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# As Trees Die, Biologists Battle Back

By CAROL KAESUK YOON  
Published: October 01, 2002

## Correction Appended


Ascending the forested slopes of Mount Tamalpais, 15 miles north of San Francisco, Dr. Matteo Garbelotto and Dr. David Rizzo point out victim after victim of the fast-spreading new disease known as sudden oak death syndrome. But despite seeing dead, wilting and yellowing plants throughout these woods, it is hard for an observer to fathom the real power of this plague until the trail abruptly ends in a heap of ghostly white branches and trunks.

"We call this site mucho destructo," said Dr. Garbelotto, standing in the streaming sunlight next to a carpet of fallen trees where sudden oak death has brought down the forest canopy. Branches fall even as he speaks.

Such is the power of this plant pestilence that has infiltrated much of California and jumped to Oregon, and that researchers fear could easily spread to the midwest and east. The disease has already killed tens of thousands of trees in California and spread to 17 different species, including huckleberry, big leaf maples, rhododendrons and bay trees. Scientists have found it can also infect the northern red oak and pin oak, species that are widespread in the East and Midwest. Recently, the United States Forest Service declared large regions of the East, including the southern Appalachian Mountains, whose climate would probably suit the disease, as areas of high risk.

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New Disease

In September, scientists reported that the disease was attacking the beloved redwood and the Douglas fir, the mainstay of the Northwest's timber and Christmas tree industries, which together are worth billions of dollars.

"It would be a huge impact if the disease did spread," said Mike Moskovitz, a spokesman for the Weyerhaeuser Company, which owns or leases more than two and a half million acres of timberland in Oregon and Washington, where Douglas firs account for 80 percent to 90 percent of harvests. Mr. Moskovitz said the company was closely watching the infestation in southern Oregon, which is still limited to a small area where foresters are scouring for infected trees and burning any they find.

Even more significant than the number of trees the disease may kill are the restrictions the disease places on who will buy them. California foresters and nursery owners are already suffering under increasing numbers of state, federal and even international quarantines restricting the movement and sales of the many potentially infected plants from California.

Scientists, meanwhile, are rewriting the biology of this botanical scourge with each new finding. Many of the surprises have come from the laboratories of Dr. Garbelotto and Dr. Rizzo. The

teams together discovered the cause of the die-offs, a previously unknown pathogen species now named *Phytophthora ramorum*. They have also pieced together much of the species' unusual and unusually damaging pattern of existence.

The researchers attribute their success in this scientific sleuthing to perseverance, ingenuity and a nearly complete lack of knowledge of what they should have expected from a *Phytophthora* pathogen. "It's not like we were thinking outside the box," said Dr. Rizzo, noting that scientists better versed in *Phytophthora* biology would never have tried some of the experiments they tried. "We were never in the box."

The story of this disease begins, depending on whom you ask, somewhere from 1993 to 1995, some say in the forests near Santa Cruz or Big Sur, and according to much of the sudden oak death lore, in a backyard in these undulating foothills of Mount Tamalpais.

Standing on their wooded hillside property, considered by many to be the site of the first known case of the disease, Don and Connie Lewis recalled noticing that a tanoak had gone from perfectly healthy one week to brown and dying the next. They called in tree disease experts, who guessed that it might be drought stress or beetle attacks and advised the couple not to worry.

But Mr. and Mrs. Lewis, master gardeners who had owned a hardwood tree farm in Pennsylvania, were not convinced that all was well in their neighborhood of multimillion-dollar homes.

"It was difficult to get anyone to listen," Mr. Lewis said. "Everyone just gave us these cockamamie explanations."

Reports of dying oak trees, often oozing a bloody red sap, continued to crop up. Some were large showcase trees worth tens of thousands of dollars to property owners.

Meanwhile, Dr. Rizzo said, California did not have a state forest pathologist, and questions went unanswered. Many blamed the weather. Some blamed beetles. Others blamed the black warty growths caused by a fungus known as *Hypoxylon* that, it turns out, only invades after sudden oak death has already done the tree in. People blamed air pollution, global warming, even cellphones. Still, no scientists got terrifically excited.

"Typically with tree diseases it's a big black hole," Dr. Rizzo said. "You research it for five years, the trees get better by themselves, and you never figure out what was wrong."

But the trees got worse and the disease spread. Finally, Dr. Garbelotto, an ebullient Italian native working at the University of California at Berkeley, and Dr. Rizzo, who works at the Davis campus and is the more senior of the pair, teamed up two summers ago to sort through hypotheses.

