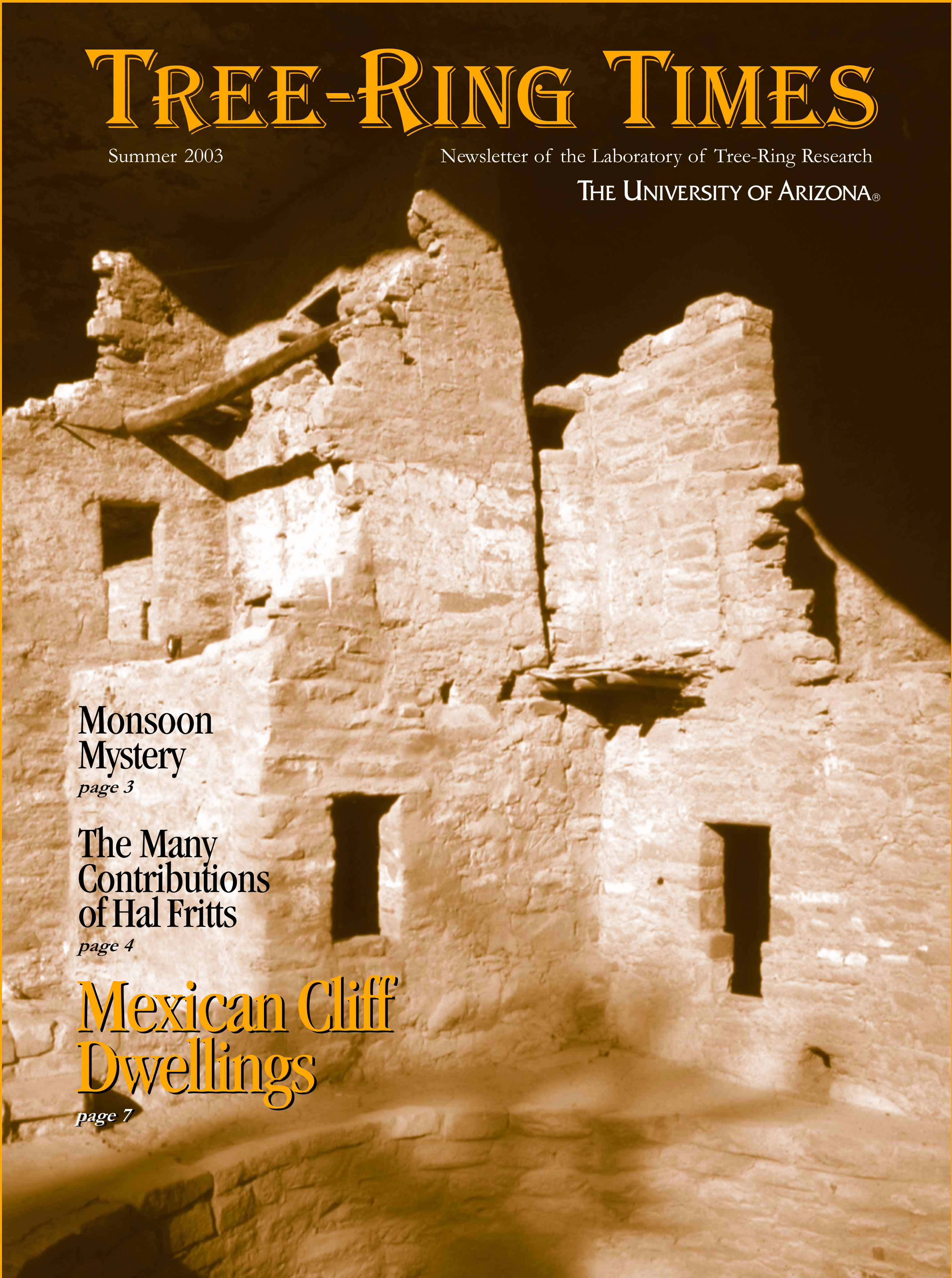
TREE-RING TIMES

Summer 2003

Newsletter of the Laboratory of Tree-Ring Research

THE UNIVERSITY OF ARIZONA®



Director's Note

The breadth of research and teaching at the Laboratory of Tree-Ring Research are well reflected in this issue of Tree-Ring Times. A great strength of the LTRR has always been its diverse inter-disciplinary mix of research expertise and applications of dendrochronology. In this issue you will read about the remarkable career of Professor Emeritus Harold Fritts, illustrating the biological roots of his research and leading to his seminal work in the reconstruction of past climate history using tree rings *(page 4)*.

