

IN VIVO

Newsletter of the University of Tennessee Division of Biology

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From the Director

Otto J. Schwarz, Ph.D.



Seasons greetings from the Division. We are soon to enter the months of deep winter and with this season will come a new year with all of its hope, promise, opportunity and, of course, challenge. In retrospect, the Division and its Departments have weathered a year dusted with problems as well as triumphs. The year began with the final efforts to vacate "Old" Hesler Hall in preparation for its gutting and rebirth as a newly renovated modern research home to be inhabited by the Botany and Ecology and Evolutionary Biology (EEB) Departments. The renovated space will be occupied mainly by faculty and graduate student offices and related research laboratories. Also included are centralized growth chamber facilities focused on supporting the research efforts of the resident plant scientists.

The Division's eyes and ears to all things structural, mechanical and electrical, **David Pratt**, Manager of the Biology Service Facility, has assured me that the

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An integrated approach to mapping species relationships

"Despite hundreds of years of debate, species boundaries are still a valid question in biology," said **Dr. Randall Small**, assistant professor of Botany. He studies species boundaries and relationships using the techniques of molecular systematics and molecular evolution as his tools.

Dr. Small combines these two different methods to form a system

now exploring patterns of speciation in the related, but less studied genus *Hibiscus*. Several nuclear-encoded genes are being explored for this work including the alcohol dehydrogenase (*Adh*) and granule-bound starch synthase (GBSSI) gene families.

It is a continuous cycle. He said, "In order to do the phylogenetic work, you have to have a good understanding of the genes you are using. But in order to



understand how those genes evolve, you have to have a good model system already in place to compare them. The more we understand about species relationships, the better we can study molecular evolution. The more we understand about molecular evolution, the

of checks and balances. Molecular systematics uses data from DNA sequences to analyze relationships among species, while molecular evolutionary studies seek to understand the processes by which DNA sequences change.

Dr. Small uses two different groups of plants from the mallow family (Malvaceae) in his work. He began with the cotton genus *Gossypium* while he was working on his Ph.D. It is an important crop that is well understood genetically and phylogenetically, which makes it a good model to develop tools for determining species relationships. Using the tools developed in the well-understood cotton genus, he is

better tools we can use to understand species relationships. Both areas of research are illuminating to each other. We are always looking for new tools, new sources of data."

Dr. Small is aided by several lab members. **Dr. Ed Lickey** is a post doctoral researcher who is working directly on Dr. Small's NSF grant to study species relationships in *Hibiscus*. **Joey Shaw** is a Ph.D. student working on phylogenetic relationships in a group of species in the genus *Prunus*, the native North American Plums.

Ph.D. student **Wusheng Liu** works in the field of molecular evolution. His focus is on genes within cotton that were recently identified as being involved in

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Keeping Botany on the cutting edge

by Ed Schilling, Ph.D.



Experienced botanists know the importance of regeneration in keeping a plant collection vibrant and healthy. Rooting a piece of an old plant

that has become weakened or grown out of form can provide a vigorous and malleable individual – this is known as making a cutting.

We can use this analogy to look at some of the opportunities being pursued by Botany as we head into a new millenium. Keeping up with rapidly developing technologies has led us toward various exciting new opportunities – taking parts of our program and growing them in new directions.

One example of vigorous new growth is found in the herbarium (see accompanying article, p. 7). This core departmental facility, which is adjusting very well to its new quarters in the Hoskins Building (the old main library), has branched out to have a major presence on the Internet. This realizes the exciting potential for herbaria and the vast amount of information that they contain to be available not only locally to a select few but also globally in virtual form to an almost unlimited community of users.

From a modest first step of putting the county distribution maps online, the herbarium has leaped into online images. Thanks to the efforts of **Dr. Gene Wofford**, **Dr. Victor Ma**, **Chris Fleming**, and others, the herbarium web site now presents one of the finest collections of on-line images of plants.


