Fall 2013

Explorations Volume 4 Fall 2013

Department of Ecology & Evolutionary Biology

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COLLEGE OF ARTS & SCIENCES

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Volume 4

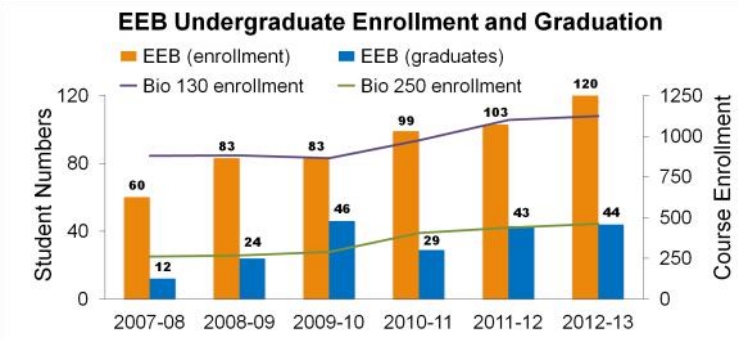
Explorations

The EEB Newsletter

Growing the Legacy

By Prof. Gary McCracken, Head

A legacy is left by those gone before. Come January 2014, my 5+ year term as Head of EEB will be over, and while I am not yet "gone before," I'm pondering legacy. All of EEB's statistics from the past five years point to our growing legacy. The increase in both declared majors and graduates in EEB has been impressive (see graph below). Our commitment to educating these students has resulted in increased enrollments in many courses, especially Bio 130 (Biodiversity) and Bio 250 (Ecology), the two biology core courses for which EEB is responsible. With more EEB faculty members engaged in teaching these courses, we are teaching more students while reducing class sizes. While bigger is not always better, the student experience in EEB has never been better.



EEB's trajectory toward growth and improvement was recognized recently at the 2013 Chancellor's Honors Banquet (visit: snipurl.com/283tci0), and this issue highlights many of the people and groups honored by the chancellor: Shanna Pendergrast, Biology's new dedicated adviser; GREBE, our celebrated Graduate Student Organization; and Rosie Gillespie, one of our most accomplished alumna. You'll see the success of our students at publishing in peer-reviewed journals; enhancing knowledge is our most enduring legacy. EEB's investments in growing and preserving our legacy are illustrated in our field station improvements (below), and in our commitments to biological collections (next page).

In January 2014, I'm going back to the easy stuff: teaching, research, and bats. Thanks to all of you, the students, alumni, and friends, for helping us grow EEB's legacy!

Field Station

The Division of Biology Field Station is entering a new era, with enhanced facilities and access to new technology! A teaching campus has come online at the Field Station in Gatlinburg, TN. The cabins can sleep up to 28 people, making it possible for an entire class to do field research as part of their course. The facility is located about halfway up the hill to the original buildings.

The original Station was donated to the Botany Department in 1999. It consists of two houses, which sleep up to 8 people, and a lab space. A bunk house (0.6 miles away) sleeps an additional 7 people. Its small size and limited facilities make it best-suited for small research groups.

Jen Schweitzer was awarded over $145,000 in Technology Fee Funds from the university in May. These funds are being used to purchase a suite of computer and environmental monitoring technologies, which will build the infrastructure at the Field Station.

At least ten upper-division EEB courses have significant field components. Technology is growing rapidly for field studies, and giving our students access to these facilities, instruments, techniques, and skills will greatly advance and enhance their learning and future career opportunities.

Inside This Issue

Collections: Herbarium

The nationally-recognized UT Herbarium (TENN) is scheduled to move to the first floor of the newly-renovated former student health clinic in November 2013. TENN is staffed by B. E. Wofford, Director and Curator of vascular plants, Ron Petersen, Curator of fungi, D. K. Smith, Curator of bryophytes, and Victor Ma, Collections Manager.

The herbarium houses around 550,000 accessioned specimens of algae, fungi, lichens, bryophytes, and vascular plants. The specimens had been held in in three separate rooms in Hoskins Library. These rooms had no proper temperature or humidity controls and were very crowded.

