Fears mount as oak blight infects redwoods

Jonathan Knight, San Francisco

A disease that is killing oak trees by the thousand in California has been found in the dying needles of the coast redwood (*Sequoia sempervirens*). The redwood is the world's tallest tree and has great symbolic and economic importance for the state.

Tests to determine whether the pathogen infects healthy redwoods, or is merely an opportunist that attacks already ailing trees, are now under way at a University of California nursery near Monterey, and may be completed within weeks.

But even if the fungus-like organism that causes the disease proves to be no great threat to redwoods, it is rapidly becoming one of the most damaging forest pathogens to have emerged in the United States in recent years.

In 1995, large numbers of tanoak (*Lithocarpus densiflorus*) and coast live oak (*Quercus agrifolia*) began dying in counties surrounding San Francisco Bay. The phenomenon was called sudden oak death (SOD) because once the first symptoms had appeared — wilted shoots and a deep red sap oozing from the bark — the entire canopy would turn brown within two or three weeks.

SOD has now spread to many areas within a 300-kilometre swath of coastal forest. In June 2000, David Rizzo, a plant pathologist at the University of California, Davis, found that the likely culprit was a member of the genus *Phytophthora*, to which potato blight also belongs.

Ridge-top infection

Although similar symptoms appear in trees infected with known *Phytophthora* species, the epidemiology was unusual, Rizzo says: "The infected trees were in a weird place for a *Phytophthora*. They were on ridge tops, not near streams."

DNA sequencing in the laboratory of Matteo Garbelotto, a plant pathologist at the University of California, Berkeley, revealed that Rizzo's *Phytophthora* was new to California but had previously been identified in rhododendrons in Germany and the Netherlands. Researchers at the Federal Biological Research Centre for Agriculture and Forestry in Braunschweig, Germany, first described the species, and named it *P. ramorum*.

To show that *P. ramorum* was the killer, Rizzo and Garbelotto experimentally infected oak seedlings at the university's nursery near Monterey, and found the same symptoms. They also inoculated the bark of healthy oak trees in Marin county, north of San Francisco, in an area where SOD was already prevalent. Within weeks, massive 'bleeding' lesions had grown that ultimately girdled the trees.

Unlike Dutch elm disease, SOD does not restrict itself to a single type of tree.

Portrait of a disease: Californian redwoods (top) may be falling victim to the fungus-like pathogen *Phytophthora* (left). Symptoms include brown leaves and oozing red sap.

The California Department of Forestry, researchers and even members of the public have reported that trees other than oaks have the same symptoms as SOD. So far, Rizzo and Garbelotto have confirmed that *P. ramorum* causes disease in 15 different species, including huckleberry, buckeye, madrone and bigleaf maple.

Last autumn, researchers at the University of California, Berkeley, noticed that the stems and needles on several of the redwoods on campus suddenly turned brown. Garbelotto's laboratory isolated *P. ramorum* DNA from the needles using the polymerase chain reaction.

"The shoots are symptomatic," says Garbelotto, "but it's a big jump to say that the tree has the disease." He is now testing *P. ramorum* infectivity in redwood seedlings. So far, he says, every species inoculated has been susceptible.

Damage limitation

Even if redwoods are a host for *P. ramorum*, the infection may not be lethal. SOD usually kills oaks and sometimes rhododendrons, but in other species the infection just causes leaf spots or the death of some shoots without killing the tree.

So far, *P. ramorum* has not done as much damage as some of its close relatives. *P. cinnamomi*, for example, has reduced vast tracts of the Jarrah forest in Western Australia to grassland since it was accidentally introduced in the 1920s. It infects the roots of nearly a thousand different species, and can be lethal in many of these if the soil is soggy,

says Everett Hansen, a forest pathologist at Oregon State University in Corvallis.

But unlike most other forest *Phytophthora* species, *P. ramorum* spreads through the air, rather than through the soil. "It is something we have not had to contend with before in forest pathology," Hansen says.

Garbelotto has found very few genetic differences between different isolates of *P. ramorum* from California, suggesting that it is a recent introduction. So far the only way of stopping the disease is to cut and burn infected trees, but Garbelotto's group is testing a variety of chemicals on laboratory cultures to see if any are effective against the pathogen. ■

► www.suddenoakdeath.org

Off colour: the diseased redwoods' condition resembles sudden oak death, in which the entire canopy can turn brown in a matter of weeks.

J. KNIGHT

FAR LEFT: GARBELOTTO LAB, UC BERKELEY; LEFT: D. RIZZO

J. KNIGHT