Another exciting new direction is the development of the Botany Field Station in Pittman Center near Gatlinburg (see accompanying article, p. 3). Thanks to the generosity of departmental friends, we have a great opportunity to benefit from a unique teaching and research facility located in a strategically favor-

able area near the Great Smoky Mountains National Park. Not only does this give us a place to deliver special field classes and facilitate student research in the Park, it also gives us the opportunity to work closely with organizations such as the Park Service and the Discover Life in America program in learning and educating about the park and its wonderful biota.

We are eagerly anticipating the opportunities provided to us by the upcoming renovation of the Hesler Biology Building. We held our collective breaths during the recent bidding process, but preliminary indications are that the funds allocated by the state are sufficient to accomplish almost everything that we requested in the renovation plan.

There is one notable exception, and that is the greenhouse complex (see accompanying article, page 4). We are pursuing vigorously any and all opportunities to see that what we hope will be a magnificently reconfigured version of the Hesler Building is accompanied by an attractive and equally improved version of the Greenhouses. Having a state-of-the-art greenhouse facility immediately adjacent to our classrooms makes possible many opportunities for hands-on teaching, and we intend to take full advantage of them.

A key to being able to take advantage of these and other opportunities to keep the department on the “cutting edge” has been the generosity of our friends. In many cases, the initial monies needed to get a project rolling have been available from places such as the Botany Enrichment Fund, and these have been leveraged many-fold both in terms of dollars and in terms of impact on students.

Each of you who have made contributions to the department is thus a partner in these efforts, and we continue to be grateful for your generosity. 

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work needed to bring all of these great things to pass will actually begin very shortly as the construction bids have finally been awarded. Eighteen months from January 1, 2003, the entire faculty displaced in the first migration, plus the entire faculty and staff now located in "New" Hesler will be rewarded with newly renovated space in "New" Old Hesler. Three months is then set aside to facilitate the moving of people and equipment. The renovation of the now "Old" New Hesler will then immediately commence and some ten months later, July 1, 2005, "New" New Hesler will be ready for occupation.

This second phase of Hesler renovation will produce almost exclusively, teaching/classroom space for Botany and EEB. As you can see, under the best of scenarios, we will suffer some disruption extending out to mid 2005, give or take a bit. Will it be worth the disruption? You bet, because we will have enormously upgraded research and teaching facilities needed to keep Biology at UTK nationally and internationally competitive.

The Division responded very well to the mid-summer shut-down. All support facilities maintained full function as the result of the dedication and just plain hard work of our support staff. We have seen a major change in the top leadership of The University of Tennessee with the hiring of our current President **John Shumaker**. His leadership, together with that of our Provost **Loren Crabtree** and the support of our current Interim Dean of Arts and Sciences **Stuart Riggsby** has resulted in the addition of four new faculty positions to several of the academic departments of the Division. So, we are ushering in a very busy recruiting year for the Division's Departments, at last count, together with the latest positions, we will be looking for ten new faculty during the first half of 2003.

This edition of *In Vivo* is focused on the happenings of the Botany Department. The department is well settled in its new, but temporary, teaching home on White Avenue, a short half block north of Walters Life Sciences building. As mentioned above, Botany's teaching laboratory and some class room facilities will eventually be moved back to the then newly renovated "New" Hesler building.

As you might suspect, the faculty is looking forward to its new, updated home, with one exception, the greenhouse facilities currently adjacent to and a part of the Hesler facility were not included in the renovation plans. In order to remedy this state of affairs, the Botany Department together with the Division is in the process of initiating a drive for the complete replacement of the currently antiquated greenhouse facility. Replacement of these facilities is a high priority as they will provide state-of-the-art facilities required by cutting edge plant research.

The conceptual design includes highly isolated/self-contained greenhouse space useful for the culture of transgenic plants, a special "cold" greenhouse enabling culture of cold climate and sub-alpine plant species as well as a two level conservatory to house an extensive teaching collection of terrestrial as well as aquatic plants and animals and much more. The design has been birthed with not only Botany in mind, but also to expand its usefulness to a broader sweep of the Division's teaching, research and public service missions. Anyone know a benefactor with a kind heart and deep pockets? Enjoy this issue. We will talk again in 2003. 

