Plant Pathologists at the Center of a Circus

A devastating oak disease has reshaped two scientists' careers

SOQUEL DEMONSTRATION FOREST, CALIFORNIA— Matteo Garbelotto stands under the redwoods and strips. The plant pathologist from the University of California (UC), Berkeley, is in the Santa Cruz Mountains to experiment on a tree-killing microbe and, as usual, things aren't going as planned. A fellow researcher forgot the cheesecloth used to cover inoculation wounds in trees, so Garbelotto tears up his undershirt as a substitute. He redresses and smiles sheepishly, as if to say, "This is just another day at the office."

Unexpected acts like this one—part performance, part sacrifice—have become the norm for Garbelotto ever since he became one of two lead scientists investigating sudden oak death. The disease is strangling oak trees in the hills of coastal Northern California and threatening to spread to other forest species; in one scenario, it could leap across the continent to eastern forests, potentially costing billions of dollars. Garbelotto's dramatic bent—inherited from his mother, an Italian actress—comes in handy. Sudden oak death has thrust him and research partner David Rizzo of UC Davis into the middle of a three-ring circus where science, government, and the media intersect.

The crisis has forced the two researchers to increase their already prodigious research output, soothe officials demanding information and solutions, and respond to concerned citizens and overeager reporters. Meanwhile, the disease remains a mystery: Where did it come from? How does it move around? And how far will it go?

The two scientist-ringmasters have not answered those questions yet. But their efforts have won an ovation from their peers. "I don't know how they're doing it all. They've got so many balls in the air," says Mark Stanley, a retired California Department of Forestry and Fire Protection official who chairs the state's Oak Mortality Task Force. "The progress is remarkable, what they have achieved in just a year and a bit, compared to 20 or 50 years [to understand] some diseases," says plant pathologist Clive Brasier of the U.K. Forestry Commission.

The oak death duo. Matteo Garbelotto (left) and David Rizzo with a specimen of the pathogen that has strangled thousands of California oaks.

CREDIT: UC BERKELEY

Budding disaster

In the spring of 2000, before Rizzo and Garbelotto had ever worked together, they visited a sunny hillside north of San Francisco that bore a dark omen—a stain on the trunk of a coast live oak oozing black sap. Some researchers thought beetles were to blame, but by January, the two had identified the cause as a water mold called *Phytophthora ramorum*, a funguslike relative of brown algae previously known only in rhododendrons in Germany and the Netherlands.

It has now become a plague, killing tens of thousands of coast live oaks, tanoaks, black oaks, and Shreve oaks from Big Sur to southern Oregon. The pathogen infiltrates food transport tubes and growing cells just inside the bark, feasting until it has girdled the tree. The process takes about 3 months in a susceptible tree, and then the tree is doomed. It soon develops cankers on the bark, and within a year the leaves fade to dead brown.

P. ramorum has appeared in 26 other species, a startling number. Most of them suffer only twig or leaf infections, but they include some of the most important species in the western United States. The list includes rhododendron, a widely traded ornamental; Douglas fir, backbone of the northwestern timber industry; and coast redwood, a symbol of California.

The story of a scourge that could devastate the Golden State's beloved forests and manicured backyards grabbed the media's attention. The humble field of plant pathology became headline news, and Rizzo and Garbelotto have been roped into almost 1000 media interviews since the outbreak began.

Rizzo, 42, traces his start in the field to his college days, when he hiked frequently in the Blue Ridge Mountains of the Appalachians. There he saw the stumps of chestnuts, once one of the tallest trees in the eastern United States. Between 1900 and 1940, a blight eliminated 3.5 billion of them. From this grew Rizzo's fascination with the power of microscopic organisms to change whole forests.

Garbelotto, 37, first became acquainted with fungi of the edible type: He grew up in Venice and the Italian Alps, where he and his siblings frequently gathered mushrooms for the dinner table. Later he studied pathogenic fungi.

Media reports often typecast the two personalities. Garbelotto has been called "dashing" and "colorful," while Rizzo is chronically referred to as "bookish" or even "balding." "He's the cool guy from Berkeley, and I'm the boring guy from Davis with two kids," Rizzo says.

