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In Unexpected Places, Clues to Ancient and Future Climate; Warming? Tree Rings Say Not Yet

By NATALIE ANGIER

THE Laboratory of Tree Ring Research at the University of Arizona, a sprawling warren of dim rooms wedged underneath the campus football stadium, harbors about one million specimens of wood. The samples range in size from fragments the size of a baby's pinkie to enormous slabs sliced from the stumps of giant sequoias around which you could comfortably serve a dinner party of 12.

And every one of those wood specimens, no matter how bland its grain or how charred and pitted its surface, tells an astonishing story.

Some tell tales of searing infernos that swept for tens of thousands of acres across the ranges of the Great Basin, flames leaping from one parched slope to the next like shining panthers pouncing on fresh prey. Other specimens speak of insect plagues almost biblical in their brutality, as swarms of spruce budworms descended on proud stands of Douglas fir and stripped their foliage to near-death nakedness.

The wood tells of volcanic eruptions tossing kilotons of ash and sulfur high into the stratosphere, of flash floods and pitiless frosts, of ancient droughts in what is now the Western United States that lasted for centuries and surpassed in extremity anything modern Californians, despite all they know about water rationing, can even begin to fathom.

The narratives are written in the rune-like script of tree rings, and the scientists at the Arizona laboratory are making great progress in deciphering their meaning.

The scientists, called dendrochronologists, are using visible and microscopic details of ring patterns in conifer trees to understand subtle shifts in the earth's climate that occurred many centuries before human observers began keeping uniform and detailed records. With these insights into prehistoric weather conditions, the scientists hope to forecast better how global climate will fare as industrialization continues.

And while the Arizona researchers take pains to plug their tree-ring laboratory as the first and largest of its kind, they are happily collaborating with other tree-ring specialists at Columbia

University's Lamont-Doherty Geological Observatory in New York, the University of Washington, the University of Arkansas, and groups in Germany, Russia, Spain and elsewhere, to thread together a comprehensive picture of the planet's changing climate as captured in the silent columns of its forests.

The instrumental data available for climate studies only go back 80 to 100 years at best, said Peter Brown, a dendrochronologist and climate researcher at the laboratory. "Tree rings give us an objective accounting of the same sort of data that takes us back thousands of years," he said.

The researchers scrutinize the ring patterns of trees that rank as the oldest organisms on earth, among them the bristlecone pines that are nearly 5,000 years old and are so hunched and gnarled they look every day of it; and a type of conifer called the Alerce that is related to the giant sequoias and that the Arizona researchers have just confirmed is the second-oldest species alive, living to about 4,000 years.

The scientists then link together slender samples cored from live trees with deadwood remnants gathered in the same area to move them even further back in time. Signs of Global Warming

Through analyzing tree rings, the Arizona researchers have concluded that they have yet to see the first fruits of the so-called greenhouse effect, the warming of the earth that many say will result from humanity's release of excessive heat-trapping gases like carbon dioxide and methane into the atmosphere.

But Donald A. Graybill, who studies bristlecone pine trees growing at high elevations in the White Mountains of eastern California, has evidence that the carbon released into the air by the burning of fossil fuels like coal and gasoline is sharply stimulating the growth of bristlecones, both by serving as fertilizer and by making the elderly wonders more efficient in their use of water.

Scientists have yet to observe any other tree or plant species respond to elevated carbon levels with a noticeable spurt in growth, but Dr. Graybill suggests the bristlecone pine may be the first and most sensitive indicator of profound changes yet to come in the world's forests and fields.

Lisa J. Graumlich, who examines the ring patterns of foxtail pine trees and western junipers in the Sierra Nevada, has compiled a detailed record of the year-to-year variation in temperature and precipitation over the last thousand years.

She has seen in the North American trees the feathery but unmistakable signatures of the Medieval Warm Period, a era from 1100 to 1375 A.D. when, according to European writers of the time and other sources, the climate was so balmy that wine grapes flourished in Britain and the Vikings farmed the now-frozen expanse of Greenland; and the Little Ice Age, a stretch of abnormally frigid weather lasting roughly from 1450 to 1850. A Crucial Question

"We can now see that these were global climate phenomena, not regional temperature variations," she said. "The question is, how did we get those warmer temperatures during preindustrial times, and what can we learn from those conditions about what is going on today?"

By her analysis, the 20th century has seen more exaggerated swings in moisture than during any comparable period in the last millennium. She and others at the laboratory are particularly concerned because the tree rings clearly declare that in the Western United States, the years 1937 through 1986 have been abnormally wet compared with past centuries -- and these are the years of the greatest immigration to the supposedly golden coastal states.

