biology."

David Lloyd began study at the University of Canterbury in 1955 and graduated in 1959 with a BSc Honours degree, with first class honours in botany. He was the first graduate from any New Zealand university to gain first class honours in a BSc Honours degree.

He then studied at Harvard University on a Frank Knox Fellowship and graduated with a PhD in biology in 1964.

Three years later he was appointed a lecturer at Canterbury University. In 1971 he was promoted to senior lecturer, going on to become a reader in 1975 and professor of plant science in 1986.
David Lloyd grew up in the small South Taranaki town of Manaia .

Emeritus Professor David Lloyd pictured in 1992 when he was elected a Fellow of the Royal Society of London.

His brother, Trevor Lloyd, says David was tenacious and determined from an early age.

"At secondary school in New Plymouth where he was a boarder David was an outstanding athlete and rugby football player despite having a less than average-sized physique. David played on the wing where he could best use his speed.

"In athletics he excelled in the 100 and 220 yard sprints and the long jump. This was just another expression of his determination and tenacity."

David's twin brother Peter, an emeritus professor of economics at Melbourne University, remembers his brother's thirst for knowledge.

"As we grew up together, he had a great curiosity about the world around him. He developed a deep interest in the plant world and wanted to add to our

knowledge of it, always seeking to develop theories to interpret his observations."

Professor Lloyd is survived by his wife Linda Newstrom-Lloyd and his three adult children - Steven, Nicola and Paul.

Mrs Newstrom-Lloyd says aside from being an extraordinary scientist with many benchmark papers in evolutionary ecology and plant reproductive biology, her husband was a unique person with a pragmatic approach to life.

"David lived the past 13 years with cheerfulness and resiliency. In spite of his difficulties as a result of his injuries, he always made the most of what he had. "We loved each other immensely and shared the belief that no matter what happens, the most important thing is how you approach it and what you do about it."

Mrs Newstrom-Lloyd pays tribute to the medical personnel who cared for her husband over the past 13 years and thanks ACC for its assistance.
"David and I truly appreciated the expertise of the people caring for him at home. They all succeeded together as an exceptional team. I am extremely grateful for their dedication, understanding, and generosity."

Professor Lloyd's daughter, Nicola, says it was their father's botanical passion that introduced them to the world of science.

"We have memories from an early age of the combined family holiday with field research, of sitting in bogs looking for obscure plants.

"Through his work we had the opportunity to travel and experience life and living in other countries."
Professor Lloyd's son Steven says his father's scientific outlook was mixed with a profound humanist spirit.

"His firm belief in equality, tolerance and capacity for difference in the wider cultural, political and social spheres, enriched us all. His non-judgemental approach gave us independence to grow and develop.

"David encouraged us to pursue our own passions. He always took a great deal of interest in what we were doing, embraced his grandchildren, and in turn wanted to learn from our experiences."

Paul Lloyd says his father was an active parent who made a tremendous impact on their lives.

"He opened our eyes to the world. Through him we saw things and had experiences that shaped our thoughts and views. Most of all David provided us with his unconditional love. And, we loved him deeply."

- Jeanette Colman, University of Canterbury

Daphne J. Osborne, 1930 - 2006

A major loss to plant science was the passing of Daphne Osborne, in Oxford, England in June, 2006. A dynamic contributor to developmental and physiological botany, an international leader in plant science, Daphne had a high talent for scientific pursuit combined with a delightful capability for communication.

Daphne was trained in botany, microbiology, and plant physiology at the University of London, followed by a postdoctoral appointment at Cal Tech. She spent most of her professional life at Oxford University, initially in the Agricultural Research Council, later in the Agricultural and Food Research Council at Oxford, and then with the Open University of Oxford. During her career, she had visiting fellowships at Cal Tech, Princeton, Canberra, and UC Davis. She was awarded visiting professorships at Hebrew University, Cornell, Calcutta and Natal. She was awarded honorary D.Sc. degrees from Natal and from Oxford, and the S.M. Sircar Gold Medal at Calcutta. She was a Leverhulme Scholar, a May Baker Research Fellow, a Rose Sedgwick Scholar, a Fullbright Scholar, a University of London Traveling Scholar, and a Lady Davis Visiting Professor. She was a Corresponding Member of the Botanical Society of America.

To illustrate Daphne's international stature as a plant scientist, she served invitation Lectureships or Visiting Professorships in Europe (Cambridge, Lausanne), in the United States (Princeton, Cal Tech, UC Davis, UC Santa Cruz. UW St Louis, U Mass Amherst, Michigan State, Ohio, Cornell), in Canada (Regina, Alberta, Edmonton), and South America (Buenos Aires), in Africa (Nigeria), in the Far East (Calcutta, New Delhi, Tirupati, Ceylon, Indonesia, Malasia, Hong Kong, Singapore, Cairo, Osaka), in Israel (Negev, Haifa), and in Australia (Adelaide, Monash, Brisbane, Flinders, Canberra). She also served as a Visiting Professor in China where she lectured in four major universities. I am sure that there were more international invitations, but these are the ones that I know of. Lectures at national meetings or conferences are not included in this list.

A reason for so much international acclaim was surely her wonderful intellectual style, combined with her proclivity for remarkable and perceptive experimental findings. In her early years Daphne worked mainly on the plant hormones. She then turned more to developmental events, and then to genetic systems in plant development. Seeking always to understand developmental regulation, it is not surprising that she developed a new concept, namely target cells as mediators of development. These are cells that become sensitized to respond to autonomous regulatory signals. They were the central focus of her book, published last year with M. T. McManus, titled "Hormones, Signals and Target Cells and Plant Development".

Daphne was always an exciting and provocative source of inventive experiments. It is no wonder that she was so sought after, and will be so missed in the plant sciences.

- A. Carl Leopold, Boyce Thompson Institute of Plant Research, Cornell University

Personalia

Anitra Thorhaug UN Who's Who of Women and the Environment

Professor Anitra Thorhaug is a scientist and advocate for restoring the earth who has influenced the protection of marine and coastal shallow-water habitats in the Americas, Asia, Africa and several island nations.

Professor Thorhaug has elucidated toxic levels of pollutants through field and laboratory experimentation and helped nations around the world to set scientific standards to eliminate a series of pollutants. She invented the first large-scale seagrass restoration process in the early 1970s to combat habitat pollution effects.

Having organized the first saltwater bay restoration effort in the world for Biscayne Bay, in Florida, she taught the methods to many nations as well the coastal zone management principals of restoration. She taught science, policy, long-term planning and advocacy of coastal protection of living resources to nations in Africa, the Americas, and Asia and the Pacific.