Hal's contributions established the basic framework for dendroclimatic studies worldwide, and we are truly fortunate that he continues to interact with our faculty, staff, students and visitors. The continually expanding and increasing importance of the field of dendroclimatology is nicely exemplified by Dr. David Meko's tree-ring work on the Southwestern monsoon *(page 3)*. Unraveling the stories of environmental change and the migration of people has long been a research theme at the LTRR. Dr. Ron Towner's exciting new work on Mexican cliff dwellings continues this tradition *(page 7)*. Graduate student Melanie Lenart's dissertation research further exemplifies the remarkable breadth of science carried out at LTRR, including ecological applications *(page 6)*. Melanie, of course, is also the Tree-Ring Times Editor, and primary writer, and I'll take this opportunity to thank her for her great work on the Times – and to offer preemptive congratulations on completing her doctorate! Last, but not least, Dr. Steve Leavitt continues his "fleamarket" saga on the final page. We are indeed an inter-disciplinary bunch!

Thomas W. Swetnam

THOMAS W. SWETNAM

COVER:
Spruce Tree House in Mesa Verde National Park, tree-ring dated to between AD 1230s to 1270s. Note the t-shaped doorway typical of Anasazi dwellings, and the similar shape in the Mexican cliff dwelling on page 7.
Photo by James Fairchild-Parks

Recognition & Awards

The Laboratory of Tree-Ring Research has benefited from numerous donations and grants in the past few years. Here we acknowledge some of the donors who collectively contributed $141,760 to various LTRR funds and programs since the beginning of 2001. The support is highly appreciated, as it enhances educational and research opportunities at the Lab.

Those donating to the LTRR Capital Building Fund / Archives include **Agnese Haury**, **Mr. and Mrs. Teddy E. Davis, Dr. Katherine Hirschboeck, Dr. Robert Maddox** and **T.J. Blasing**.

Betty Bannister, and **Paul and Suzanne Fish** contributed to the Agnese Nelms Haury Endowment.

Jonanthan I. Lunine and **Mr. Edwin B. Kurtz** donated to the Douglass Scholarship Fund, and Mr. Kurtz also contributed to the Schulman Scholarship Fund.

Mr. and Mrs. Alexander J. Lindsay, Jr., supported LTRR archeological projects, and **Cathie M. Hayden** provided support for dendroarchaeology field trips.

Those donating to the LTRR unrestricted fund include **Malcolm Weiner, Michael J. McGinnis, Mr. and Mrs. Bruce Balmat, Kenjiro Sho, Ann Follett Liebert, Dr. Katherine K. Hirshboeck** and **Dr. Robert Maddox**.

The Tree-Ring Lab thanks all of these generous donors!

Several University of Arizona graduate students benefited from the generosity of donors when they received competitive scholarships recognizing their outstanding academic achievements.

David Grow and **Kurt Kipfmueller**, both of whom have since completed their Ph.D. programs, received Andrew Ellicott Douglass Scholarships in recognition of the excellence of their graduate work and the faculty's high expectations of their future contributions to dendrochronology, the science of tree rings.

Jeff Balmat and **Ellis Margolis** received the Alsie/Edmund Schulman Scholarship, which is awarded to outstanding students in dendrochronology courses who demonstrate a high potential for future contributions to dendrochronology.

Linah Ababneh received the first Bristlecone Pine Student Scholarship for her research on nitrogen and carbon stable isotopes in leaves and tree rings of bristlecone and foxtail pines in California.

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LTRR Director: Dr. Thomas W. Swetnam
Editor: Melanie Lenart
Production: Darla Keneston, AHSC Biomedical Communications

Meko Uses Tree Rings to Solve Monsoon Mystery

• *By Melanie Lenart*

The North American monsoon usually arrives in the Southwest with fanfare, making lightning bolts fly, rivers flow, and trees grow. Like the clouds carrying the rains, though, evidence of the monsoon was quickly dissipated – until LTRR researcher Dave Meko figured out how to detect a long-lasting signal in tree rings.

Meko, a Principal Research Specialist at the Laboratory of Tree-Ring Research, managed this by dividing the annual growth of certain trees into pre-June (earlywood) and post-June (latewood) growth. Using a separation technique developed by Senior Research Specialist Chris Baisan, Meko worked out the statistical details so the annual rings can yield seasonal information.

