Science Show

on ABC Radio National

Tree-rings

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The tree-ring laboratory at the University of Arizona has specimens dating back to 700AD. The store room has 3 million specimens and is the largest collection of ancient timbers. Dark blackened scars indicate wounding from fire and reveal the fire history of a tree. The rings show a correlation between fire events and El Nina events.

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Transcript

Tom Swetnam: So we're in our largest storeroom. This is the world's largest collection of ancient timbers, and what you have is probably close to three million specimens. They range from these little pencil-sized cores taken from trees to these giant slabs from Sequoias.

Robyn Williams: Boxes of wood as far as the eye can see, going up to the ceiling. Don't you throw anything away?

Tom Swetnam: We never throw anything away. We keep all of our wood because we're studying them now for droughts and fire and temperature et cetera, but in the future someone will discover something new, some other kind of indicator embedded in the tree-ring and we'll come back here and pull these off the shelf.

Robyn Williams: What was the one you were showing me before back there, the name beginning with 'O'?

Tom Swetnam: Oraibi, yes. What you have on the left here is a long row of boxes that contained materials from archaeological sites. That particular box contained specimens from the oldest continuously inhabited village in North America, Old Oraibi, the Hopi village in north-eastern Arizona.

Robyn Williams: How long occupied?

Tom Swetnam: Over 1,000 years, yes, maybe longer. And there's wood here from all over. On the right you can see more boxes, this is actually our southern hemisphere collection and so there's wood here from Australia and South Africa, Tasmania, a large collection obtained in the 1970s and 1980s from one of our faculty members who started studying tree-rings in the southern hemisphere to begin to look at climate history there.

Robyn Williams: And why were they studying tree-rings in the first place, way back?

Tom Swetnam: Initially the original application was for archaeological purposes. Some archaeologists were excavating these great ruins of the southwest, the cliff dwellings, and they noticed these roof beams. This fellow, Douglas, at our laboratory was studying tree-rings and they said, can you tell us how old these beams are? Can you tell us when these trees were cut? And by studying the tree-rings and matching the tree-rings from the beams with living trees, he was able to cross date them and match them, and he told the archaeologists that the dwellings were built more than 1,000 years ago. He gave them exact dates of cutting for these trees. So that established the science of dendrochronology.

Robyn Williams: When was this, roughly?

Tom Swetnam: About the 1920s, and since that time these methods have been applied all around the world. So they're used for dating things like Viking ships. Excavated Viking ships out of the mud and off the bottom of the fiords can be tree-ring dated, and so exact dates of ship construction throughout Europe and parts of the Mediterranean have been used for that purpose.

Robyn Williams: And since then looking at the tree-rings is used for all sorts of things.

Tom Swetnam: Oh yes, from their archaeological applications to climate studies, drought and now ecological studies as well, and even geological; we study volcanic eruptions, we study earthquakes, debris flows and floods, all these kinds of things are quite faithfully recorded in the tree-rings.

Robyn Williams: This is not the only store you've got here?

Tom Swetnam: No, it goes on. In fact, this one extends on around, we can walk down here. We have collections in this room and about four others on campus. All together something like 10,000 square feet of space in storage.

Robyn Williams: The thing that puzzles me...you say 'on campus'...this is in fact a football stadium. Explain this to me.

Tom Swetnam: Yes, we are in the football stadium. We were put here temporarily, it was going to be temporary quarters and that was in 1937. It's what happens to a lot of laboratories, I think. These strange little laboratories, strange researchers doing oddball things, like...I think the first nuclear reaction at the University of Chicago was in the football stadium, and on the other side of the stadium is the mirror lab where they build these giant mirrors for telescopes, so some of the best science in Arizona is done in the football stadium.

Robyn Williams: And you're going to be staying here, are you?

Tom Swetnam: It looks that way. We're currently expanding in the stadium, we're actually taking up some more space, for one thing to house the rest of our wood, because you see we're crowded here, this storeroom is already full.

Robyn Williams: So you're underneath the stands. How do you work when there's a match on?