Professor Thorhaug's academic career includes faculty positions in leading Universities in the USA (Berkeley, Yale, University of Miami, and Florida International University). Currently, she is researching remote sensing of coastal tropical pollution at Yale, and serves as Chair of Physiology of the Botanical Society of America, President of the USA Club of Rome, and is a member of the International Club of Rome.

She is author of 10 scientific books plus hundreds of scientific papers. She has led scientific exchange delegations to Asia, Africa and the former USSR. Her work has focused attention on series of critical issues: for example, on thermal and salinity pollution, heavy metals and radioactivity contamination, oil spill clean-up, pollution in specific nations, and on "The Future of the American Hemisphere".

Her consulting career includes United Nations Agencies (UNEP, FAO, IOC, UNDP), many national governments, and industry, where she has been influential in alleviating pollution as well as protecting and restoring near-shore resources.

Professor Thorhaug remains active in the restoration of coastal ecosystems. She planted a very large seagrass meadow in the Laguna Madre in Texas, the only bay shared by developed and developing nations. 75 acres have been sucessfully planted. She has also begun planting corals on sand where they have been killed.

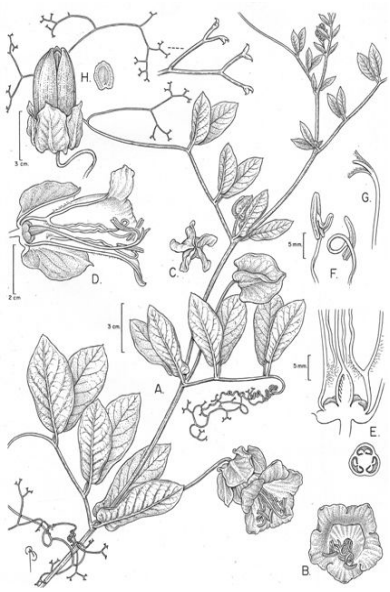
She has planted a great many marshes, mangroves, and seagrasses in the heavily used, but damaged Florida Parks, and was on the Florida Governor's advisory committee to examine the effects of the restoration of the everglades in Florida on bays, particularly Biscayne Bay. This was almost a year's work with intense public debate between agencies doing the planning of various parts. It was a 25-year-later add-on to her book Biscayne Bay Past, Present and Future. Biscayne Bay was the first major bay in the USA to have a complete intensive examination by scientists, government and citizens followed a plan of action.

Bobbi Angell, Botanical Illustrator, receives Jill Smythies Award

Ms. Bobbi Angell received the 2006 Jill Smythies Award of the Linnean Society of London at their annual meeting held on 24 May. The judges unanimously chose Bobbi from this year's field of several strong candidates. She is the first American to be so honored.

This Award was established in 1988 by the late Mr. Bill Smythies Hon FLS in honor of his wife Florence Mary Smythies ("Jill") whose career as a botanical artist was cut short by an accident to her right hand. The rubric states that the award "is for published illustrations, such as drawings or paintings, in aid of plant identification, with the emphasis on botanical accuracy and the accurate portrayal of diagnostic characteristics."

Bobbi received a bachelor's degree in botany from the University of Vermont in 1977 and began her career as a botanical illustrator at The New York Botanical Garden the following year. Her first project was creating illustrations for the multi-volume *Intermountain Flora* under the direction of Dr. Noel Holmgren.



Cobaea scandens Cav., published in *Flowering Plants of the Neotropics* (Nathan Smith et al.)
see also p 103

Over the last 25 years, her illustrations have reached a broad popular audience through the *New York Times* weekly gardening column, two books based on different compilations of these columns, and notecards with water-color portraits of endangered species sold by the Center for Plant Conservation.

Her primary focus, however, has been to illustrate scholarly works with pen and ink drawings. Her botanical training, keen observational skills, and artistic sensibility result in illustrations that are not only scientifically accurate but also beautifully composed, even when they are reconstructions of flattened dried specimens. The clarity of the microscopic details that usually escape the naked eye are a boon for identification. Many people go directly to illustrations rather than to keys and descriptions, and those who use a flora illustrated by Bobbi find that a picture truly is worth a thousand words.

Publications illustrated completely or mostly with her drawings are: *Intermountain Flora, Vols. 2B, 3A, 3B* (Holmgren et al. 2005, Cronquist et al. 1997, Barneby 1989), *Vines and Climbing Plants of Puerto Rico and the Virgin Islands* (Acevedo-Rodriguez 2005), *Flora of St. John* (Acevedo-Rodriguez 1996), *Guide to Vascular Plants of Central French Guiana, Part 2: Dicotyledons* (Mori et al. 2002), *Flowering Plants of the Neotropics* (Smith et al. 2003), and the Flora Neotropica Monograph of *Meliococceae (Sapindaceae)* (Acevedo-Rodriguez 2003). Each of these books is worth contemplating for the pleasure of the illustrations alone.

She has drawn more than 2400 plant species, including c. 1000 neotropical ones. Admiring taxonomists have named three species in her honor: *Potentilla angelliae* N. H. Holmgren, *Mezia angelica* W. R. Anderson, and *Macrocarpaea angelliae* J. R. Grant & Struwe. Unaware of the authors' intentions, Bobbi illustrated each.

Award Opportunities

American Philosophical Society, RESEARCH PROGRAMS

All information and forms for all of the Society's programs can be downloaded from our website, http://www.amphilsoc.org. Click on the "Fellowships and Research Grants" tab at the top of the homepage.

New this year:

1. It is now possible to submit applications electronically to the Franklin, Lewis and Clark, Phillips, and Sabbatical programs.

2. The **Lewis and Clark Fund for Exploration and Field Research in Astrobiology** is accepting applications. The American Philosophical Society and the NASA Astrobiology Institute have partnered to promote the continued exploration of the world around us through a new program of research grants in support of astrobiological field studies undertaken by graduate students and by post-doctoral and junior scientists and scholars. Grants will depend on travel costs but will ordinarily be in the range of several hundred dollars to about $5,000.

3. **Sabbatical Fellowship** applicants should have received the Ph.D. no later than 1999 and no earlier than 1986. The last financially supported leave should not have been subsequent to September 1, 2004. Writing samples are mandatory.

INFORMATION about ALL PROGRAMS

Purpose, scope
Awards are made for non-commercial research only. The Society makes no grants for academic study or classroom presentation, for travel to conferences, for non-scholarly projects, for assistance with translation, or for the preparation of materials for use by students. The Society does not pay overhead or indirect costs to any institution or costs of publication.