"By separating out the summer with the latewood component you get a super signal," Dr. Meko explained. "It's been so dry in the spring before the rains start up that the trees are primed to respond to whatever happens."

The monsoon typically sweeps into the Southwest by early July. The hot, cloudless days of May and June inspire many southwestern trees to taper off their wood production, putting down darker wood that remains as a telltale sign of the seasonal slowdown. By recognizing these seasonal markers and separating the growth periods into "before" and "after" the dry spring, Meko has improved reconstructions of past precipitation for both summer and non-summer.

For example, using five Arizona sites in various mountain ranges stretching north between Tucson and Tombstone, Meko and colleagues were able to predict about 53% of the variability in regional summer rainfall and 64% of the variability in non-summer precipitation, using historical records as the basis for comparison. This compares to being able to predict about 45% of the variability in annual precipitation when both growth periods are lumped together into one annual ring.

One result of this pioneering research is that Meko can reconstruct monsoon strength beyond historical records, which extend only to 1868 at best.

"It turns out the quality of the latewood is good enough to use in a regression model and get accurate estimates back in time," Meko noted.

So far, the LTRR researcher has created a 242-year proxy record of summer rainfall that reflects monsoonal strength in southeastern Arizona and southwestern New Mexico. By "splicing together" information from wood samples stored in the LTRR archives, Meko hopes to extend the information on Southwest summer rainfall back to the 1500s or beyond.

The regression model relates the average size of the summer season tree ring to estimated inches of rainfall that season. Previously, Meko and Baisan used a non-linear model to reveal unusually dry summers of the past without trying to reconstruct rainfall totals.

Their initial analysis indicated the monsoons in the 20th Century were more reliable than those of the previous century, where a cluster of three dry summers in 1822 capped off 11 dry summers since 1791. A summer was considered dry in the historic part of the record if less than five inches of rain fell after June.

The expanded regression analysis also increases understanding of another feature of summer rainfall in the region. Historical records show little correlation between southwestern winter precipitation, which is generally related to large-scale circulation patterns like El Niño, and summer rainfall, which is usually linked to thunderstorms, tropical depressions, and the monsoon.

Meko's tree-ring reconstruction indicates winter and summer precipitation patterns are no more strongly related in the long term. So attempts to predict monsoon strength based on winter precipitation will generally fail in the region covered by his analysis.

Winter precipitation might not help predict the coming monsoon's strength, but Meko hopes the creation of a longer timeline of monsoonal rainfall will shed light on other cyclical patterns.

"This will give us an idea of the mechanism behind the monsoon," he noted. "And anything that helps us understand the mechanism of the monsoon can help us predict future occurrences."

LTRR researcher has created a 242-year proxy record of summer rainfall…by "splicing together" information from wood samples.

Dave Meko, shown here in the Rincon Mountains before the 2003 monsoon season, uses tree rings to estimate past summer rainfall.

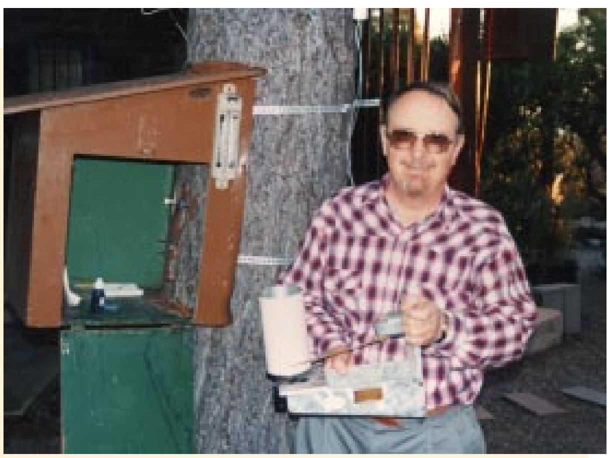
From Skeptic to Provider of Proof:

Hal Fritts' tree-ring career covers many themes

• *By Shoshana Mayden*

When Hal Fritts was a young lad growing up in Rochester, New York, he trained his dog Princess to make deliveries along his paper route. Rather than laziness, this was the cleverness of a boy who needed time for other things.

A fascination with the natural world led him to collect bones, fossils, and bird nests, while he cultivated plants in his victory garden. Once again Princess was employed, this time to deliver vegetables to town.