Tom Swetnam: We avoid the place like the plague! It shakes and rattles. There are 55,000 people here during a football game.

Robyn Williams: And what about the students who are staying here?

Tom Swetnam: The students actually...one side of the stadium is a dormitory, so there are people living down there...

Robyn Williams: And they're playing rock 'n' roll and...

Tom Swetnam: Yes, it's kind of a strange place to do science.

Robyn Williams: Do you sometimes worry that when they throw their matches or their lighters your entire collection would go?

Tom Swetnam: We do worry about this, yes, and it's not cooled in here, so on a hot Arizona summer day it's well over 120 degrees Fahrenheit in here...whatever that is Centigrade, 38 or something, 42...

Robyn Williams: Hot!.

Tom Swetnam: Yes.

Robyn Williams: Professor Tom Swetnam in his trove of trees. And you duck through the stands of boxes along a narrow corridor to a set of draws and he opens one of them. There in cellophane wrappings are more sets of wood but these are extra special. They were the samples of timber used to test carbon dating techniques when they were first being introduced, wood being used to test atomic fingerprints. But Tom Swetnam's main preoccupation these days is fire.

Tom Swetnam: That's right. When you look at the tree-rings closely you can see these dark blackened areas, charcoal, coming right into a tree-ring. It's from a wound at the base of the tree, where the section is taken right near the ground, and in the past, fires had burned around the base of these trees and caused an injury, a scar, if you will. And the tree survived and grew the tree-rings over the top of the scar, and it turns out that this happens repeatedly. So, as we can see on this section on the wall here, there are dozens of these black lines, dozens of fires recorded over 1,000 years on this one tree.

Robyn Williams: Interesting, and that's the Sequoia, that's the redwood?

Tom Swetnam: Yes, the Giant Sequoia, west slope of the Sierra Nevada, now it's the third-oldest tree species. They get to be about 3,200 years old.

Robyn Williams: That's pretty good, and they're adapted...like where I come from, the gum trees and various other ones are used to fire. These are used to fire as well?

Tom Swetnam: Indeed. It turns out, from studying these fire scars, that we see that fires occurred at least once or twice per decade for thousands of years in these forests. So generally the fires are burning so frequently that the fuel does not accumulate, and so the fires are burning as what we call surface fires. The flame lengths are a metre tall, low intensity fire, not killing the trees. And of course they have very thick bark, so they're resistant to being killed by these surface fires. So they record the fire events, and the fire was very important of course in cycling nutrients and maintaining open forests.

Robyn Williams: As I look at the one that you indicated which is, as you say, huge, two metres across, and covered in all sorts of patterns of black...how do you start analysing something as complex as that?

Tom Swetnam: Well, first of all we sample it, and it takes a while to prepare a surface. We use belt sanders like we're sanding a floor and then with microscopes we can count the rings and date them carefully and observe the fire scars in the rings.

Robyn Williams: What are you looking for? Outbreaks of fires? Trying to make a pattern out of it?

Tom Swetnam: The main objective is to try to understand the frequency of fire in these forests in the past, but most importantly what were the causes of these fires in terms of climate? What kinds of climate events might have been driving the occurrences of fires? And what we find is that when we sample many trees over large areas, entire regions of the western United States, we find the same fire dates showing up again and again in different tress in widely scattered mountain ranges, synchronised fire occurrence over enormous areas. So, for example, the year 1748, a very fiery year in the western US, there were fires burning in most mountain ranges. A drought year. Of course it was a drought year, and indeed we can see this. But even more interestingly we find that these big fire years also correspond with El Nino and La Nina patterns. So the ENSO, the El Nino Southern Oscillation, is controlling fire activity in the western US, and we can see this in the tree-ring record.

Robyn Williams: And you have the same El Nino effect as we do, connected with drought, do you?

Tom Swetnam: It's actually the opposite, it's reversed. So the southern part of the States, from southern California, across Arizona, New Mexico to Florida, generally have wet conditions during an El Nino, whereas I believe in most large parts of Australia, northern Australia especially, very dry during El Nino events.