Eligibility
Applicants may be residents of the United States or American citizens resident abroad. Foreign nationals whose research can only be carried out in the United States are eligible. Grants are made to individuals; institutions are not eligible to apply. Requirements for each program vary.

Tax information
Grants and fellowships are taxable income, but the Society is not required to report payments. It is recommended that grant and fellowship recipients discuss their reporting obligations with their tax advisors.

Contact information
Questions concerning the FRANKLIN, LEWIS AND CLARK, PHILLIPS, and SABBATICAL programs should be directed to Linda Musumeci, Research Administrator, at LMusumeci@amphilsoc.org or 215-440-3429.

Questions concerning the LIBRARY RESIDENT Research Fellowships should be directed to J. J. Ahern, Assistant Manager of Technical Services and Programs, at jjahern@amphilsoc.org or 215-440-3443.

BRIEF INFORMATION about INDIVIDUAL PROGRAMS

Franklin Research Grants

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

Eligibility
Applicants are expected to have a doctorate or to have published work of doctoral character and quality. Pre-doctoral graduate students are not eligible, but the Society is especially interested in supporting the work of young scholars who have recently received the doctorate.

Award
From $1,000 to $6,000.

Deadlines
October 1, December 1; notification in February and April.

Lewis and Clark Fund for Exploration and Field Research

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

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

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

Deadline
March 15; notification in June.

Linda Musumeci
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Symposia, Conferences, Meetings

"50 Years of the Phytochemical Society of Europe" conference

Conference title:
50 Years of the Phytochemical Society of Europe
Highlights in the Evolution of Phytochemistry

Dates:
11 – 14 April, 2007

Abstract submission deadline:
27 October 2006

Location:
Churchill College, Cambridge, UK

Website:
www.pse50.com

Organiser:
Phytochemical Society of Europe

Sponsor:
Elsevier, publisher of the journal *Phytochemistry*

Secretariat:
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Tel: +44 (0) 1235 868811
Fax: +44 (0) 1235 227322
Email: phillipa.fletcher@dsl.pipex.com

ROCK ON! Celebrating Stone in the Garden – the ultimate art and nature event of Autumn, 2006

ART IN NATURE EXHIBIT - **'ROCK ON! *Celebrating Stone in the Garden*.'** New England Wild Flower Society's Garden in the Woods features 37 stone sculptures by top New England artists in a glorious 45-acre garden setting **now through October 15.** Sculptural and environmental works by Curtis, Hoffman, Kuyper, Mazur, Phillips, Rudnicki, Stanley, and Wheelwright surrounded by 1,500 wildflower species and cultivars on garden trails and in natural areas. Fruits, foliage, and berries highlight the season. Make your own sculptures at the interactive mini-sculpture park. RAIN OR SHINE. Special events run throughout the show, check www.newfs.org for schedule. The show is included FREE with admission. **New England Wild Flower Society's Garden in the Woods,** 180 Hemenway Road, Framingham, MA. (508) 877-7630. 1,500 native plant species on display including 200 rare and endangered species.

SPECIAL ROCK ON EVENTS

September 16-17 - ROCK ON! ROCK FEST 12-4 Bring your instruments and have a **ROCK JAM** with kids of all ages. Whether you are a ROCK musician or play acoustically, come raise up your sound at the New England Wild Flower Society. Walk the ROCK ON trail, take a ROCK scavenger hunt, and meet 'GRANNY GRANITE' a costumed rock with lots of stories. Make a MINI-ROCK GARDEN to take home and learn about STONE in the HOME LANDSCAPE. Fall is a great time to plant trees and shrubs-take some home for planting now for winter interest. Make your own ROCK ART at the sculpture mini-park and ROCK ON!

October 15 - ROCK ON! FALL FAMILY FESTIVAL IS FREE 12-4 Join us for a grand farewell to ROCK ON! Take a fall scavenger hunt, say goodbye to GRANNY GRANITE, and discover treasures in the fall garden. Make your last pieces in the ROCK ON interactive sculpture mini-park. Now is a great time to select your nature programs for the year from the New England Wild Flower Society Fall/Winter course catalog to stay in touch with nature and the outdoors throughout the seasons.

Credit: New England Wild Flower Society/Tom Smarr

Caption: "Portal" by Chris Curtis at ROCK ON! calls our attention to the natural world-and space

Other

Help Wanted – Ancient Trees Website

I am building a website, which will focus on the ancient trees of the Americas. The Woodland Trust in the UK states: "The term ancient tree is one that is not capable of precise definition but it encompasses trees defined by three guiding principles:

·trees of interest biologically, aesthetically or culturally because of their age
·trees in the ancient stage of their life
·trees that are old relative to others of the same species"

Ancient trees are known from Canada, the United States, Mexico and Brazil, among other countries in the Americas and often elicit considerable interest from the public. This interest can be used to help conserve individual trees such as the Árbol del Tule in Oaxaca, Mexico and tracts of land such as the Sequoia National Forest in California. My aim is to make the website a clearing house for information on ancient trees: ecology, conservation, culture/history, education etc. I am currently looking for contributions in the form of short articles, photographs, artwork etc. This will be a sister site to the UK Ancient Tree Forum:
http://www.woodland-trust.org.uk/ancient-tree-forum/

For further information, please contact Chris Briand (chbriand@salisbury.edu), Department of Biological Sciences, Salisbury University, Salisbury MD 21801.

Some Biogeography and Biography on the Web

Below are several (noncommercial) educational websites developed by Dr. Charles Smith that fall generally within the realm of biogeography.

The Alfred Russel Wallace Page http://www.wku.edu/~smithch/index1.htm Materials on and by the English naturalist and social critic (1823-1913), including bibliographies, lists, commentaries, a biography, and the full-text of hundreds of his writings.

Early Classics in Biogeography, Distribution, and Diversity Studies: To 1950 http://www.wku.edu/~smithch/biogeog/ An enhanced bibliography of historical sources in biogeography and related fields, with links to biographical information and the full-text of many of the sources listed.

Early Classics in Biogeography, Distribution, and Diversity Studies: 1951-1975 http://www.wku.edu/~smithch/biogeog/index2.htm A continuation of the preceding site covering the literature from 1951 to 1975.

Some Biogeographers, Evolutionists and Ecologists: Chrono-Biographical Sketches http://www.wku.edu/~smithch/chronob/homelist.htm A collection of over 250 short biographical sketches of the main figures in the history of biogeography and related fields, sorted by name, nationality, and subject.