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A New Field Station

A property with 19 acres of land and some residential buildings that is located near the Greenbrier entrance to the Great Smokies National Park is the site of the nascent Botany Field Station. Fifty years ago most of the land had been cleared for farming, but now the trees have reclaimed the property. A winding gravel road ends at a small hilltop on which a pair of white block houses sit. The view is breathtaking, the environment stimulating for botanical studies.

The property was originally owned by **Bernice Stevens** and **Dorothy Zimmerman**, two friends who were master crafters of jewelry and who relocated to the Gatlinburg area in the 1950s to take advantage of the local artisan community and the pleasant environment. They were good friends with **Dr. Aaron "Jack" Sharp**, who was instrumental in arranging for them to donate the land and houses to the University for the purpose of establishing a Botany Field Station.

With its prime location near the Park, the property has significant value, and under normal circumstances would never have become available to the department. Although graduate students over the years have taken advantage of a smaller block house located at the base of the property for short term stays, it is only now that the initiative is being taken to convert the property into a fully functioning station for teaching and research.

Structures on the property include two residences connected by what had formerly been a jewelry workshop. One house has a kitchen, one bedroom and a living room that opens to an impressive view of Mt. LeConte. The other house has a similar though somewhat more expansive layout, with kitchen, two bedrooms, two baths, ample storage closets, and a living area that faces outward to an equally spectacular view of Mt. Guyot. A

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Operation greenhouse

The ability to grow and manipulate plants is an essential part of many teaching and research projects in our Botany department. This is why we are working so hard to see that a new Greenhouse Complex becomes part of the Hesler Renovation Project.

Some of the readers of this newsletter may remember an early set of greenhouses attached to the building. However, by the late 1970s they had become nearly nonfunctional, in part because of an inadvertent application of permanent shade paint that made them more suitable to grow fungi than plants. That is why there was considerable rejoicing when the new Greenhouse Complex opened in the 1980s. Although it represented a great improvement, we still spent a lot of effort to modify the heating/cooling and humidifying systems to allow us to actually grow plants within the shiny new structures.

By the year 2002, however, the control and electrical systems and even the benches on which the plants sit have deteriorated to the point of no return, and a complete overhaul is needed. Unfortunately, the greenhouses were not included in the Hesler Renovation project, they were considered to be outside of the "footprint" of the building and not part of the project, thus there are no funds to undertake this work. Nevertheless, it makes perfect sense to seize this opportunity to try to provide the renovated Hesler Building with a Greenhouse Complex that will meet the teaching and research needs of the department into the foreseeable future.

A great deal goes into planning a new configuration for any major structure, and this is especially true for a greenhouse. It should be aesthetically pleasing as well as functional. Placing a greenhouse adjacent to an academic building in an area as tightly packed as the "Hill" presents additional logistical challenges. Through the combined efforts of **Dr. Otto Schwarz**, Interim Director, **David Pratt**, Manager of the Biology Service Facility, **Dr. Ed Schilling**, Head of Botany, and **Dr. Kenneth McFarland**, Greenhouse Manager, a plan has been generated that would result in an impressive and functional structure (see diagram above).

Dr. McFarland has been involved in the functional planning stage of this project. This new complex will accommodate the highly specialized needs of modern plant science as well as provide first rate facilities for hands-on student participation.

According to Dr. McFarland, "the greenhouse will have multiple rooms, each dedicated to different requirements. Some space will be dedicated for classroom activities such as research projects by undergraduate students in conjunction with the General Botany courses."


There will also be space designated for faculty and graduate student research. This will include specially outfitted space to grow transgenic plants and to provide cold and desert climates. A key feature of the new greenhouse will be the ability to provide environmental isolation and computerized climate control. This will increase the diversity of plants maintained

by Botany and make available new opportunities for teaching and research to its faculty.