LTRR Emeritus Professor Harold C. Fritts, shown above holding a "Fritts-dendrograph," takes growth measurements of an Allepo pine in the early 1990s. Photo by Robert W. Fritts

This love of nature and ingenuity would later combine to bring Harold C. Fritts, a Laboratory of Tree-Ring Research emeritus professor, to the top of his field. He is best known for his 1976 book "Tree Rings and Climate" (Academic Press), which laid out the basic biology of trees and how to use statistics to reconstruct climate. Over the course of his 40-year career, Fritts was also instrumental in legitimizing the science of dendrochronology and bringing the tree-ring research community together – all the while staying at the forefront of new statistical and computing technologies.

While his affinity for animals originally led him to study zoology as an undergraduate at Oberlin College in Ohio, Fritts later switched to botany. He continued his studies at Ohio State University where he received his master's degree and doctorate.

This was when Fritts began a long love affair with trees. For his dissertation, he studied the radial growth of beech trees – a project that required a new way to measure growth. During OSU's holiday break, he went to his father, Edwin C. Fritts, a physicist at Eastman Kodak, for help. Together they designed and built what is now known as the Fritts-dendrograph, a mechanical device attached to a tree with a probe touching the outer bark and a recorder to chart real-time growth.

"Now it is all being done electronically, but it recorded on a rain gauge clock and had a 100 (times) magnification – quite adequate to measure the growth of trees," Fritts said. "We built six of them, which I put up in my research project."

Fritts went on to sell the dendrographs for many years – manufacturing more than 200 of them – and brought several of the devices to the LTRR when he joined the lab in 1960. Despite his studies of living trees, Fritts admits he was initially a skeptic of tree-ring science, having read journal articles criticizing the work of Andrew E. Douglass, the lab's founder, and Douglass' protégé Edmund Schulman.

"When I came, I'd been essentially brainwashed," Fritts confessed. "I didn't tell anyone, but I was going to do some investigation. For the first few years that was my chief thing."

That investigation involved testing concepts such as crossdating, where ring-width patterns are matched between trees in the same and neighboring stands. Fritts found that although the lab's early scientists were trained as astronomers, not biologists, their work had been rigorous. In fact, he later wrote in "Tree Rings and Climate" that crossdating was the most important principle of dendrochronology.

"Schulman and Douglass came out smelling like a rose," Fritts said. "And I became an evangelist – they converted me."

For the next decade, Fritts set out on his own rigorous studies of living trees to establish the basic physiology of tree growth. Using his Fritts-dendrographs he tracked tree-ring growth in pine trees on Mt. Lemmon to see how it related to changes in rainfall and temperature. On occasion he enclosed entire trees in plastic bags to study processes such as photosynthesis and gas-exchange. He also began using statistics to relate biology to climate.

"You work out the biological relationships, the whole purpose of that is to try understand how it records, how it reflects climate," Fritts said. "I had enough statistics that I wasn't afraid to use it."

This early work picked up where Schulman left off, according to LTRR Director Thomas Swetnam, who considers Schulman to be the father of "dendroclimatology," the application of tree rings to climate studies.

"Schulman had started collecting tree-ring samples from all over the western U.S., but he hadn't really gone to the next level to understand the mechanisms and biological basis of tree response to climate," Swetnam said. "Hal brought this biological background and really superb mathematical and statistical ability to try to model tree-ring growth."

Not only was Fritts not afraid to jump into statistics, he also embraced the power of new computing technologies that became available in the late '60s. At the same time, statistical techniques such as multivariate analysis were becoming more refined.

"Hal took those techniques and applied them to tree-rings," Swetnam said. "That was groundbreaking – not only for dendrochronology, but for the whole world of paleoecology and paleoclimatology."

The culmination of this work was his first book, which came after a series of published papers in prominent journals. Fritts wanted the book to be accessible to people in other fields and tested several chapters out in the graduate courses he taught.

"I'm most proud of 'Tree Rings and Climate,' that seems to have stood the test of

Fritts' research team uses a plastic tent to study carbon dioxide fluctuations and photosynthesis on Mt. Bigelow in 1964.
Photo courtesy of Harold C. Fritts

time," Fritts said. "I really have my students to thank and friends who helped me with the editing."