All of these items have had OCLC WorldCat records established for them, so notice of their existence could also easily be added to any institution's electronic catalog of holdings.

Contributed by:
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charles.smith@wku.edu
http://www.wku.edu/~smithch/index.html

Brooklyn Botanic Garden Science Research Interns Win Grand Prize in National Science Research Contest

Brooklyn, NY—July 7, 2006—Brooklyn Botanic Garden science research interns, Shadae Dixon and Thinlay Dolma, juniors at Brooklyn Academy of Science and the Environment (BASE), won first prize in the high-school age bracket and grand prize overall from iScienceProject, a national science competition established to involve students (K-12) and teachers in projects that stimulate interest in science. The students captured the coveted grand prize title for their project titled "Thermogenic Temperature Measurements of Skunk Cabbage (*Symplocarpus foetidus)* Spadicies and Magnolia (*Magnolia x loebneri* 'Merrill') Flowers. Ms. Dixon and Ms. Dolma are enrolled in a new program at BBG that allows high school students to work with scientists from the Garden on challenging research projects.

The objective of their study was to determine if skunk cabbage and magnolia trees in North America are thermogenic (i.e. produce their own heat), and—if they are thermogenic—to study the heating pattern. The students hypothesized that these plants are thermogenic, in order to help volatize and disperse odors to attract pollinators, and also as protection from frost. Using very fine and sensitive temperature sensors to measure the floral temperature of the two plants thought to be thermogenic, Ms. Dixon and Ms. Dolma recorded temperature measurements of a skunk cabbage (*Symplocarpus Foetidusi*) and magnolia (*Magnolia x loebneri* 'Merrill') at Brooklyn Botanic Garden.

Their results indicated that the skunk cabbage did produce heat, and they found that the female inflorescences of the skunk cabbage produced more heat than the male. The results of the magnolia flower study showed no difference between the ambient air and the temperature of the flower. The students theorized that no heat was detected either because the magnolia they studied is a temperate, hybrid species that does not produce heat, or its flowers were not at the female stage, during which most heat is produced.

Shadae Dixon and Thinlay Dolma set up data loggers in the Native Flora Garden at Brooklyn Botanic Garden.

In addition, due to climate variation over the study, cold weather and snow may have also affected the flowers.

Both Ms. Dixon and Ms. Dolma hope to enter pre-medicine programs in college after graduating from Brooklyn Academy of Science and the Environment. Launched in September 2003, BASE is a New Century High School developed by Brooklyn Botanic Garden and Prospect Park Alliance in collaboration with New York City Department of Education and New Visions for Public Schools. BASE was developed to take full advantage of the extensive natural and educational resources of BBG and PPA.

Books Reviewed

An Introduction to Plant Structure and Development. Beck, Charles B. 2005. ISBN 0-521-83704-5 (Cloth US$55.55) 431 pp. Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211.

"My objective has been to prepare a new plant anatomy textbook for a new century, incorporating the best research in the most active and significant areas with the widely accepted common knowledge that provides the foundation of the field. Only you the readers can decide if I have succeeded." It is this readers judgment that Beck has produced the legitimate successor to the "the little Esau (1977)" for use in undergraduate plant anatomy courses. His text is a very readable treatment of developmental plant anatomy that highlights the excitement of the field today.

A particular strength of this text is that it identifies current controversy, and presents counter arguments from different schools of thought,

documenting these issues with an extensive list of references and further readings at the end of each chapter. All of the major secondary sources are cited, but the end-of-chapter references are mostly to current primary literature. For instance, chapter two begins by contrasting two perspectives on the origin of multicellularity. The organismal theory, championed by Kaplan and Hagemann (1991) is posited as an alternative to the traditional cellular theory of the development of plant multicellularity. The significance of the presence or absence of plasmodesmata and the extent of the symplast is stressed throughout the book.

A second area of interesting debate occurs in the sections on transport mechanisms in both the chapter on xylem and the phloem chapter. We are all familiar with the cohesion-tension theory of water movement, but what about Canny's (2001) compensating pressure theory? And what kind of support (no pun intended) does xylem anatomy provide to these competing views? In the phloem we are all familiar with the pressure-flow hypothesis, but what about Spanner's(1974) electroosmosis theory. Again, anatomy must be considered in evaluating the merits of both. Of historical interest is the discussion of "slime" and p-protein and the controversy over how much, if any, of the latter is an artifact of preparation.

Beck's work, and that of his students, bridges the span of extinct and extant vascular plants. He uses this expertise to provide an evolutionary framework to plant structure and development. While the main focus of the book is on flowering plants, and gymnosperms to a lesser degree, Beck does not ignore the ferns and fern allies, and their fossil forms, where they can provide clarity to the story he tells. I found myself making notes to refer back to the next time I teach plant kingdom.

Of course much of the excitement and many of the significant discoveries in modern plant anatomy have to do with the cytockeleton and molecular control of development. In each chapter current research in the area, using modern techniques, is summarized and integrated into the classical descriptive anatomy. Again, the extensive citations of primary literature at the end of each chapter illuminate the path for further study for those who are interested.

The text is 100 pages shorter than Esau (1977) or Mauseth (1988) and the format is single column, 2/3 page width vs double column in both earlier volumes. Beck does not provide the "coverage" of either of these earlier works. There are not separate chapters on cell types and simple tissues and flowers, fruits, and seeds, the subjects of five chapters in Esau and three in Mauseth, are covered in a final chapter on reproduction and the origin of the sporophyte. Beck acknowledges that some "…subjects may not be as fully covered as some teachers and researchers would desire…" but again, the necessary literature is cited, particularly secondary literature for these major areas. Beck has done an admirable job of identifying the key concepts underlying plant structure and development and developing these concepts in depth and clarity – a much more difficult and useful task than simply providing encyclopedic information.

I did have some disappointments with the text. While the quality of line drawings was excellent, some photomicrographs were poorly reproduced and/or illustrations were poorly labeled. For instance, only one of the two contact parastichies are indicated in Fig. 7.14 and fig. 7.5 will be difficult to interpret, for those not familiar with representing sympodial branching of stem vasculature in a single plane, because the corresponding sectional diagrams include separated leaves containing a bundle that are not the bundle-containing leaf bases indicated by a triangle in the plane view. While most technical terms were bold faced the first time used, and there is an extensive glossary, occasionally terms were not defined, eg., versiculate (pp 43 and 146). Finally, a personal peave. Why is "provascular tissue" consistently substituted (with one exception) for "procambium" throughout the text?