In the new facility, all collections will be in the same place. The herbarium will increase in size from about 5000 to almost 7000 square feet. It will now have a library room, more working space, and room for future expansion. An NSF herbarium improvement grant has funded new cabinets on rails, allowing compaction of the entire fungal collection. Most importantly, the new climate control system will maintain the facility at 60˚F and 40% humidity, to protect specimens from moisture, insect, and fungal damage.

The digitization of such an extensive collection is time-consuming and expensive, but thanks to several NSF grants, progress is being made. The moss/lichen herbarium is undergoing barcoding; a record of each specimen is being created and linked to a label image. The fungal herbarium has been databased and is completely online. Research notebooks belonging to Dean L. R. Hesler (for whom Hesler Biology Building was named) were digitized and are available through the UT library website.

The UT Herbarium is moving to 1818 Andy Holt Avenue.

For more information, please visit the TENN website at tenn.bio.utk.edu. When the move is completed, we will post an invitation to all on the EEB blog.

Ichthyology Collection

The University of Tennessee Etnier Ichthyological Collection (UTEIC) contains over 450,000 specimens of fish collected from around the world. It is the largest fish collection in Tennessee and the third largest in the southeastern US. UTEIC started in 1965, when Dr. David A. Etnier began collecting fish for teaching and research. The current curator is Dr. Darrin Hulsey.

UTEIC's material has contributed to at least 44 PhD and MS degrees and over one hundred publications. Thousands of undergraduates have learned about the diversity of Tennessee fishes in ichthyology classes using its specimens. Private and governmental agencies also commonly use UTEIC as an authoritative physical reference of the fish diversity found in the waters that drain the western slope of the Smoky Mountains.

UTEIC is on the 5th floor of the Hesler Biology Building.

Because the Tennessee River Basin alone has over 250 endemic fish species, UTEIC's extensive holdings from the southeastern US make it an invaluable facility for understanding our state's natural history. Other important components of the collection include pre-and post-impoundment sampling from the Tennessee River, photographed specimens used in the book *The Fishes of Tennessee*, and physical and tissue specimens of non-game endangered fish.

Vouchered material from UTEIC is used for studies ranging from conservation genetics to molecular phylogenetics that attempt to understand the temporal framework that has contributed to our region's staggering freshwater diversity. UTEIC contains priceless information for understanding the historical ecological niches of fishes and for documenting changes in distribution that occur as humans alter river drainages.

For more information, please visit the UTEIC website at tennfish.bio.utk.edu. To help ensure the continued viability of this incredibly valuable collection, please consider contributing to the D. Etnier Ichthyology Museum Fund (more information on page 7).

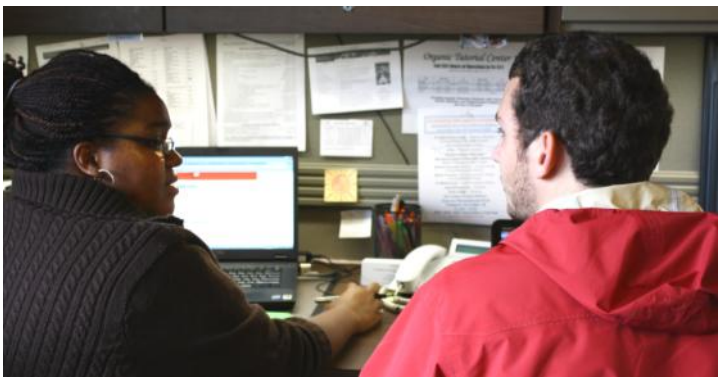
Undergraduate News

Good Advice

By Shanna Pendergrast

In Spring 2013, the Division of Biology hired me to serve as the academic advisor in the newly-created Biological Sciences Undergraduate Advising Center. Prior to joining the biological sciences team, I served as an academic advisor in the College of Arts and Sciences Advising Center for three and a half years. I am excited to work with students, faculty, and staff in biology.

I advise incoming students (freshman and transfer) during orientation. I serve as the primary advisor for undergraduate students until they officially declare their biology concentration. I also occasionally meet with declared majors to conduct graduation checks and answer questions regarding general education requirements.



Shanna is based in room 404 of the Hesler Biology Building.

When a student comes to see me, I remind them that academic advising is a partnership. It's a conversation, not an item to check off a list. Students should plan ahead of time what they want from the meeting. They need to reflect on their academic record so far and to think about what courses they want to take next. They need to set goals for themselves, whether the targets are related to GPA, research, involvement, career, etc.

