Early Start for Plant-Insect Dance

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tinuous evolution of ribozymes in a test tube, Wright was able to create molecules that had the ability to catalyze the creation of a specific phosphodiester bond and then retained and perfected this ability generation after generation, without further interference or manipulation.

"We see no end in sight," Joyce told the meeting, but cautioned that his team's RNA molecules cannot be considered alive because they do not catalyze their own replication—Wright "cheats" by adding modern protein RNA polymerase enzymes to the system to allow the RNA to reproduce. Nevertheless, says biochemist David Deamer of the University of California at Santa Cruz, "The results Joyce described represent a major step toward the goal of finding an RNA that carries both genetic information and a catalytic site for RNA replication." And, comments James Kasting of Pennsylvania State University, "it's extremely significant just to show it can be done. Maybe he can eventually wean this molecule away from its dependence on proteins."

A paper in the 25 July issue of *Nature* by former Szostak associates Eric Ekland and David Bartel—who are now at the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts—shows that such optimism might indeed be warranted. Ekland and Bartel report the creation of a ribozyme that can add up to six mononucleotides—the subunits that make up RNA—to the end of a growing RNA chain in a template-directed fashion, thus mimicking the activity of protein RNA polymerases in making exact copies of nucleotide sequences. If Joyce and his colleagues can harness this ability in their own experiments, they may not be too far from demonstrating a plausible RNA world. As one scientist told *Science*, "Gerald is out to create life in a test tube, and he probably will do it one day."

–Michael Balter

PALEOBOTANY

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Insects and plants have been exploiting each other for millennia, often to spectacular effect. Hungry insects, for instance, spurred plants to invent attractive flowers, which bribe insects into carrying pollen by offering them meals of nectar. Most scientists have assumed such mutual manipulations date back about 125 million years, when flowering plants first appeared. But new evidence indicates that insects and plants took some of the first steps in their intimate dance nearly 200 million years earlier—and that they paired up not for mutual benefit but in a drama of attack and self-defense.

Paleontologists Conrad Labandeira of the National Museum of Natural History and Tom Phillips of the University of Illinois, Urbana-Champaign report in the 6 August issue of the *Proceedings of the National Academy of Sciences* that they have found fleshy protuberances called galls in the fossilized remains of now-extinct tree ferns that lived 302 million years ago. In the galls of today, parasitic insects feed on this extra tissue, which the plant may form in response to the insectan attack. If the same process is responsible for the fossil galls, Labandeira says, complex interactions between plants and plant-eaters must have been underway 175 million years earlier than had been thought. Peter Price, an ecologist and an expert on modern plant galls at Northern Arizona University, says the finding opens a new view of this evolutionary pas de deux. "This is the first time we can really know what these ancient insects were doing," he says. "The detail the [scientists] have been able to see is phenomenal."

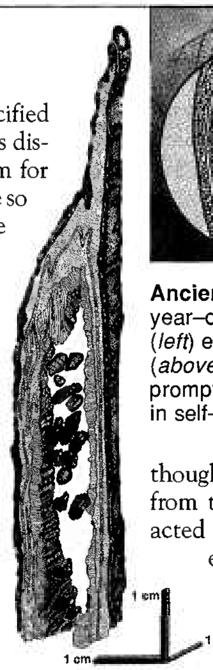
The fossils that Labandeira and Phillips describe were collected over the last 30 years from an Illinois coal mine—the remains of a swampy seaside forest that grew during the Late Carboniferous period. Having turned to coal, most of the forest is unrecognizable, but interspersed in the coal are pieces of calcified peat called coal balls. While coal miners discard the balls, paleobotanists prize them for their high-quality plant fossils, which are so well-preserved that cellular structures are often visible.

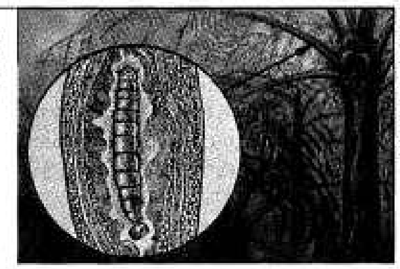
The plant experts who first examined these fossils weren't attuned to signs of insect activity, but Labandeira, an entomologist, was. As he examined cross-sections of the fossilized fern fronds, he found nearly 30 with chambers in their base about the right size and shape to host the worm-like larva of an insect. The chambers and the cells around them closely resembled modern galls, which are made from layers of rapidly dividing, swollen cells that—scientists believe—form in response to chemical signals from the invader. According to one hypothesis, the plant protects more vital tissue on the leaves or fronds by producing extra tissue for the larva to eat.

Labandeira and Phillips did not find any fossilized larvae, which would have clinched the case. But they did come up with the next best thing: The fossil chambers contained pellets that look remarkably like the pellets some insect larvae excrete today, and several galls had openings that resemble the exit holes modern insects leave behind.

This cycle of foreign invasion and host attempts at appeasement among such ancient organisms comes as a surprise. "People tend to overestimate our time and think that we are much more sophisticated," says Jarmila Kukalová-Peck, who studies Paleozoic insects at Carleton University in Ottawa, Canada. But early geologic eras can contain interactions rivaling contemporary complexity, she says.

Labandeira says the ancient galls are evidence that the flora and fauna of the time,





MARY PARRISH, NMNH

Ancient enemies. This 300-million-year–old fern may hold fossil pellets (*left*) excreted by insect larvae (*above*), whose appetites may have prompted plants to form a fleshy gall in self-defense.

though completely different species from those we observe today, interacted according to some of the same ecological rules. "The same niches were there," he says, "and organisms took advantage of them in remarkably similar ways."

Not everyone is convinced that the chambers are true galls, however. William Chaloner, a paleobotanist at the University of London, says the extra cells could be a plant's standard reaction to a wound rather than a specialized response induced by the insect. And David Grimaldi, an entomologist at the American Museum of Natural History in New York, notes that one crucial piece of evidence is missing. "They have a good case," he says, "but I'd still like to see a fossilized larva."

Grimaldi yet may get his wish, says Hiram Larew, a biologist and gall specialist at the U.S. Agency for International Development in Washington, D.C. He notes that the fossils Labandeira and Phillips analyzed lay in a collection for many years before anyone noticed evidence for plant galls. "People have looked at these before, but they haven't been looking with the right kind of lens," he says. "There's a lot more out there to discover."

–Gretchen Vogel