The obvious audience for this book is undergraduate students of plant structure and development. It will provide them with the basic background of traditional descriptive anatomy yet excite them with the power of the modern techniques currently being employed in the field. The less obvious audience is any professional botanist trained a dozen or more years ago who is responsible for teaching introductory botany. So much is changing and much of it is summarized in Beck's book!

-Marshall D. Sundberg, Department of Biology, Emporia State University, Emporia, KS 66801

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The Geographic Mosaic Theory of Coevolution. John N. Thompson. 2005. Cloth $75.00 (ISBN 0-226-79761-9); Paper $28.00 (ISBN 0-226-79762-7). 400 pages. University of Chicago Press.

John Thompson has provided an updated version of his sensible theory on coevolution. He intentionally only covers new ground since his previous books (1982, 1994). All three volumes are necessary reading for anybody interested in coevolution.

His latest book is incredibly detailed. He reviews a myriad of empirical studies on coevolutionary processes amongst populations. This includes reproduction of the data graphics from many seminal works, especially Craig Benkman's work on interactions between crossbills, conifers, and red squirrels, and the Brodies' work on garter snakes and *Taricha* newts. In many ways, Thompson's latest book is reminiscent of Mary Jane West-Eberhard's magnum opus *Evolutionary Developmental Plasticity*, except that Thompson is not quite so exhaustive, especially in his index. Thompson demonstrates expertise and interest in all life forms, including plant-animal interactions. Thus, we see his own botanical work. Thompson takes particular pains in laying out many testable hypotheses arising from his geographic mosaic theory of coevolution, thereby providing research ideas for an entire generation of empirical biologists.

This book also shines in presenting gorgeous theoretical work supporting the geographic mosaic theory of coevolution, theory developed by his Pullman/Moscow colleagues Dick Gomulkiewicz and Scott Nuismer. The marriage of theory and detailed empirical work is wonderful.

One peculiarity of this book is that the concise one-sentence summary of the book's topic apparently does not appear until chapter six, i.e. a quarter of the way through the book. At this juncture, we learn that the geographic mosaic theory of coevolution is nothing more than the statement that evolution acts on populations, and not species. This was the classic Fisher-Wright debate of whether or not populations are panmictic. Realizing the importance of populations removed the typological view of species from evolutionary biology. Yet, Thompson is correct in pointing out that much work on coevolution maintains the erroneous typological view of the importance of species…as does much work in macroevolution. His book goes far in dispelling the anachronistic view that, in evolution, species matter more than populations. He persistently reminds us that evolution does not equal speciation. He persistently reminds us that evolution, including coevolution, can be rapid. Evolution can and does occur on ecological time scales. His geographic mosaic theory places coevolution firmly within the purview of evolutionary ecology.

Thompson is relentless is stating that coevolution occurs at the population level. He points out that individuals and populations are often <u>not</u> generalists, even if the species appears to be. Say that a given plant population is only be pollinated by one or a few species of insect, yet different populations of this plant species are pollinated by different insects. Many biologists would have deemed this plant species to be a generalist with respect to pollination, and ignored the fact that each population consists purely of specialists. Analogously, it would be erroneous to say that humans are generalists with respect to languages because, world-wide, humans speak thousands of languages. In fact, each population tends to be very much of a specialist with respect to number of languages spoken. The main message of this book is that coevolution is very much a local (population-level) ecological phenomenon. And, if we are to understand coevolution, we must dig down to the details of dynamics of many interacting multi-species meta-communities.

I believe Thompson has primarily presented a Wrightian view of coevolution (although, based on pages 133-134 of his book, Thompson would disagree with this assertion). If we envision evolution as temporal changes in allele frequencies within a population, then coevolution are the changes in the joint distribution of allele frequencies across populations across both space and time. This can be thought of as a generalized from of epistasis, where the interacting alleles are not confined to a single individual, but can be between multiple species. Alleles from other species form part of the genetic background of a focal individual. Such a generalized, multi-species view of epistasis admittedly does not yet exist. There has been no real theory developed to support this generalized Wrightian view of coevolution. Yet, I suspect it is a theoretical direction that will place coevolution firmly within the modern neo-Darwinian framework.

The book ends with a chapter on humans, which seems to be a modern publisher's requirement for all books on evolution. Compared with the rest of the book, this is a relatively weak chapter. For example, Thompson seems surprised at there being a geographically large coevolutionary cold spot between corn (*Zea mays*) and corn smut (*Ustilago maydis*; huitlacoche) with human cultivation. He implicitly assumes that humans highly value corn and greatly deplore corn smut. Yet many people in southern Mexico highly value both organisms in their diet (Ruiz-Herrera & Martínez-

Espinoza 1998 *Internatl Microbiol*). Thus humans impose a geographic mosaic on the three-way interaction between corn, corn smut, and humans. But this is a minor complaint and the last chapter can largely be ignored as window dressing.

Read this book. Savor the intricate details and appreciate the marriage of nascent data with nascent theory. If the devil is in the details, then this book will certainly please.

- Root Gorelick,

Crop Ferality and Volunteerism. Gressel, Jonathan, ed. 2005. ISBN 0-8493-2895-0 (Cloth US$ 169.95) 422pp. CRC Press, Taylor and Francis Group, 6000 Broken Sound Parkway, NW, Suite 300, Boca Raton, FL. 33487-2742.

Crop Ferality and Volunteerism is a magnificent original contribution concerning one of the significant new botanical challenges of our age. A workshop titled "Crop Ferality and Volunteerism: a threat to Food Security in the Transgenic Era?" sponsored by the OECD Cooperative Research Program and hosted by the Rockefeller Foundation Conference Center in Ballagio, Italy, from May 24-28, 2004 formed the foundation for this book. Growing public concerns due to the increasing territory of commercial cultivation of transgenic plants motivated the workshop's subject.

The editor's Foreword states that transgenic plants were grown on more than 60 million hectares in 2004 and expected to increase in the future. Volunteerism is well known in the daily practice of agriculture, and ferality is usually neglected. Only plant breeders are well aware of ferality due to their experiences based on long-term selection efforts. The phenomena of volunteerism and ferality have to be considered in this transgenic era especially in relation to gene flow. Since no one is performing research related to ferality *per se*, the inquiry was addressed by convening those world experts who are most actively working in related fields. It was anticipated that on the basis of their recent findings, the scientific community would be able to find out whether trangenics are different in this context from normally cultivated crops.