The centerpiece of the greenhouse will be the two-story conservatory, a living classroom with adjoining teleconferencing and multi-media room. The juxtaposition of these two facilities will open up new educational and research opportunities for students in undergraduate and graduate classes. This space will also be available to the college and university for much needed educational as well as cultural use providing participants with a stimulating environmental experience.

The \$2 million dollar greenhouse project will be funded primarily from the private sector. Therefore, the success of this project will depend upon the generous support of our alumni and friends. The flexibility of the space and its visibility on campus will provide many opportunities for the Division of Biology and The University of Tennessee. For our alumni and friends, it is a wonderful way to support the academic endeavors of our faculty, students and the community.

Dr. McFarland has already begun taking cuttings and collecting seeds from current plants in the old greenhouses to be reestablished in the new teaching and research facility.

For more information regarding gifts, pledges, endowments, or deferred gifts to support this important project, please contact Jen O'Brien in the College Development Office at (865)974-2365 or at jobrien@utk.edu. 

FIELD STATION, *Continued from page 3*

graduate of the UT Ecology program and former GTA for Botany, **Jessica Bier**, currently occupies one of the houses and acts as caretaker of the property. The center section, which was formerly a workshop, has now been converted into a biological laboratory that has already been used by the All Taxa Biodiversity Inventory (ATBI) of Discover Life in America (DLIA) for an insect sorting class.

The layout of the houses provides the department with considerable flexibility for meeting the needs of various individuals or groups who might utilize the Field Station. Plans to install bunk beds in one of the bedrooms of the residential sections would provide housing for students



Surveying the new station: Dr. Otto Schwarz, Emily Jones, Dr. Ed Schilling, Dean Stuart Riggsby, Jeanie Hilten and David Pratt

from field classes and could also be utilized by visiting researchers or sabbatical visitors.

A key to developing the Field Station and seeing it reach its full potential is coordination with other groups involved with research in the Smoky Mountains. These include the Discover Life in America (DLIA) program, which is coordinating the complete biological survey (ATBI) of the park, and the research arm of the National Park Service. **Jeanie Hilten**, DLIA Administrator and **Emily Jones**, Friends of the Smokies Development Coordinator, are excited about the


prospect that the Field Station could help to meet some of the critical needs of their programs. The small amount of research space available in the Park is already overflowing, and space is particularly needed for volunteers to work on projects. In addition, they face an ongoing problem of being able to provide housing for visiting scientists, toward which development of the residential aspects of the Field Station would make a tremendous contribution.

There is one hurdle though: after standing dormant for several years, the houses are in critical need of repair. The Department does have one great resource, however and that is the expertise of the Division's Biology Service Facility (BSF).

Through their hard work and ingenuity, and the initiative of **David Pratt**, most of the needed repairs to the laboratory have already been made, in part using surplus materials freed up by the Hesler renovation project. For example, the fixtures and benches were resurfaced and refitted into the available laboratory space.

However, the most pressing need is replacing the roof. BSF hesitates to do much

more on the renovation until the roof is replaced. A local contractor has estimated the cost at \$27,000. Further funding for the Field Station hinges on this repair. Donations are being sought from alumni and friends of Botany for this much needed renovation.

The Field Station promises to further the alliance among researchers working with UT, the National Park Service, and the DLIA. Most importantly it will offer students an opportunity for "hands-on" experience in the field. This will go a long way to increase interest in Botany and strengthen the overall department. 

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the control of flower development. Dr. Small describes this as a hot area of research called "EvoDevo" or the evolution of development.

Charles Winder is a master's student who is concentrating on a conservation genetics problem on the Cumberland Plateau. His focus is on the rare and endangered Cumberland stitchwort, which is in the same family as carnations, baby's breath, and fire pinks.