One of those students was Edward Cook, who as an undergraduate in 1970 got permission to take the graduate-level course in dendroclimatology taught by Fritts. He recalls chapters from the book being used in the first part of the course, as well as how Fritts drove home the principles of dendrochronology, expecting students to know more than 100 of them by the end of the semester.

"This was a good exercise for me because it taught me how to think when doing research," said Cook, who is now director of the Tree-Ring Laboratory at Lamont-Doherty Earth Observatory at Columbia University in New York.

While Cook managed to keep up with much of the demanding course, he struggled with the statistics portion, taking an incomplete and eventually barely passing. Despite such a shaky beginning, Cook later returned to the University of Arizona to study statistical dendroclimatology under Fritts. He is now considered to be one of the leading lights in the field.

To find a downloadable version of Dr. Fritts' model and manual, go to the following web site: http://www.ltrr.arizona.edu/webhome/hal/treering

"To this day, I wonder how I survived and stuck with tree-ring research as a profession," Cook said. "I still have the utmost respect for Hal and his seminal contributions to the science that I love."

Always wanting to stay at the cutting edge, Fritts next moved to studying the spatial array of climate. He created large-scale climate reconstructions for eastern and western North America, while others did similar work in Europe.

His work in this area resulted in a second book, "Reconstructing Large-Scale Climatic Patterns from Tree-Ring Data: A Diagnostic Analysis" (University of Arizona Press, 1991). The research in this area didn't catch on as much as he hoped, Fritts said, in part because publication was delayed during his first wife's struggle with cancer. In addition, he feels some of the ideas were ahead of their time.

Around the time of his retirement in 1992, Fritts returned to his biological roots – using computers to model tree growth. Working with Russian dendrochronologists, he created a model that grows tree rings in the computer at the cellular-level based upon physical and biological principles.

"It actually grows the tree on a daily basis – using rainfall, the water balance, photosynthesis – keeping track of every cell in the radial file as it grows, divides, expands, and matures," Fritts said.

The model is very detailed, he added, and therefore there hasn't been much interest in its application. But he is hopeful that other researchers will pick up on it and expand the work. Swetnam is also optimistic about its uses, especially in light of how climate change is affecting tree growth in unexpected ways.

"If you want to project into the future a situation that's never occurred before, you go look at the process," Swetnam said. "That I think is one of the great potentials of Hal's model."

Looking back over four decades of research, Fritts will likely be remembered most as an innovator of tree-ring science. But he also admits he was difficult to get along with at times – holding high standards for himself, his students, and his colleagues.

"I've learned in later years to be a little more mellow," Fritts said. "I was a bit of a young man in a hurry."

Despite this history, former students and colleagues expressed affection for Fritts, recalling his generous spirit and outreach work. Fritts worked hard to draw researchers in the tree-ring community together, as well as to promote the field to a wider academic circle.

"I feel that I was an important catalyst," he said. "I think I filled a very important need of establishing the fundamental importance of dendrochronology to science."

Fritts organized the first international dendroclimatology conference, held in Tucson in 1974. The workshop set the stage for new collaboration in the field and was a "turning point for knowledge about climate variability," said LTRR Professor Malcolm Hughes, who attended the conference as a young scientist.

LTRR is planning another international

Continues on page 6

A Focus on Uprooting

By Melanie Lenart
Graduate student

The eventual fate of most trees is to fall over, either by breaking or uprooting. The uprooting process mixes up the soil profile, bringing long-buried plant nutrients to the surface. Uprooted trees fulfill an important role in forest ecology, with some tree species preferring to establish on the resulting soil mounds and others favoring the pits formed where the tree once stood. My dissertation research focused on the size of mounds – that is, the soil, rocks and roots pulled up when a tree tips over – created by uprooted trees.

My research involved a comparative study of two very different forest types: tropical moist forests of Puerto Rico and cool temperate forests of Colorado. In Puerto Rico, I studied uprooting frequency and the quantity of soil uplifted by freshly uprooted trees in various forest stands by Hurricane Georges, which passed over the Caribbean island in September of 1998 during my three-month research stint there.

In Colorado, my research included two sites at about 9,000 feet, one in the Rocky Mountains and the other in the Sangre de Cristos range. I surveyed a spruce-fir stand in the Rocky Mountains' Routt National Forest about 10 months after it had been struck by an unusual catastrophic wind event in 1997 involving a brush with the jet stream. The Sange de Cristos site, where conifers such as Douglas-fir and ponderosa pine mix with aspen, involved background uprooting rather than a catastrophic event. There, I used tree-ring crossdating to determine the year of final ring formation, and used that to approximate uprooting dates for 50 mound/pit complexes.