Whatever their quirks, the two seem doomed to being cast as heroes chasing after a villain. "You have this Godzilla fungus, and the scientists are often portrayed as the Lone Ranger and Tonto," says plant pathologist Susan Frankel of the U.S. Forest Service in Vallejo, California.

When the disease hit, neither was in an ideal position to ride in on a white horse—Rizzo was focusing on pear trees and conifers, and Garbelotto was newly hired and just setting up a lab. Yet due to recent retirements, they were the only forest pathologists in the UC system, so they took the lead.

Now more than 1000 researchers and officials are actively involved in sudden oak death research, and some 300 attended a December meeting on the disease in Monterey. Yet Rizzo and Garbelotto remain central. Rizzo's lab is still the only one with enough expertise to certify infections in new areas. And during the epidemic's early days, Garbelotto's lab was the only one performing polymerase chain reaction tests to identify *P. ramorum*.

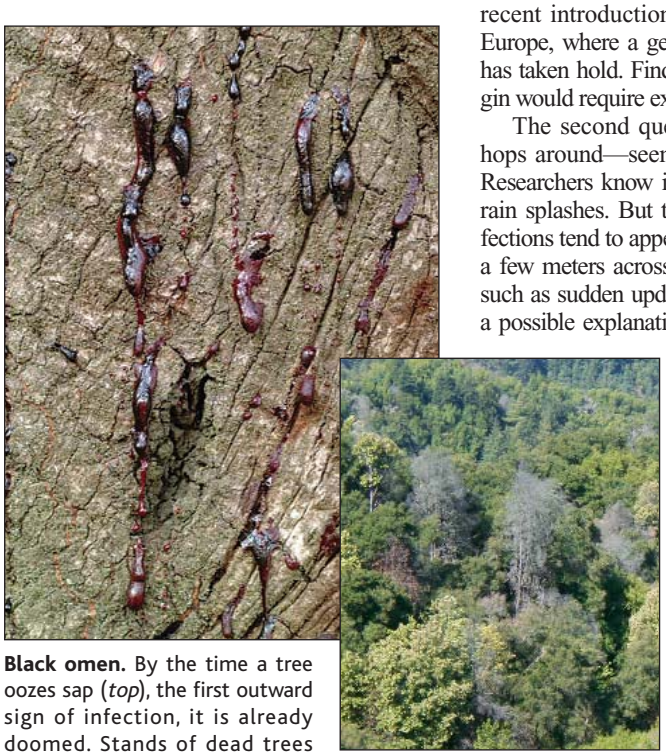
Both labs field a steady flow of questions from local, state, and federal officials, as well as the media and the public. At first, the differing approaches of government officials and researchers caused confusion. For example, any announcement of a new species capable of hosting *P. ramorum* triggered an automatic quarantine preventing the trees from being exported, something researchers say put undue pressure on the release of new information.

Now regulators have decided to wait for peer review in many cases, Garbelotto says.

Add an aggressive media to the mix of science and government, and the circus really comes to town. In the most explosive example, a newspaper filed a Freedom of Information Act request for any material about sudden oak death. The California Department of Food and Agriculture, which keeps tabs on the disease, released internal e-mails that mentioned that Garbelotto had found a preliminary positive result for *P. ramorum* in the Sierra Nevada Mountains. The messages became the basis for an article in March 2002 headlined "Oak pest discovered in Sierra"—which would have been a major leap from the west coast of California almost to its eastern border. The paper partially retracted the story the next day, and it's still not clear whether the disease has reached the Sierra.

That kind of exposure—when today's work can become tomorrow's quarantine or front-page news—can make Rizzo and Garbelotto feel more like tightrope walkers than scientists. But it would be wrong to retreat into the lab, Garbelotto says. Instead, he and Rizzo have decided to respond to all media requests and to answer direct questions openly instead of concealing preliminary data.

The pair's approach may be distasteful to other scientists—many disdain public relations—but Garbelotto says it is appropriate for crises such as sudden oak death. "Having all this new stuff coming in fairly frequently feeds the public interest and keeps the legislators thinking that this is a hot issue."



Black omen. By the time a tree oozes sap (*top*), the first outward sign of infection, it is already doomed. Stands of dead trees mark the disease's path.