John Beck is Dr. Small's newest Ph.D. student and since it is his first year, he has not yet selected his research project. As demonstrated by the wide range of research being conducted in the laboratory, Dr. Small does not limit his students to his personal research. He said, "Part of my philosophy on graduate students is that they should do what they want to do and not what I want them to do."

Dr. Small enjoys the study of plants in the wild as well as in the laboratory, so sometimes his passion for hiking mixes with work. "I can't help it," he said. While enjoying a hike he often collects plants for DNA analysis, or to be added to the Herbarium collection.

This is one reason why he is happy to call the Smokies home. He said, "I fell in love with Tennessee during my bachelor's work." Originally from Ohio, he attended East Tennessee State University in the early 90's. He then moved back north to complete his master's at Miami University in Oxford, Ohio and his Ph.D. at Iowa State University. However, he said, "When I was finishing my Ph.D. my wife and I decided we really wanted to go back to the southeast. When this job came open it was my dream. How many people can say that they got their dream job?"

He has found a home in Botany as well. He said, "I couldn't be happier. It's a great department. I feel like I fit in here really well. There is a lot of support for the work we do." 

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Gardens of knowledge

Dr. Kenneth McFarland is an instructor and the greenhouse manager for the Department of Botany. However simple his titles may seem, he shoulders a diverse set of responsibilities that include teaching, coordination, preservation, and planning.

Dr. McFarland is a teacher at many levels. He teaches and coordinates the General Botany 110 and 120 courses on campus. Off campus he teaches and coordinates non-credit courses for the Smoky Mountain Field School and for the annual Wildflower Pilgrimage in the Great Smoky Mountains National Park (see <http://www.wildflowerpilgrimage.org>).



In the area of preservation, Dr. McFarland maintains the various outside gardens and greenhouses for the department. His main goal is to conserve plant diversity, and to educate both students and the general public about it by grouping his collections by families or distinctive morphologies.

Some of the gardens are used for classes and for student projects. Some are home to rare and endangered species, such as Ruth's golden aster, the Tennessee coneflower and Price's potatoes. Dr. McFarland collects seeds from the rare plants grown in these gardens to distribute to other universities as far away as Wisconsin where similar gardens are maintained. He also sends

seeds to the USDA for their gardens and storage.

McFarland has designed and planted a garden featuring species of ethno-botanical interest selected in cooperation with **Dr. Gary Crites** of Anthropology. Dr. Crites has great interest in the plants that were used by ancient Native Americans in East Tennessee, and that is the focus of this garden. Dr. McFarland's interest in ethno-botany has been fostered by his cooperative work with UT's McClung Museum. The garden has been a great success and has been emulated by other institutions.

Within his gardens, Dr. McFarland

has assembled a fascinating collection of insectivorous plants. He has, however, been forced to hide them among his other plants because such species as the Venus fly-trap are often

taken by students for "pets".

He maintains a rock garden that harbors unique plants that are normally found only on rock out-croppings. He also manages plants being studied for research by Botany faculty and has a new garden that is still under construction at the White Avenue Biology Annex (WBA).

His experience with gardens and teaching comes together in the greenhouses, both old and new. Although aspects of preparing the Hesler Biology Building renovation have raised problems for some faculty members, Dr. McFarland has been able to relocate most of the old greenhouse specimens to the WBA.

He is happy with this temporary arrangement and said, "We have all


the General Botany classes in the WBA now along with three quarters of the greenhouse. The space is somewhat smaller, but the autoclaves and distilled water are more conveniently located than they were in Hesler."

Dr. McFarland's interest in ethno-botany has been fostered by his cooperative work with UT's McClung Museum. The garden has been a great success and has been emulated by other institutions.

He is always careful to find ways to enhance the greenhouse environment as a whole. For example, he implements the Integrated Pest Management system, which uses predatory insects to control pests within the greenhouses. Some students have done projects on this system, but it is mainly used to cut down on the use of pesticides in the Botany greenhouses.