As this information is otherwise unavailable in depth, it was decided to collate the information into a book. Accordingly, the logistical preparation was exceptional: chapters in this book were peer-reviewed prior to the workshop. The questions and answers in the long discussions that followed every presentation were recorded. Each author was given the prerogative of either including the issues and answers from the discussion directly as part of the revised text or including them at the end of the chapter in a separate section.

For the duration of my reading I had the flashback of sitting at the Crop Evolution Laboratory's conference table having conversations with Jack R. Harlan and J.M.J. de Wet and their numerous visitors. This volume draws from those foundations. Suzanne Warwick and C. Neal Stewart's authoritative opening chapter about three principal paths of weed evolution is launched with a quote from Harlan and de Wet. Titled Crops Come from Wild Plants – How Domestication, Transgenes, and Linkage Together Shape Ferality, it defines essential terminology - [1] plant domestication [2] weediness and [3] ferality. A table recognizes comparisons among the three groups: crop, weed, and wild, by means of a series of genetic traits. The characteristics of weediness and domestication traits are explored thoroughly. Each succeeding chapter describes those phenomena probing our foremost food crops.

Since, during the discussions it became apparent that there were other cases of ferality or instances where ferality might become an issue, a special chapter (15) was added by participants and/or was commissioned after the workshop. This multi-authored chapter, Issues of Ferality or Potential for Ferality in Oats, Olives, the *Vigna* group, Ryegrass species, Safflower and Sugarcane appends the vast array of measures plants have used to evolve ferality.

Contributors with exceptional credentials were brought together to inform one another about the world's major crops and their wild and weedy relatives. The result is both scholarly and inspirational. The usual drawback of multi-authored volumes is absent here, thanks to skillful editing and extraordinary groundwork.

This book will appeal to a wide variety of readers. Those interested in theoretical aspects of plant domestication as well as persons with applied interests e.g. assessing the environmental risks of transgenic volunteer weeds, the potential economic damage by feral crops, will profit from this book. I find the contents extremely thought provoking as a primer in consideration of my own monographic revision of the genus *Sesamum* and its various forms: crop, weed and wild.

The book is carefully edited, and each chapter is comprehensive and well referenced. However, one feature followed in this volume as with other CRC publications, is the custom of placing sources cited only by a number in (parentheses) (*sic*), without

giving author name(s)! It is irksome to this reader, who is unable to find out in context what the source of information is without, each time, the additional tedious, time-consuming step of searching for that person responsible at the end of the chapter.

-Dorothea Bedigian
Missouri Botanical Garden, St. Louis.

Demons in Eden: The Paradox of Plant Diversity. Silvertown, Jonathan. 2005. ISBN 0-226-75771-4 (Cloth US$25.00) 169 pp. The University of Chicago Press, 1427 East 60th Street, Chicago, IL 60637-2954.

How does plant diversity evolve and why does it persist? What allows some plants to occasionally escape their natural limitations and form new species, thereby increasing diversity and what limits the invasiveness of newly formed species, thus decreasing diversity? These are the broad questions Silvertown addresses in this deceivingly small and thoroughly engaging volume. In less than 150 pages of text, the author develops some of the major ideas of contemporary plant ecology and evolutionary biology, through personal narrative and historical story telling. Each of the ten chapters concentrates on one or two major concepts illustrated by the plants of a specific locality and in each case key figures, both historical and contemporary, are introduced as their contributions are highlighted. Such an interesting, enjoyable, and educational read!

The story begins in the Princess of Wales Conservatory at Kew Gardens. Ten different tropical zones are represented that highlight the biodiversity of earth, convergent evolution, and adaptation. The author's narration was a guided tour of the glasshouse and I found myself recalling my visit and wondering how many of the subtleties he was describing did I notice at the time? If you've not been there, the single plate provided matches part of the word picture being painted by the author – almost a slide show. This engaging style is used throughout the book. If you've been to any of the locations described by the author, his descriptions will elicit memories - - if not, by the end of the chapter you'll feel like you've been there!

The purpose of the first chapter is to develop the concept of natural selection and to raise an apparent paradox. If natural selection favors those species that leave the most progeny, "Darwinian demons," while the progeny of other species decline and eventually are lost, how can this generate diversity? The rest of the book provides the answers, particularly with those demons known as invasive species.

What are some of the concepts explored and who are some of the scientists highlighted? Let me share just a few of my favorites. The work of Mark Chase and his colleagues is used to explain phylogenetics and the role of molecular biology in understanding evolutionary history. Some of the problems with the grand concept of island biogeography are highlighted using the Canary Islands. Steven Hubble, Dan Janzen and Joe Connell, and the author provide alternative hypotheses to explain how Barro Colorado Island in the Panama Canal has virtually as many species of native flowering plants as all of England – rare species are favored. The Park Grass Experiment, now running for more than 150 years, provides evidence for the role of atmospheric nitrogen pollution in the current loss of species diversity. Finally, what is the threat from genetically modified plants? "Will the Darwinian demons, held in check for so long by nature's laws, conquer at last through human folly and indifference? They may, and in places they already have; yet it is not too late for action."

Demons in Eden is an appropriate read for college freshmen - - I will use it as one of my text-substitute readings the next time I teach honors biology. It would also be a good outline for an upper division/ graduate seminar in plant ecology or evolutionary biology. The chapter-by-chapter general sources and notes at the end of the book cite appropriate primary literature, classic books, general sources and web sites. This slim volume should be in every biologists library!

-Marshall D. Sundberg, Department of Biological Sciences, Emporia State University.

Gardens of New Spain, How Mediterranean Plants and Foods Changed America. Dunmire, William D. 2004. ISBN 0-292-70564-6 (Paper US$24.95) 375p University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819

William W. Dunmire vividly recreates the colors, tastes, and smells of ordinary life in colonial New Spain as he describes the transmission and mixing of food plants and food ways from old world Spain into the vegetative and culinary new worlds of Spanish colonial North America. The author sets the stage for the development of gardens in New Spain with rich descriptions of the plant life and food

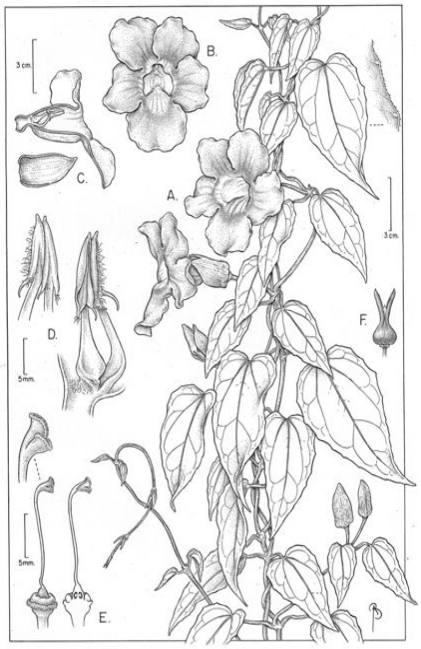
culture of late fifteenth century Spain, Mexico and the American southwest. He then follows the travels of Spanish colonizers as they dispersed plants throughout Spain's North American colonies, creating "European plantways," through the Caribbean into Mexico and, finally by the middle of the eighteenth century, across the southern third of what would become the United States.