It turned out that the quantity of soil uplifted by freshly uprooted trees was similar at all three sites, as long as tree size was considered. In addition, landscape-level soil disturbance based on the proportion of uprooted trees was similar for the two sites involving catastrophic uprooting. This was a somewhat surprising finding given the differences among the sites in climate, soil, and tree species.

The tree-ring study in the Sangre de Cristo Mountains allowed me to consider how long it takes for soil mounds to decay and pits to fill in with soil and debris. The results indicate that soil and rocks erode from the mounds before roots decay. Also, it seems pits tend to outlast mounds at this site, with both features fading away within about a century except for root remnants.

These results can be useful in estimating mound and pit formation and decay at these sites. And because the influence of tree size seems to override site variables, the formulas may even apply to other sites. If so, they might provide an efficient means for researchers studying uprooting frequency during an event or background treefall gap formation to address soil disturbance, in addition to increasing our understanding of the effects of uprooting at the three sites surveyed in this study.

Hal Fritts

Continued from page 5

gathering in Tucson to mark the anniversary of Fritts' landmark conference. The workshop, set for April 6-9, 2004, will take a look back at what has been achieved in the last 30 years and where the science is headed. And while details are still being ironed out, one agenda item is certain: a tribute to Fritts' remarkable and varied accomplishments.

These days, Fritts is spending less time on research and finding new ways to express his love of nature. Tired of writing scientific papers, he embarked on a more creative writing project for young people about the "Tales Trees Tell." And using his new digital camera, he has become an avid and accomplished nature photographer.

Still, he has a few scientific articles in the works and would like to get his latest model in better shape – so the last chapter on his research may be forthcoming.

"I can say that I have had the greatest time working in dendrochronology I could have in my life," Fritts said.

Towner Launches Beam Expedition

• *By Melanie Lenart*

Carrying on a tradition that brought the Laboratory of Tree-Ring Research its initial prominence as a research institution, LTRR adjunct professor Ron Towner has launched a "beam expedition" in northern Mexico.

Dr. Towner and colleagues are collecting hundreds of samples from beams used to build ancient cliff dwellings in northern Sonora, as well as cores from nearby living and dead trees. He plans to use these samples to create tree-ring chronologies that he hopes will apply to prehistoric archaeological sites throughout Sonora and Chihuahua.

"It's all concerned with the movement of prehistoric folks across the Southwest," Towner explained. "What we're interested in is human interaction."

The research effort harkens back to the expeditions of LTRR founder A.E. Douglass, whose tree-ring dating of beams from southwestern archaeological sites early in the last century established dendrochronology as a science, and the LTRR as a world-class institution.

"Without a regional chronology, some of the most interesting anthropological questions – particularly those related to interaction, trade, and migration – are impossible to address," noted the research proposal prepared by Towner and co-principal investigators, LTRR Professor Jeff Dean and Elizabeth Bagwell of the University of New Mexico. The international research team also includes collaborator Elisa Villalpando of the Instituto Nacional de Antropolgía e Historia Sonora, the state archeological office of Mexico.

The potential of the Sonoran dendroarchaeological research was indicated by David Street's dating of some of the laboratory's archived samples collected in the 1930s from cliff dwellings in neighboring Chihuahua. Dr. Street has recently returned from England to work as a Research Specialist in LTRR's archaeology program. Obtaining more dates for cliff dwelling beams would shed light on an ongoing debate in academic circles. Some scholars believe the ancestral Puebloans who thrived at Chaco Canyon in New Mexico from the 9th through the 12th centuries migrated south to establish the sophisticated cliff dwellings in northern Mexico. Others note that the cultures of the south in Central America were more complex than those in the north, indicating the cultural migration likely moved northward.

But all agree that interaction between the Southwest and Central America occurred, and that prehistoric cultures in northern Mexico must have been involved in the cultural exchange. Yet few sites in northern Mexico have been dated, and even fewer have been dated with the precision afforded by tree rings.

"The evidence from our collections will certainly contribute to the question of the direction of movement. With only a few pieces of data, you can create whatever theory you want. With more and more data, it often makes the picture more complex," Towner said.

