Ancestor of Modern Trees Preserves Record of Ancient Climate Change

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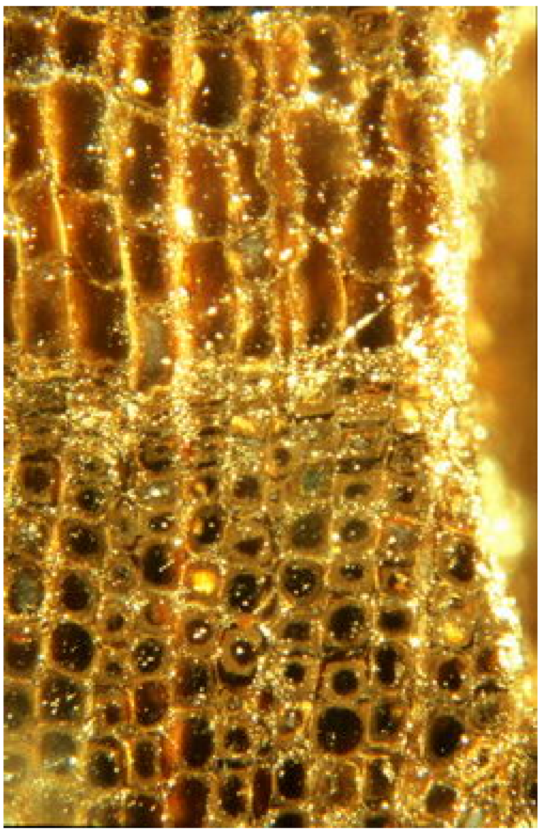

This fossil wood, called &acuteAraucarioxylon&acute (magnification 200X), is reported as coming from the Olentangy Shale of Ohio. This wood shows the &acutetemperate&acute type of growth ring. Down is the inner late wood (with small cells), up is the outer early wood (with large cells). "Unfortunately, the Olentangy Shale brackets a wide slice of Middle and Late Devonian time. This particular fossil was said to be from the earliest Carboniferous, but was collected over 100 years ago when the geology of Ohio was much less understood. ...," Scheckler said. "If correctly attributed to the Late Devonian-Early Carboniferous of Ohio, which is not certain, then it shows that some trees during that time suffered cold winters."

About 350 million years ago, at the boundary of the Devonian and Carboniferous ages, the climate changed. There was no one around to record it, but there are records nonetheless in the rocks deposited by glaciers and in tissues preserved in fossils of ancient life.

“Events at the transition had terrific biological impact, marked by extinctions and the beginnings of new life forms,” said Stephen Scheckler of Blacksburg, professor of biological sciences and geosciences at Virginia Tech. He reported on evidence of climate change that he found in the fossils of the ancestors of modern trees at the at the Geological Society of America national meeting in Philadelphia Oct. 22-25.

“This glaciation was not widely understood until recently,” Scheckler said. “It was a worldwide event. The Europeans recognize the extinctions as the Hangenburg event, documented in a black shale deposit that contains a series of fauna changes. But the eastern United States was at a tropical latitude at that time, so the flora and fauna show less impact – but it is there. It is believed to be a time of coldness, because there was less diversity, but it is a subtle signal.”

Scientists exploring parts of the world farther from the equator have found glacial deposits, where the earth was scoured and sediment was dropped as the ice moved across Africa and Brazil. “Then glacial deposits were discovered in the former tropics. There is a widespread belt of rocks in Pennsylvania that were glacially deposited,” said Scheckler, who studied fossils from New York, Pennsylvania, West Virginia, and Ohio, from an age when the equator ran through New York and south through Virginia and the region was uniformly at a low elevation.

In his search for evidence of climate change, Scheckler, an authority on the earliest modern tree (Nature, April 22, 1999), looked at plants that made wood in the same way modern plants make wood. In modern trees, cambium tissue produces layers of wood cells on the inside and bark cells on the outside. The cambium moves outward as the tree grows and the kinds of cells it produces reflect seasonal dormancy induced by wet and dry or warm and cold conditions. The layers, of course, are tree rings.

In the fossil record, lignophytes – all those trees that grow like modern seed plants -- also produced successive layers of wood from perennial cambium tissue, “and left a permanent record,” said Scheckler. “And if they did everything else the same as modern trees, maybe they responded to climate the same.”

Tree rings are a response to resumption of growth after a period of dormancy. “Cessation of growth and resumption of growth leave an anatomical signal that differs between tropical and temperate dormancy,” Scheckler said.

In temperate trees, cells become smaller and thicker walled before growth is stopped by cold, then the new wood cells become large and thin walled when growth resumes. In tropical trees, the rings are subtle, with no change in cell wall thickness and only slight changes in cell size. And the changes occur more in response to wet and dry periods, rather than cold periods, so can happen several times a year.

Using this background from modern trees, Scheckler studied the ancient plants that had the same genetics for controlling wood growth and produced the same signatures for dormancy. He has documented that the fossil “trees” from most of the Devonian period show tropical growth rings, but those from the latest Devonian and earliest Carboniferous show growth rings that resemble those of temperate trees.

“That plants of this time responded as modern plants would to cold supports the idea that there was a sudden chilling at the end of the Devonian,” Scheckler said. “Later in the Carboniferous period, you no longer see the temperate signature rings because the glacial event went away.”

He delivered his talk, “Woody plant growth as a proxy for climate change at the Devonian-Carboniferous boundary,” as part of the session on the Devonian–Early Carboniferous Climate Change: Glacial Deposits and Proxy Records, during there were other presentations on analysis of rocks and fossils from the period.

Source: Virginia Tech

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