I am not the only advising resource available to students. I always recommend that undergrads connect with a graduate student in their field of interest. This type of mentoring relationship can enhance a student's understanding of the EEB department at UT and the scientific community as a whole. I have a steady supply of grad students who are interested in taking on new mentees. Declared majors also need to meet with their assigned faculty advisor, as faculty advising is an important part of the undergraduate experience. I support faculty in their advisory role by answering their questions on the general education curriculum and university and college policies.

I also collaborate with the STEM Career Consultant in Career Services to develop resources which educate students on the vast career opportunities available to Biological Sciences majors. With jobs in research, health care, conservation management, forensic science, politics, education, journalism, and business, just to name a few, there are many paths open to students with a degree in EEB.

Agricultural Pests

Undergraduate Research: Devin Jones

McCracken lab undergraduate Devin Jones has been studying migration patterns of the fall armyworm moth, *Spodoptera frugiperda*. This agricultural pest migrates annually from the northeastern US to Florida and Texas. There are two morphologically identical but genetically distinct strains: the corn strain prefers large grasses (like corn and sorghum), and the rice strain prefers smaller grasses (like rice and bermudagrass).

Devin examined differences in habitat preference and migration patterns between the strains. She collected moths with pheromone traps at agricultural (sorghum) and small grass sites in Uvalde, TX, from September to November in 2011. Samples were randomly selected after early-, mid-, and late-season cold fronts, which are important for the moths' southward migration. She used DNA restriction digests to determine the proportion of each strain present.

As fall progressed, the percentage of corn strain increased significantly at the agricultural site, but not at the grassland site. This suggests that the corn strain migrates into Texas throughout the fall and shows habitat preference as it migrates. The rice strain may stay in Uvalde year-round.

Devin won a UT EURēCA award for this research. She is now a grad student at Grand Valley State University.

Fall armyworm infestations in the northeastern US are influenced by agricultural practices in Texas. The two strains have different susceptibilities to commonly used pesticides and genetically modified crops. Climate change could impact the timing and location of moth migrations. Understanding migration patterns is necessary for the control of these agricultural pests and for predicting impacts on the predators (largely bats) that feed on them.

Hopeful Hybrids

Graduate Research: Dylan Dittrich-Reed

Recombination between isolated populations can result in hybrids with novel phenotypes. When new hybrid phenotypes have higher fitness than parental phenotypes in an extreme environment (transgressive hybrids), adaptation should proceed more rapidly for hybrid populations than parental populations. But how often does this happen?

Graduate student Dylan Dittrich-Reed addressed this question by studying how hybrid and parental populations of the red flour beetle (*Tribolium castaneum*), which typically live in wheat flour, adapt to living in soybean flour. He crossed 12 populations of *T. castaneum* to produce 36 hybrid crosses and tracked population growth and developmental rate over 11 generations on soybean flour. Using age-structured models of population growth, he found that hybrid populations adapted to soybean flour more rapidly than parental populations by evolving accelerated developmental rates (time from egg to adult), by decreasing density-dependence (probably by decreasing cannibalism rates), or both. The two mechanisms were independent of one another, meaning different hybrid populations adapted to the same environment in different ways.

The red flour beetle is in most bread products you consume.

Dittrich-Reed's research suggests that hybridization often results in transgressive hybrids and that hybrid populations may respond to selection more rapidly than their parental populations.

These findings have applications for the food storage industry and conservation biology. Red flour beetles are pests of many stored food products worldwide. If contaminated food products from different countries are stored together, subsequent beetle generations may shift their diet to previously unaffected food products. In conservation biology, hybridization between different populations might help endangered species adapt during climate change. Conversely, hybridization might increase the invasiveness of introduced species.

Mushrooms in Australia

Faculty Research: Brandon Matheny

Australia is loaded with fungal diversity. Assistant Professor Brandon Matheny has an NSF grant to study the taxonomic diversity and evolutionary history of a family of mushroom-forming fungi, the Inocybaceae, in Australia.

The Inocybaceae are important root symbionts of many Australian plants, including eucalypts, acacias, and southern beech (Nothofagus). They provide their plant partners with nutrients that are limiting in Australia's nutrient-poor soils. In exchange, the fungi receive sugars produced by their photosynthetic partners. Species of Inocybaceae occur in a wide range of habitats throughout Australia, but they are particularly diverse in the mediterranean climate of southwest Western Australia and Tasmania.

