TREE NOTES

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

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Port-Orford-cedar Root Disease

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Introduction

Port-Orford-cedar root disease, caused by the pathogen *Phytophthora lateralis*, is a fatal disease of Port-Orford-cedar (POC), *Cupressus (Chamaecyparis) lawsoniana.* The only other known host is Pacific yew *(Taxus brevifolia*), which is much less susceptible, and becomes infected only when growing in close association with infected POC.

Because of the ecological significance, limited distribution, and economic value of POC, the disease has had considerable impact. POC is an important component of riparian areas, providing shade and habitat for fish and other aquatic organisms. Native Americans use POC in ceremonial houses and sweat lodges. Local markets include use for flooring, paneling, and arrow shafts. The export market has been substantial, making it one of the world's most valuable timber species.

History and Distribution

Although the origin of *P. lateralis* is unknown, it is likely introduced to the native range of POC. Non-native, invasive forest pests like *P. lateralis* have profound effects on forest ecosystems and on ecologically significant hosts like POC.

The disease was first reported on POC in ornamental nurseries near Seattle in 1923. The pathogen then spread southward in contaminated ornamental plantings of POC, largely through transport of infected nursery stock. In 1942, the pathogen was described as a previously unidentified species. Attempts to control the disease were futile; the ornamental cedar industry was largely abandoned by the early 1950s.

The disease was first observed in the native range of POC near Coos Bay, Oregon in 1952. Forest road surveys showed increasing levels of infection and spread south on the Siskiyou National Forest. In 1980 the disease was identified in the Smith River drainage in northwestern California. In 1996, *P. lateralis* was reported at two locations in the Klamath River drainage and at one location in the disjunct Sacramento River population of POC. The pathogen is now present throughout much of the range of POC (Fig. 1). Although the disease is now widespread, only about 10% of the acreage within POC's range is infested.

Figure 1. Range of POC and *P. lateralis*

Symptoms and Signs

Figure 2. Dying roadside POC.

Dead and dying POC are most abundant along roads, and along streams and drainages at areas of slow-moving or standing water (Fig.2). Mortality is less common or absent on upland, well-drained microsites.

A sharp line of demarcation between the white color of the live cambium and phloem and the cinnamon to dark brown color of the dead tissue is evident at the

root collar (Fig. 3). The stain can be followed down into the roots, and is diagnostic for *P. lateralis* infection. Infected trees usually undergo a rapid decline as the pathogen girdles the trunk at the soil line. The foliage throughout the crown turns yellow, then bronze, then light brown (Fig. 4). Attack of weakened trees by cedar bark beetles (*Phloeosinus* spp.) commonly occurs.

Figure 3. Discoloration of the inner bark.

Figure 4. Crown symptoms on Port-Orford-cedar trees infected by *P. lateralis*.

Life History

The disease cycle is presented in Fig. 5.

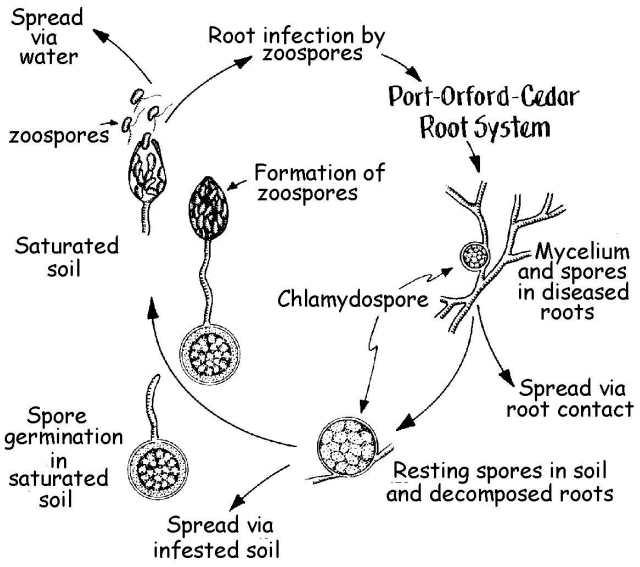

Figure 5. Disease cycle.

Phytophthora lateralis is a soil borne pathogen that infects young, non-suberized roots. Motile zoospores, produced in sporangia (Fig. 6), are chemically attracted to the root tips. Following infection, the pathogen grows through the roots to the root collar, where it girdles and kills the tree. Thick-walled resting spores (chlamydospores) are produced in host roots and soil (Fig. 7). The chlamydospores can survive in soil for a

Figure 6. Sporangium.

Figure 7. Chlamydospore.

number of years. In cool, wet soil, the chlamydospores germinate and produce sporangia.

Sporangia release motile zoospores when soil saturation occurs. Free soil water is necessary for zoospore production and spread.

Disease Spread

Long distance spread of *P. lateralis* between watersheds or drainages occurs through movement of soil infested with the resistant chlamydospores or with infected host tissue. Humans have been the main vectors. Movement of infested soil in construction, road maintenance and use, logging operations, cedar bough cutting, and recreational activities are implicated in spread. Movement on the feet of elk and cattle also occurs.

The motile zoospores swim only a few centimeters, but are easily moved in surface water and free soil water. Zoospore spread is mostly downslope or downstream. Limited tree-to-tree spread may occur through root grafts.

High-risk areas for infection are stream courses, drainages, and low-lying sites downslope from infested areas, or below roads and trails where new inoculum (usually soil containing chlamydospores) is introduced.

Impact

Despite the widespread, but localized, occurrence of the root disease, the existence of POC is not endangered.

Disease Management

Once introduced, no practical means of eliminating the pathogen are available. Management strategies involve prevention and deployment of resistant stock.

Prevention involves limiting the movement of infested soil or water from infested sites to the roots of healthy

trees in uninfested areas. Management strategies include:

1) Road closures: Roads that access pathogen free areas are closed during the rainy season or year round to lessen the risk of introducing the pathogen (Fig. 8).

Figure 8. Gated road with sign.

2) Cleaning of vehicles and equipment before entering or leaving specified areas (Fig. 9).

Figure 9. Washing of vehicle leaving infested site.

3) Restricting stand entry activities (logging, bough cutting, for example) to reduce movement of infested soil.

4) Sanitation: Roads through areas without the disease may be cleared of POC to prevent disease establishment in trees adjacent to the road. This procedure eliminates inoculum available for transport to uninfested areas.

5) Resistance: A small percent of POC appear resistant to the pathogen. An operational resistance-breeding program is identifying POC that are resistant to infection. The currently identified trees are tolerant, but not immune. Resistant seed became available in 2002.

6) Public awareness and education: Informing the public as to why preventive measures are needed is essential to successful disease prevention.

The mix of appropriate strategies for use in a particular situation is determined by risk analysis.

References (Additional Reading)

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