The diffusion of the Mediterranean foods and tastes of Spanish colonizers produced the possibility, for example, of mixed gardens in semi-arid places like New Mexico and Arizona that could feature figs, melons, oranges, lettuce and anise alongside more traditional indigenous crops like corn. Spanish colonist and missionaries combined their knowledge of Spanish *acequias*, or irrigation ditches, with Indian canals to provide reliable sources of water for their imported plants. It was, of course, not just the gardens of New Spain that brought culinary change but, also its pastures. The author also explains the significant impact of the introduction of European domesticated livestock on the diets of the indigenous peoples of New Spain.

New Spain was, indeed, a garden as Europeans and Indians joined their plant and animal resources and their technologies to produce a rich and distinctive agriculture. Dunmire concludes his narrative with stories about present-day inhabitants in the Southwest to illustrate both the persistence and blending of European and Indian and agricultural and food cultures.

Dunmire is mindful that there is a less beneficial side to the diffusion of plants and animals to America, the introduction of weeds and new diseases and overgrazing are just a few examples. That is not his focus. Nor is it the author's intent to discuss impact of new world plants on old world Spanish agriculture. Dunmire's focus is "Mediterranean crop and food connections" that developed in Spanish colonial America. He provides extensive tables, diagrams and maps illustrating when, where and by which pathway foods arrived in America. All of this is supplemented by a useful bibliography. The author's geographic emphasis is Mexico and what is, today, the American southwest. Although historians of California and the American southeast will be disappointed that there is not more information about these areas, the study is an important reference source for the agricultural history of New Spain. This study is also a welcome addition to the social and cultural history of early North America as it allows us to glimpse colonial and Native American farmers at home in their gardens.

- Sara Sundberg, Central Missouri State University, Warrensburg, MO 64093.



Thunbergia grandiflora Sims, (by Bobbie Angell) published in *Vines and Climbing Plants of Puerto Rico and the Virgin Islands* (Pedro Acevedo)

Inspiration and Translation:Botanical and Horticultural Lithographs of Joseph Prestele and Sons. White, James J., Jugene B. Bruno and Susan H. Fugate. 2005. ISBN 0-913196-80-0 (Paper US$18.00) 84 pp Hunt Institute for Botanical Documantation, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213.

The Hunt Institute for Botanical Documentation and the Special Collections of the National Agricultural Library has done a great job of constructing this book. The layout has details throughout, similar to the Prestele botanical prints. This book shows off the Prestele families amazing talents as artist and more. Included are not only their prints but essays giving the reader insight into their religious community, the lithographic techniques they used and the legacy the Prestele family has left to the botanical community, along with many additional essays that add so much to their story.

The book itself came about as a chance happening to a Prestele descendent, Mrs. Marcelee Konish, whose essay is also included in this book. Reading a press release for an earlier Smithsonian Botanical Art exhibition, Mrs. Konish approached the gallery, telling of the 150 colored lithographs she inherited

from her grandfather, a great grandson of Prestele, and viola, an exhibition was born. Obviously a lot of time, interest and labor went into putting this exhibition together to show the Prestele's family art work to the public. The curators were also able to add so much more to the exhibition about the Prestele's family's personal and professional life which is so intrinsic to the history of early American botanical work.

The story tells of how this new found collection inspired an exhibition and how the collection details were brought together. The curators have provided the reader with an insight into the Prestele's community structure and religious beliefs, as well as the relationship within the Prestele family. Included is their connection to each other through their craft of lithography and watercolors as it is incorporated into scientific discovery and documentation. The curators were able to describe in detail about the different transactions during projects, communication with illustrators, and movement of the lithographic plates and prints. They also included detailed records of which family member did what task during the different processes. Most importantly, the book shows off the comprehensive reproductions of botanical illustrations that truly capture the details of the plants, leaving the botanical and horticulture sciences with a legacy of information and documentation on early discoveries of United States plants.

The Prestele family of artists, worked on numerous pieces for Asa Gray's including *Genera Florae Americae* (1848) and the Pacific Railway survey's (1855-1860) for the US Army. They also worked on the prints for The Mexican boundary survey (1857-1859), the Great Salt Lake expedition (1852), and as well as for countless nurserymen like James Vick of Rochester, who was the publisher of the *Horticulturist* and a variety of well known botanical illustrators. The curator were also able to share some of the prints that were commissioned for early scientific works but never published, such as Asa Gray's *Forest Trees of North America Project* (1849-1859). Many other additional texts in the Prestele collection, which add to this story, are shared in this book such as the first letter to Asa Gray inquiring about employment and a letter to the great botanical illustrator Isaac Sprague

The curators were able to show how understanding what makes a great collection is not just the individual pieces, but the cross referencing to find the connections in their relationships. This constructs a more complete story of the Prestele's impact on how we see the natural world around us, and to look more closely at the details we have chosen to use to categorize these plants. The connections between the pieces of the collection, like a picture of Joseph's ledger opened to John Torrey's account has been matched to one of the commissioned drawings, including a pencil drawing by Joseph Prestele of *Aster bigelovii*. There were also descriptions of the lithograph technique and a wonderful picture of a completed *Acer rubrium*, including a picture of the lithographed stone with the final print, colored to perfection by Joseph Prestele himself.

The Prestele's had an amazing eye for detail, which is another reason why this book is so well thought out. The authors were able to include roughly half of the exhibitions works into this small, compact book (7x10, 82 pages). Included in the index are the account books of clients for Joseph as well as one of his sons, Gottlieb's. An index of the exhibitions catalogue, and where each piece is deposited, is also included. The only criticism of this book is the indexing of the prints in the book, which go by the exhibition number system and not how they are laid out in the book. It would also be a nice addition to have included the literature cited.

Just about anyone can enjoy this book, for its botanical art and its scientific tools of close observation captured in drawings, lithography, and watercolor. It documents an important time in the history of American botany and hopefully will inspire the reader to peruse the only other book in print about their life, Drawn from Nature by Charles Van Ravenswaay.