Should an extended and profound drought similar to those that frequently arise in the tree-ring record again strike the West, they said, the blooming Central Valley of California, a food basket to the nation and already the region's most rapacious consumer of scarce water resources, could become completely unsustainable.

"People responsible for water management look at our data, and they just throw up their hands in despair," Dr. Graybill said.

In another department of the laboratory, researchers use tree rings to date timber and charcoal samples taken from archeological sites throughout the Southwest, findings that resonate with the lives of the Old Ones, the Hohokam and the Anasazi, who in the pre-Columbian era built great cliffside dwellings and other architectural spectacles and then mysteriously abandoned them.

By comparing the age of one piece of wood in the wall of one room with, say, another timber sample that has fallen from the roof of another room, the researchers can tell not only when the room was built, but what it was used for, when it was deserted, and when it may have been renovated by another family.

Among the most surprising revelations to come out of tree-ring research is that many of the largest ruins in the Southwest, including the magnificent Casa Bonita of Mesa Verde in Colorado, may look as though they were built as a permanent community, but in fact were used only for a very brief period, perhaps 50 years or less.

"We don't know yet why they were abandoned," said Jeff Dean, a professor of dendrochronology. "My feeling is the places were pretty unhealthy. People used to throw their trash and what-have-you right out the front door, and eventually the households could have become pretty rank and unlivable."

The reason trees are such an extraordinary barometer of the world around them is that they respond to shifts in temperature, rainfall or other environmental conditions by altering their growth.

During a boom year of warmth and wetness, a tree will pack on a lot of extra tissue, and its annual ring will correspondingly be fat. But in dry or cold times, growth slows and the ring comes out narrow.

Whatever its width, one year's ring can be distinguished from the next by the two-stage process of tree growth: the first part of the ring, laid down in spring, is relatively loose earlywood, while the second part is composed of denser and thus darker latewood, which grows in the summer.

But trees often show false intra-annual rings, the result of a mid-year cold snap that broke the normal growing season in half; and dendrochronologists spend many hours struggling to distinguish between genuine and false tree rings.

By comparing tree-ring patterns from species found in very different habitats, the scientists are able to discriminate between local and worldwide climate pulses, and between the relative effects of rain and temperature on growth. They have also begun looking at individual cells of the rings to see whether their shape, width or composition may yield insights into the nuances of the climate at the moment those cells were born.

Malcolm K. Hughes, the director of the laboratory, who is now on sabbatical, and Steven W. Leavitt, the acting director, are studying isotopes within discrete rings, variations in the type of carbon molecules making up the wood. By measuring ratios of one carbon isotope to another, the researchers can estimate mid-season climate conditions for any given year: a short mid-summer drought, for example, would leave a tree ring with more carbon-13 isotopes than carbon-12 isotopes when compared with a wetter season.

The specifications and cross-comparisons are fed into a computer, and about 8,000 parameters are calculated for every representative stand of tree samples.

Other clues to ancient climates exist: for example, scientists are extracting ice cores from Greenland and Antarctic glaciers to measure gas ratios and particle deposition in the deepest layers as a way of understanding atmospheric conditions that prevailed when the ice was formed. But for the lords of the rings, trees have the advantage over glaciers of being found around the globe, rather than merely at the poles. History of Ancient Fires

Fires also leave revealing scars in the tree tissue, and if enough trees in a wide enough region prove to bear fire scars at the same time, researchers can guess the year was extremely dry, for aridity invites a blaze's spread. Studying fire marks in giant sequoias, Thomas W. Swetnam and co-workers have discovered that major conflagrations sweeping across many mountain ranges in California and the Southwest were a long a common feature, occurring at least twice a decade and apparently linked to oceanic currents much farther south, the so-called La Nina events that often result in droughts.

"Finding this synchronicity in fire events was a big surprise to us," he said. "It tells me that Western landscapes in presettlement era were very smoky places."

But by the end of the 19th century, settlers seeking to carve out grazing terrain for their livestock had cleared away much of the forest undergrowth that had served as fodder for the fires, and oscillating fire cycles became a thing of the past. So, too, did the long-term vitality and diversity of many forests, and park and wilderness managers are now seeking Dr. Swetnam's advice on how to recapitulate, in a controlled manner, the synchronous infernos of the past. "We made the forests safe for cattle," said Dr. Swetnam, "and now we must make them safe for fires once again."