Robyn Williams: We've got an El Nino that's just about waning, and of course we've had the most gigantic bush fires over January and early February.

Tom Swetnam: Typical kind of pattern. And then of course the reverse of the El Nino is the La Nina condition, and that brings the reverse patterns; we're typically very dry here, we have droughts and that's when our fires occur. So this is very interesting to see these really large ocean patterns synchronising fire activity. We find even that our fire activity here in the southwest is even synchronised with fire in southern South America where the El Nino has a very similar response in Patagonia. So El Nino has produced wet conditions and there are few fires, and during La Ninas there are more fires.

Robyn Williams: What's the pattern now as you look at what's happened recently? Is the rate going up? In other words, are the oscillations becoming more severe?

Tom Swetnam: That's correct. It seems to be that the variability has increased in recent decades. We had an enormous El Nino event of course in '82, '83 which you'll probably recall. That was the event that really woke everyone up to the importance of El Nino especially. But we're seeing some other kinds of trends, warming temperatures in particular, and increasing droughts. The western US has been gripped by drought in the last six or seven years, extreme drought. And the warming temperatures in the western US, which is probably related to global warming, seems to be driving increasing numbers of large fires in the western US, it's correlated with the warming temperatures.

Robyn Williams: Where is this research taking you now? Obviously you've got an immense amount of detail, how are you building it up?

Tom Swetnam: We're trying to understand these different climate patterns. You have these trends, warming trends of the warming that's occurring globally, but superimposed upon that are these oscillations: the El Nino and now we've discovered the Pacific decadal oscillation and the Atlantic multi-decadal oscillation and the North Atlantic oscillation, and so there are all these oscillations that scientists have been discovering and they affect climate worldwide. So the objective is to try to know and understand how these oscillatory patterns influence climate in different locations and the fire responses in different locations.

Robyn Williams: Essentially it's huge patches of warm water in various parts of the ocean, namely the Pacific, and that's causing the oscillations and the kind of effect that you describe.

Tom Swetnam: Yes, it's the ocean temperatures and the associated atmospheric pressure patterns that are related to these sea surface temperatures, and that of course then drives the circulation features; the jet stream, the amount of variability in the circumpolar vortex as well, which is affecting storm tracks. So during La Nina events in particular in the western US we tend to get these blocking highs, these high pressure patterns which prevent the moisture from coming in from the oceans, and so we get these drier conditions.

Robyn Williams: Are we going to have to get used to these greater extremes?

Tom Swetnam: That is the prediction. In fact, the new IPCC, the fourth IPCC report from the UN on climate change indicates, indeed, that more extremes of both wet and dry are likely to occur. And this spells bad news for fire because fire has to have something to burn, right? So if you have an extremely wet period of one or two or three years, that tends to build up the fuels and holds down fire activity, and then you have an extreme dry within a few years...that is a key combination that drives these really large fire events that we've been seeing in our arid landscapes.

Robyn Williams: And that will burn up the undergrowth and the small trees as well.

Tom Swetnam: That's right, and the problem in the western US is that these fires seem to be increasing in extent and severity and at the same time our population is growing. The state of Arizona is the fastest growing state in the US now, and so people are moving here and they tend to be moving out into the wild lands, they're moving into the bush and right into the areas where fire is most prevalent and has a greater chance of occurring.

Robyn Williams: The more fire, the more CO_2, of course.

Tom Swetnam: That's the other worrisome thing about fire and climate change. It could well be a positive feedback. So as we burn more and more of our landscape globally and particularly in the tropics, there's a real likelihood that we're going to increase the carbon input to the atmosphere which would then accelerate the whole process.

Robyn Williams: But you're still smiling!

Tom Swetnam: Well, it is pretty worrisome actually, but there's a lot more to learn about this, there's a lot of uncertainty about when and where these effects are going to take place, so we're going to be busy.

Guests

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Saturday 12pm
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