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-Linda Jennings, Collections Manager, University of British Columbia Herbarium

Vanishing Beauty. Native Costa Rican Orchids. Vol. 1. *Acianthera-Kegeliella*. F. Pupulin and collaborators (18 collaborators which include most of the recognized specialists in neotropical orchids are listed on pp 408-409). 2005. ISBN 9977-67-956-8 (Cloth) xxx+421 pp., numerous color photographs, 25×33 cm. Sistema Editorial y de Difusión Científica de la Investigación, Universidad de Costa Rica, San Jose, Costa Rica.

One of the more beautiful books in my library is *Géneros de Orquídeas de Costa Rica* by Rafael Lucas Rodríquez. It was published in 1986 and contains several hundred gorgeous paintings of Costa Rican orchids and only a representation of a large collection painted between 1965 and 1981, the time of Rodríquez's death. Now almost 20 years later the University of Costa Rica has published the first of three volumes which also show the beauty of Costa Rican orchids, but this time as seen through the lens of Franco Pupulin with text by himself and 18 other orchid experts from Costa Rica, Germany, Mexico, U. K., U. S and Venezuela.

The book and the projected series are reminiscent of other great series of books which illustrate, describe and celebrate the orchids of a country or a region, as for example, *Venezuelan Orchids Illustrated* by G. C. K. Dunsterville and L. A. Garay (mainly excellent line drawings), *The Native Orchids of Colombia* by R. Escobar, *The Native Ecuadorian Orchids* by C. H. Dodson (both with excellent color phorographs), *Orchids of Malaya* by R. E. Holttum (mostly line drawings), *The Orchids of Peninsular Malaysia and Singapore* by G. Siedenfadan and J. J. Wood (line drawings and color photographs), *Orchids of Java* and *Orchids of Sumatra* (color photographs) by J. Comber and the three volumes of *Orchids of Borneo* (color photographs) by C. L. Chan, A. Lamb, P. S. Shim and J. J. Wood (Vol. 1), J. J. Vermeulen (vol 2) and J. J. Wood (vol. 3).

An excellent historical account by Franco Pupulin (Professor of Botany at the University of Costa Rica) and Carlos Ossenbach (an architect who has become a very accomplished and excellent historian of orchids in the region) is presented on pages XI-XXX. What makes this chapter stand out is not only its exceptional scholarship but also photographs of pre Colombian golden representations of *Oncidium cebolleta*, early drawings and classical color paintings and drawings. This chapter is a pleasure ro read and behold. My only quible is its pagination in Roman numerals which suggests that it is somehow outside the main part of the book. For me at least it is a major and very valuable part of the book and series.

Pages 1-401are devoted to photographs and descriptions of genera and species nu Pupulin and the other experts. Descriptions are mostly for genera as a whole, but species are also described. Cultivation requirements are also included. The photographs are breath taking, often highly magnified and always reproduced superbly. For example, the photograph of *Chranichis diphylla* on page 158 is magnified 20:1 with most of the flower in sharp focus.

Excellent paper and production complete what is easily one of the best and most beautiful, informative and scholarly orchid books to come across my desk in recent years. It is a book to have, a book to give and most certainly and book to enjoy and learn from. I look forward to volumes 2 and 3.

– Joseph Arditti, Professor Emeritus, University of California, Irvine, CA 91697.

Wild Orchids of Thailand. 4th and Expanded Edition. Nantiya Vaddhanaphuti. 2005 (but the US publication date is given as 2006). ISBN 974-9575-80-6, [Paper 995 Baht ($26.04 in Thailand) and $45 in the US], xi+272 pp., 767 color photographs, one map, six × nine in. Silkworm Books, Sukkasem, T. Suthep A. Muang, Chiang Mai 50200 in Thailand (www.silkwormbooks.info) and University of Washington Press, P. O. Box 50096, Seattle, WA 98145-5096 in the US.

Much of what is currently known about the orchids of Thailand is due to the life's work and publications of the Danish diplomat and economist, Dr. Gunnar Siedenfaden (1908-2001). Many years ago Dr. Seidenfaden told me over lunch in Copenhagen that he started out to become a botanist, but gave up on finding out that the requirements included knowing every plant in Denmark. He became a diplomat instead and served his country in Washington, Moscow and elsewhere before finding himself in the Danish embassy in Thailand, a country which probably has more orchids than Denmark has plants. He became an orchid expert who despite being self taught and an amateur (the term is used here in its old sense which means a person engaged in an occupation not for gain, and is not the equivalent of "hobby" or "dilettante") was at the top of his field. His publications are numerous and acknowledged by all experts as being excellent, but they are in scientific journals and specialized publications. Therefore popular books on the orchids of Thailand like a previous one (Kamemoto and Sagarik, 1975)

and the present volume are needed.

The concept of this book is excellent. It presents short, but informative descriptions and color photographs of 687 species (some illustrated twice). It also includes 16 pictures of albino variants and 20 photographs of anomalies. The photographs are a problem. Most are too small, not a few are blurry and the color rendition is often not all that good. The result is a collection of illustrations which suggests rather than shows how beautiful Thai orchids can be.

A list of references concludes the book. It contains enough sources to lead interested readers into the literature, but two important works are missing, Eric Holttum's classic book on the orchids of Malaya, a country which borders on Thailand and shares some orchids with it (Holttum, 1964; there are several editions, this is the third) and Gunar Seidenfaden and Tem Smitinand's preliminary list of Thai orchids (Seidenfaden and Smitinand, 1965). This book is clearly aimed more at growers and the general public than at scientists, but it uses scientific terms. Therefore, it should have included a glossary. Another problem with terminology is the use of "pod" (p. ix) to describe the orchid fruit which is actually a capsule.

Altogether this book does manage to serve its purpose, but could do so much better if more attention was paid to the quality and size of photographs, additional sources were included in the list of references and use and explanation of language were better. The near doubling of the price by the University of Washington Press is puzzling.

–Tim Wing Yam, Singapore Botanic Gardens, Cluny Road, Singapore and Joseph Arditti, Professor Emeritus, University of California, Irvine, CA 92697.

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Argentine Chaco Forests: Dendrology, Tree Structure, and Economic Use. 2. The Humid Chaco. Encyclopedia of Plant Anatomy volume 14, part 7. Roth, Ingrid and Ana-Maria Giménez. 2006. ISBN 3-443-14028-9 (Cloth US$106.00) 204 pp. Gebrüder Borntraeger, Johannestrasse 3 A, D-70176 Stuttgart, Germany.

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