Four examples of the diversity of Inocybaceae found in tropical and temperate Australia.

When the project began, only 17 species of Inocybaceae were recognized from Australia. Current results indicate that there are over 130 species. This number will go up even further as more areas of Australia are explored.

Matheny and his colleagues are using ribosomal RNA sequences to construct phylogenetic relationships between species. The Inocybaceae are composed of numerous, unrelated small clades. However, one clade contains around 90 species and is endemic to the subantarctic region.

Hypotheses concerning regional endemism, biodiversity hotspots, ancestral plant associations, and rates of diversification are being tested. Unlike most taxa, this group appears to be more taxonomically diverse in temperate regions than tropical regions. Associations with Nothofagus (thought to be the lynchpin of southern hemisphere biogeography) were assumed to have come first, but results indicate that eucalypt and other plant associations are more ancient. Radiations will be dated to determine if subantarctic clades co-diversified with initial divergence of eucalypts (ca. 60 million years ago) or coincided with aridification of the continent (ca. 30 million years ago).

In the Face of Change

Faculty Research: Joe Bailey

Predicting community and ecosystem consequences of global climate change is one of the most challenging and pressing problems in evolutionary ecology. My group seeks to integrate ecology and evolution along the gradients of global change to understand the whole-system consequences of biogeographic range shifts. We do this by 1) focusing on how genetic variation in plants affects species interactions and the services ecosystems provide, and 2) placing this work along the selective gradients (such as fragmentation, soil type, and precipitation) that impact the evolutionary dynamics of interacting species.

We study *Populus angustifolia* trees to understand the factors that drive genetic variation. Using nearly 20 river systems that occur along elevational gradients from southern Arizona to Canada, we can identify the selective gradients that have resulted in evolution in this species in the past. A variety of factors affect *P. angustifolia*, including temperature, precipitation, herbivory, soil substrate and biogeographic barriers. Most global change research is based simply on temperature and precipitation.

Populus angustifolia *in Lamar Valley, Yellowstone National Park, Wyoming.*

Climate change-induced range shifts often cause fragmentation of populations. On the Big Island of Hawaii, we are using kipukas, (naturally formed habitat fragments found in historic lava flows) to understand how fragmentation can act as an agent of selection. With *Metrosideros polymorpha* trees as a model species, we are examining how fragmentation influences genetic variation, thereby influencing biodiversity and ecosystem function. Preliminary data indicate that fragmentation and colonization are evolutionary processes. Fragmentation in the context of global change may be one of the most profound and largely overlooked selective gradients in human history.

Theory suggests that local adaptation and the evolution of endemics are major evolutionary consequences of fragmentation due to range shifts. My lab is working in Australia and Tennessee to understand the biodiversity and ecosystem consequences of these evolutionary processes. Our research clearly indicates that endemics are functionally different from their widely distributed counterparts. This difference provides strong support for the conservation value of endemic species. This research program is critical if we are to understand how the services ecosystems provide change in the face of range shifts.

The Games Spiders Play

Faculty Research: Sue Riechert

If I were to sum up my research program through the years, it would best be described as peripatetic, an apt name given to Peripatus, an early arthropod resembling a caterpillar. This "living fossil" gives the appearance of wandering about, and I have let the results of my research lead me off in numerous directions over the four decades of my career at Tennessee. The central theme of this work is animal adaptation and/ or lack of it to both physical and biotic environments. My test animal is the spider, a predator placed under the same constraints as mammalian predators. This system has the advantage over mammalian systems, because spiders have an annual life span, large population sizes, and poor eye sight. They make excellent test subjects for behavioral ecological studies!

I joined EEB as a physiological ecologist. In this early work, I utilized heat transfer physics models borrowed from engineering to predict where spiders could best place their webs, to maximize the time they could be out capturing prey in hot desert environments. I found that individuals actively selected these favorable sites and defended them from others. This led me to studies in behavioral ecology and significant contributions over the years to this field, as well as studies in evolutionary game theory, behavioral genetics, animal sociality, and even insect pest control.

A look into a social spider nest in East Tennessee.