The only northern Mexico site with reasonable age estimates for construction is in Paquime, near the town of Nuevo Casas Grandes in Chihuahua. Yet even these dates, some secured by LTRR professor Jeffrey Dean, are estimates because of erosion and because the prehistoric builders shaped the beams by squaring them off on one side.

Ron Towner extracts a core from a beam at Cueva Bringas in Sonora, Mexico.
Photo by Júpiter Martinez

Towner plans to incorporate some of the samples from living trees and missions in northern Sonora collected by retired LTRR professor Marvin Stokes in the 1970s. Although the results were not published, the samples remain in the LTRR archives. Chihuahua collections from tree-ring researchers Mark Kaib and David Stahle also might contribute to clarifying the bigger picture.

Dr. Stahle, of the University of Arkansas, developed a chronology that goes back to 1600 for the Chihuahua region. Towner hopes to build upon this to develop chronologies that would apply to the northeastern Sonoran cliff dwellings, which he suspects date back to the 1300s or 1400s.

His hope is to lay down the groundwork that will make tree-ring dating of archeological sites in northern Mexico "commonplace" over the next decade, thus improving understanding of these ancient people and the migrations that helped define their culture.

"People used to think that prehistoric people didn't go more than 20 miles from their homes in their lifetimes, and that's just not true," Towner said. "They were moving around."

Ron Towner

Cliff dwelling in Sonora, Mexico.

BEHIND THE WOODSHED

An irreverent microanatomical view of life at the LTRR

By Steve Leavitt

Reaching out there – way, way out there

Educational outreach is one of the service activities emphasized in the Laboratory of Tree-Ring Research. On occasion, this activity is conducted by our faculty and graduate students, but usually it involves staff, particularly one Rex Adams. This outreach includes visits to schools or service and social groups, but more likely these groups get a pep talk about dendrochronology and a tour of West Stadium, and now also the recently acquired space in the basement of the Math Annex building (also known as "Tree-Ring West" or "the root cellar").

In a typical year, this outreach involves from 2,000 to 3,000 people, largely students from grade school to graduate school, but also retirees and visitors, some from outside Tucson and even outside the United States. With such large numbers, it is therefore not uncommon to unwittingly stumble out of an office into the midst of a large flock of tree-ring tourists, which is sort of like inadvertently being caught in the festive chaos of a fleamarket disaster preparedness drill.

To what are these visitors actually exposed on the tours and what do they take away with them? I think perhaps the most revealing way to answer these questions is to look at the letters and notes sent by students who visited the Lab. No matter what grade level of the tour, there seems to be two obligatory elements to these letters, including (1) "Thank you for giving us a tour of the lab," or "Thank you for showing us how to find out how old a tree is," and (2) "I had a fun time," or "I really had a great time at Tree-Ring Lab."

I find this monotonous chorus of positive response to be suspicious, and dare I say that I "smell something rotten in Denmark," very similar to the overwhelming stench of the walrus-blubber rendering plant adjoining the fleamarket deli. To investigate, I could take the tour but I would probably get the "nosy faculty" sanitized version with everyone on their best behavior and doing things by the book.

Fortunately, the actual goings-on in these tours can be gleaned from some of the more candid undertones in these letters. And when we take this closer look, it is not a pretty sight.

- One student especially liked the "twisting into the tree." Obviously this was a tour guide showing the kids what he called "a hip, fancy dance move" without paying attention to where he was going.
- Another enjoyed the "illustration of tree-ringing." I think that illustration is outside the Director's office next to the picture of the dogs playing poker.
- I detect a particularly flagrant violation of LTRR protocol in the words of a student who wrote, "You said a lot of big words." This can only mean an unauthorized visit to the secret storage room where we keep all of the really big dendrochronological words reserved for writing emergencies.
- Another student found it "cool that trees don't die if they catch on fire." The guide must have used petrified wood in demonstrating this maxim, although come to think of it, now and again at the sound of sirens, I see some of these tour guides fleeing the premises.

Finally, one student commented, "It was also cool that you can get the inside of the tree so smooth with sandpapering it." I am the least certain of this one, but it might be a reference to the vinyl wood-grain paneling on the inside of a staff member's 1976 Dodge Aspen.

When this humble commentator thinks "high-quality educational tour experience," fleamarket flapjack museum is the first thing that springs to mind. In light of the comments above, however, it is time to ask the tough question: Are we really making any serious effort to attain this ideal?

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