The answers began to come when Dr. Rizzo tried to grow laboratory cultures of what was living in recently infected tree tissue. What grew in the petri dishes looked like a *Phytophthora* species but did not match anything ever seen. Dr. Garbelotto studied a region of DNA in the mystery species that had been studied in other *Phytophthora* and again found no match to anything in the scientific literature.

"That pretty much sealed it," Dr. Rizzo said. "We knew that it was something new."

But scientists still did not know whether the new species recovered from infected trees actually made the trees sick or whether it just preyed on debilitated plants. To find out, they had to fulfill what is known as Koch's postulate. Named after Robert Koch, a German scientist who also did the earliest studies on anthrax, in the late 1800's, Koch's postulate requires that a disease organism be isolated and then used to infect healthy individuals to show that it can cause the disease in question.

Researchers inserted samples of the new *Phytophthora* in large tanoaks and coast live oaks. In weeks, the trees were bleeding and in a few months they showed patches of dead and dying tissue identical to that seen in the field.

For *Phytophthora* specialists, the results were unthinkable.

"People were saying it couldn't be a *Phytophthora*," said Dr. Rizzo, standing in the dry mountainside forest where the disease is rampant. "These organisms are always found in low-lying areas with lots of moisture." And this funguslike microscopic organism, which researchers

discovered was a single-celled two-tailed swimmer, known as a protist, had more surprises in store.

Phytophthora are often known to infect roots. Only after infesting an entire plant do their spores overflow into the leaves. But Dr. Garbelotto found that bay trees appear to be infected in leaves and nowhere else. More surprisingly, these leaves, whose only symptoms are small discolorations, are so full of spores that the laboratory machinery cannot detect the total number.

"They were off the charts," Dr. Garbelotto said. The finding revealed bay trees, not oak trees, to be the unexpected, key disperser of the disease.

Because the group Phytophthora includes many devastating pests like the species that caused the Irish potato famine, confirmation of the culprit's identity fed the alarm about its potential damage.

Suddenly the number of researchers poking around in wilted oak forests jumped from a handful to more than a hundred, studying the evolutionary history of the species, techniques for monitoring the disease from the air, the pathogen's mating behavior and a variety of other concerns.

Interest in the species is so strong, Dr. Garbelotto said, that the Department of Energy is planning to sequence the entire Phytophthora ramorum genome.

And with every new finding, regulators have had to reconsider which of the harvests from California's richly productive lands will be quarantined and which will not. Researchers have puzzled over what to do about infected bay tree leaves that are harvested from forests and used to make bay leaf wreaths; how much to restrict the movement of Douglas fir, a popular Christmas tree and a prime source of timber and pulp; and how likely it is that redwood bark, used widely for landscaping, is going to be infectious.

The disease has brought changes for Dr. Rizzo and Dr. Garbelotto as well. Dr. Rizzo hails from the obscurity of studying fruit tree diseases and Dr. Garbelotto is from the backwaters of tropical tree research. But now there is a white hot spotlight on their work and a public that is unwilling to wait for a researcher's data to complete the journey through scientific peer review and publication before the results are announced. So the two have announced many findings by news conference first to avoid misinformation and panic.

Much remains unknown. While scientists once suspected that the disease came from Europe, genetic evidence has muddied the waters. "It's still a completely open question where it came from," said Dr. Rizzo, noting that it may be very hard to track down since, in its area of origin, the species might be causing little obvious damage.

And there is no cure in hand, said Dr. Garbelotto, whose team has been trying out various chemicals, applied various ways, with no silver bullet in sight.

One major question is how much the disease will hurt mature redwoods and Douglas fir. Researchers will soon be climbing into the tops of some of these towering trees to look for evidence of infection.

But the biggest unanswered question of all is how, in the end, will this epidemic finally play out? Dr. Garbelotto notes that in these forests, many of which have spread and grown up since fire suppression began in the early 1900's, little is known of the long-term ecology of the habitats, providing precious little base line to work with.

"Some days I think maybe it's not going to be so bad," Dr. Rizzo said. "But maybe the real effects of this disease are going to be played out later, 15 years from now. Dutch elm disease, chestnut blight took 50 years. Sudden oak death was just observed seven years ago."

Still in an early stage of expansion, the disease may have been slowed somewhat recently, after a couple of dry winters, the researchers say. But they fear that after the next really wet winter, sudden oak death will flare up and fan out even more aggressively.

"We just hope we're wrong," Dr. Rizzo said.

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**Correction:** *October 4, 2002, Friday A front-page picture caption in Science Times on Tuesday with an article about a new tree disease, sudden oak death syndrome, misidentified leaves that showed signs of infection. They were from a bay laurel, not a coast live oak.*

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