Dr. McFarland's other professional endeavors include the study of mosses, liverworts and hornworts. He has made monographic studies on the genus *Brachythecium*, floristic studies of bryophytes in the southern Appalachians, impact assessments of rare, endangered bryophyte species, and studies the developmental morphology of bryophytes.

He is originally from Xenia, Ohio. He received his undergraduate degree from Central State University, his masters from Ohio University in Athens and his Ph.D. here at UT under **Dr. David K. Smith**. His interest in Mexican moss flora initially brought him here in the mid 1970's to work with **Dr. Jack Sharp**.

Although he wears many hats, Dr. McFarland's passion remains two-fold; to preserve our botanical heritage and to bring the study of Botany to life for students at UT. 

Digital images of the flora of Tennessee

by B. Eugene Wofford, Ph.D.

Historical Perspective. In the early 1990's a project was undertaken by a group of five Tennessee botanists to produce a county distribution Atlas of the Flora of Tennessee, i.e., county distribution maps for the approximately 2,900 species of vascular plants occurring in Tennessee.



The Atlas was published in two volumes in 1993 and 1995 through funding provided by the Austin Peay State University (APSU) Center for Field Biology. However, plant distributions are not static and since thousands of specimens representing new county records have been subsequently collected, our hard copy publications rapidly became outdated and obsolete.

Therefore, rather than periodically publish revisions of the Atlas, a second initiative began in the mid 1990's. On July 4, 1997 the distribution map web site became available through the UT Botany Department and the APSU Biology Department.

The original database format required the user to be knowledgeable of botanical taxonomy, classification, and nomenclature; e.g., to view the distribution map of tulip poplar (Tennessee state tree), one had to know it is a dicot, belongs to the Magnoliaceae, and its scientific name is *Liriodendron tulipifera*. Unfortunately, for the general public this was extremely unwieldy and user unfriendly.

Recent Initiatives. The initiative to add plant images to our existing



distribution maps of the vascular plants of Tennessee began with a grant from The University of Tennessee Libraries Digital Center to scan over 1,500 slides into electronic format. About 400 images of the woody plants of Tennessee are from the recently published "Guide to the Trees, Shrubs, and Woody Vines of Tennessee" by **Dr. Edward W. Chester** and myself.

Chris A. Fleming, Botany graduate student, scanned and processed more than 1,100 images of grasses, sedges and rushes from specimens deposited in the UT herbarium. An additional 1,435 images of mostly herbaceous species were added to the data base by Chris.

The images were then linked and displayed dynamically via the online database developed by **Dr. Q. Victor Ma**, Herbarium Collections Manager. As of November 6, 2002, 3,180 images of over 1,800 species are available for browse and search. We estimate that we now have images of two thirds of the state flora online.

A second, and equally important, development was to add a link to common names of species as part of the

distribution map/image page. Doing so, provides user-friendly access to information in the data base for the general public or anyone with only minimal botanical knowledge. These changes and additions have significantly enhanced

the quality, content, research, usefulness, and education potential of our web site. For the professional botanist, images and distribution maps can be viewed for research, teaching, or general inquiry.


The east-west axis of the state of Tennessee cuts across all of the major physiographic provinces in the eastern U. S. resulting in an extremely diverse flora.

Endemic species, state and federally listed rare plants, and species with closest relatives in Southeast Asia are easily found and studied. There are many professional and amateur botanists who have never seen an image of many plant species that occur in our rich Tennessee flora, and this gives a worldwide internet audience easy access to our unique collection.

The addition of a common names link provides a resource to a broad audience, which includes the general public, public and private schools, poison control centers, state and federal



agencies, land managers, and conservation groups. We have already seen the number of site visits in October double those from July, August, and

September, respectively. We believe that as more people discover the site and its utility, the number of visitors will increase significantly. The utilization of electronic media has amplified significantly the scope and value of what is already a unique and invaluable resource. 

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University of Tennessee Herbarium
Largest Collection from Southern Appalachians
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