My lab's current work centers on the genetic mechanisms underlying temperament/personality and on the social behavior of the only social spider species found in the US, *Anelosimus studiosus*. Social spiders that cooperate in web maintenance and defense, prey capture and the rearing of offspring account for only 50 of the 37,500 described species of spiders. Only *A. studiosus* is found outside of the tropics and has a mix of social and asocial individuals.

Outreach: GREBE

By Riley Bernard, 2013-14 GREBE President

EEB's graduate student group, GREBE (Graduate Research in Ecology, Behavior and Evolution) is one of the most productive such groups in the College of Arts and Sciences. We strive to enhance students' experiences beyond their academic education. Our efforts were recognized when we received the 2013 Extraordinary Community Service award at the Chancellor's Honors Banquet in April. We are involved in outreach, fundraising, departmental support, professional development, and advocacy.

GREBE's flagship outreach event is KidsU, a university-sponsored academic summer camp. Our recent summer courses include: Snakes Alive!, Vertebrate Zoology, BUGS!, and Fungus Among Us. We are also involved with Boo at the Zoo, Darwin Day, and Year of the Bat.

We raise funds to assist EEB graduate student travel to conferences, such as the Ecological Society of America. Our fundraising efforts include yard sales, t-shirt sales and KidsU summer camps. Over the past three years, we have awarded $5,525 in travel grants.

In Fall 2012 and Spring 2013, GREBE organized the EEB seminar series. We also organize the Welcome Back! ice cream social, EEB recruitment weekend, and Think-Tank workshops to promote collaboration among students. Our workshop topics include how to win research funding, how to make a website, and what NSF panels are like. Students can also use Think-Tanks to present their research and get feedback from peers prior to presenting at conferences.

KidsU students in Snakes Alive! 2012 have a behind-the-scenes tour of the tortoise exhibit at the Knoxville Zoo.

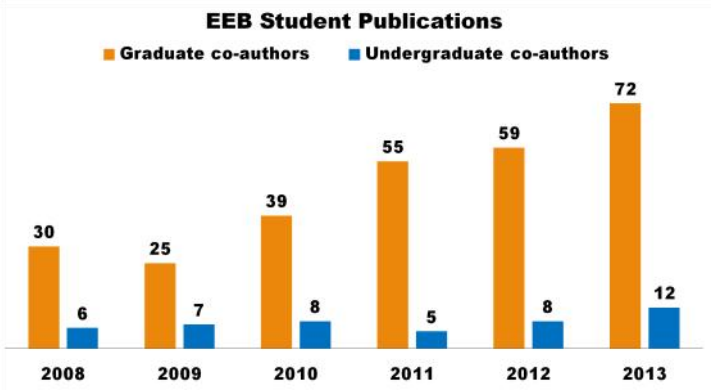
GREBE has advocated for policy improvements to benefit all UT graduate students. We submitted two position papers on stipends, fees, and residency status based on analyses of other leading research universities.

As GREBE continues to mature, we look forward to continuing to be a voice for graduate student interests to the department, college, and university.

Moving on Up

EEB's student body continues to grow in numbers, quality, and success. Forty-four undergraduate and ten graduate students graduated from EEB in 2012-13. Fully half of the EEB students who received their BS degrees at the 2013 Spring Commencement graduated cum laude, magna cum laude or summa cum laude. Congratulations to all of our graduates! As evidenced by the jobs that our MS and PhD students obtained (see list below), our students are well-prepared for life after UT.

Success in ecology and evolutionary biology is measured in part by the number of peer-reviewed research papers produced. The number of both undergraduate and graduate student publications has increased dramatically over the last five years. A student need not enter academia to benefit from publishing papers. A publication is evidence that the author carried out a substantial amount of independent, novel work, saw the task through to completion, and has learned how to communicate effectively. It is an instantly verifiable component on a CV. And hopefully, the author derives personal satisfaction from a job well done and the lasting legacy s/he has contributed to science.



The number of student publications is on the rise.

Master's Degrees:
Anna Becker, Melissa Burt (Technician, North Carolina State University), Morgan Douglas (Technician, Conservation Fisheries, Inc.), and Laura Rubio (Biology Teacher, Medellin, Colombia).