CREDITS: (TOP) D. RIZZO; (BOTTOM AND INSET) M. GARBELOTTO LAB

For Garbelotto's less gregarious colleagues, his openness is a boon. "It's great because he attracts the media attention and leaves the rest of us an atmosphere that's quite a bit quieter than we might otherwise have," says plant pathologist Everett Hansen of Oregon State University in Corvallis, who leads research in the state's attempt to eradicate *P. ramorum*. Rizzo often works behind the scenes, answering questions from people whom some scientists might dismiss as crazy Californians. For someone so busy, he writes surprisingly long replies to messages alleging that sudden oak death is caused by airplane contrails, radiation from radio towers, or genetically modified organisms.

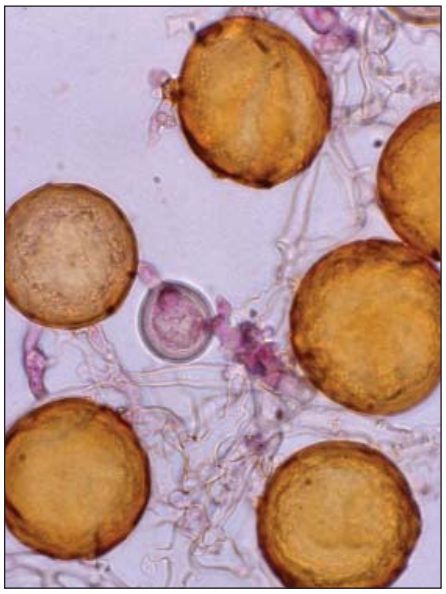
Rizzo and Garbelotto say they are open to unorthodox ideas despite the hassle. For example, a nonexpert prodded them to treat sudden oak death with chemicals containing phosphoric acid, a technique that has worked against *P. cinnamomi* in Australia. Experiments showed it can prevent *P. ramorum* infection, and several chemical companies are now working on getting phosphoric acid certified as a pesticide to save backyard trees. Because it is difficult to apply, it is probably not a practical treatment for large numbers of forest trees.

Decision tree

Three persistent riddles now occupy the minor-celebrity researchers. The first is figuring out where the pathogen came from. Knowing that would help scientists find pools of genetic resistance and narrow the list of possible chemical treatments. All signs point to a recent introduction, but not from Northern Europe, where a genetically distinct pathogen has taken hold. Finding *P. ramorum's* true origin would require extensive surveying.

The second question—how *P. ramorum* hops around—seems a little more tractable. Researchers know it travels short distances in rain splashes. But they can't explain why infections tend to appear in clumps ranging from a few meters across to a hectare. Rare events such as sudden updrafts during rainstorms are a possible explanation but are also very difficult to test. Rizzo's lab has hung buckets as high as 50 meters in forest canopies to track spore movements.

In a related question, the researchers would like to know which trees most of the spores come from. They suspect that bay trees and other understory species are reservoirs for the disease. In experimental plots, they are monitoring how often each species becomes infected and whether neighboring trees fall prey at the same time. This basic epidemiological information is essential to predicting the plague's future.



Tree hunger. *Phytophthora ramorum* could devastate eastern forests as well as western ones.

The third question is the most ominous: How far will the deadly pathogen spread? Preliminary research at containment facilities in Fort Detrick, Maryland, show that eastern oak species are even more susceptible to *P. ramorum* than western species, raising concerns that its spread could be catastrophic.

"This is the scariest thing to ever happen in my lifetime," says Kurt Gottschalk of the Forest Service's Northeastern Research Station in Morganville, West Virginia. He says if *P. ramorum* jumps the Great Plains, its economic impact could exceed that of chestnut blight, because it could affect most of the hardwood timber in the eastern U.S.

More immediately, researchers worry that the pathogen could jump California's central valley into the Sierra Nevada. In late 2001, Garbelotto's lab got an ambiguous positive result for *P. ramorum* from a maple tree in the foothills east of Sacramento. They have since found about 100 similar results, but all of the trees also test positive for a related pathogen. Some of these trees have died from symptoms resembling sudden oak death, but intense research has so far failed to find the exact culprit.

Both scientists remain vigilant for signs of death outside the most susceptible tree species. In the Santa Cruz Mountains, Garbelotto has finished his experiment and now looks for discolored redwood branches and blackened sprouts from tree trunks. He searches hard, hoping to find nothing. He would literally give the shirt off his back to know how to stop this disease. **–BEN SHOUSE**

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