Doctorate Degrees:
Dylan Dittrich-Reed (Assist. Prof., Clemson University), Mauricio Gonzalez-Forero (Post Doc, University of Lausanne, Switzerland), K. Denise Kendall (Post Doc, University of Kentucky), Maria Noelia Barrios Garcia Moar (Post Doc, University of British Columbia, Canada), Mariana Rodriguez-Cabal (Post Doc, University of British Columbia, Canada), and Katharine Stuble (Post Doc, University of Oklahoma).

A Labor of Love and Learning

by Rosemary Gillespie (PhD Zoology 1986)

Gillespie received the 2013 Notable UT Woman award at the Chancellor's Honors Banquet, for making "outstanding contributions" to the university. She is currently a professor in environmental sciences at the University of California, Berkeley, and director of the Essig Museum of Entomology.

Born and raised in rural Scotland, I had my first taste of research during my undergraduate years at the University of Edinburgh, during which I learned of the work of Susan Riechert. She did exactly what I wanted to do! UT was the only graduate school to which I applied.

As a grad student with Susan, I learned a number of important lessons that I try to pass on to my own students. First, be independent and creative in your research; it has to be exciting and the product of your own imagination. Second, know the right questions to ask; know the biology of your organisms, and have a firm grasp of the research literature. Third, take some risks in the directions of your research. And finally, work hard if you want to succeed; it helps if you find something you really love to do.

The dwarf cloud forest of Mt. Kaala, Oahu, is home to a host of spiders that are unique to this particular site.

Photo by George K. Roderick.

I could not have chosen a better environment in which to learn these lessons: my research site in the Smoky Mountains was an area of exceptional beauty. My instructors were outstanding and took a deep interest in every single student. They set a fabulous example of scientists who work extremely hard, yet have fun doing their research.

I left UT to take a postdoctoral position at the University of Hawaii on the feeding behavior of the aptly named "happy face spider." However, after just a couple of days in the field, I happened upon something truly extraordinary: the long-jawed spiders that I had researched in the Smokies were in great abundance in the Hawaiian forests. The morphological, ecological, and behavioral diversity of species was utterly inconceivable. Since my funding was for only 6 months, I spent the next few years scrounging up (really) small pots of funding to allow me to keep working on this largely unknown and undescribed adaptive radiation. I joined the faculty at the University of Hawaii in 1991. In 1999, my husband, George Roderick, and I moved to the University of California at Berkeley. My research program is still based in Hawaii and still focused on the relatives of the long-jawed spider on which I worked during my graduate years at UT.

Giving Opportunities

EEB has several departmental funds to support our vision of excellence in science education.

Ecology and Evolutionary Biology Enrichment Fund

This fund is the primary departmental account. It supports instructional and academic programs within the department, including

- Undergraduate and graduate research;
- Travel funds for students to participate in meetings and workshops;
- Other departmental activities that are in need of support.

If you have specific philanthropic goals, you may wish to consider one of EEB's other funds, a few of which are listed here:

Mulholland Post-Doctoral Fellowship in Environmental Sciences
Graduate Research in Ecology and Evolution Fund
H. R. DeSelm Graduate Award Fund
D. Etnier Ichthyology Museum Fund

L. R. Hesler Herbarium Support Fund
Field Botany Fund *(also supports ecological field work)*

If you would like more information about any of these funds, or if you wish to support a fund not shown here, please contact the EEB office (865-974-3065) or the College of Arts and Sciences (865-974-2365).

To contribute online, please visit eeb.bio.utk.edu, scroll towards the bottom of the page, and click on

Contribute to a big idea. Give to EEB.

The EEB Enrichment Fund will be selected for you.

To mail a contribution to EEB, please make your check payable to The UT Foundation, and write the name of the specific fund to which you would like to contribute on the memo line (EEB address on back page).

THE UNIVERSITY of TENNESSEE KNOXVILLE

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Wildflower Notecards

EEB has worked with retired botany professor Alan S. Heilman to develop a set of eight wildflower notecards. Each card features one wildflower native to Tennessee. The prices include shipping and handling within the US: $13 for one set, $24 for two sets, and $35 for three sets. Please visit eeb.bio.utk.edu/wildflower-notecards for information on how to purchase these notecards. All proceeds go to the EEB Enrichment Fund.








All photos are from The Botanical Photography of Alan S. Heilman, © Alan S. Heilman, © The University of Tennessee Libraries, 2011.

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